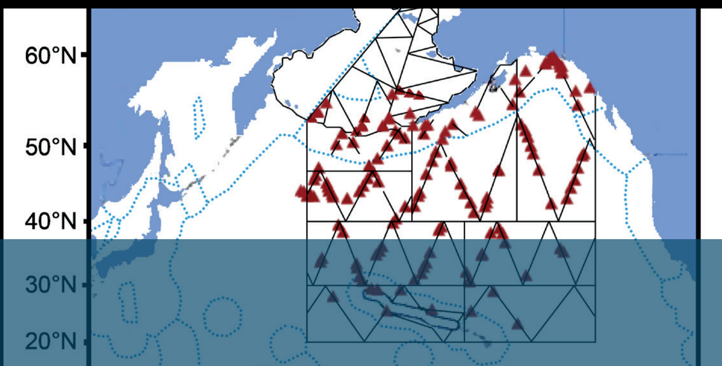
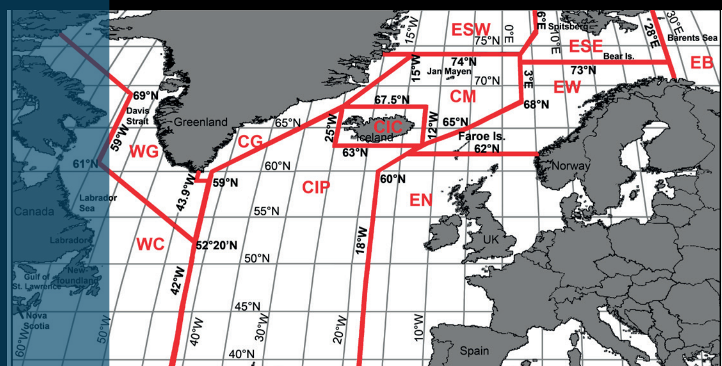
INTERNATIONAL WHALING COMMISSION

75 years of science and stewardship 1946 – 2021





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INTERNATIONAL WHALING COMMISSION
75 years of science and stewardship 1946 – 2021

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The Journal has been established to publish papers on those matters of most importance to the conservation and management of whales, dolphins and porpoises, and in particular papers that are relevant to the tasks of the IWC Scientific Committee

These will include papers on:
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- population biology
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- direct and indirect exploitation
- environmental changes and threats in the context of cetaceans
- scientific aspects of whale watching and sanctuaries

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Editorial

Welcome to this the supplement to the twenty-second volume of the *Journal of Cetacean Research and Management*.

This supplement to the Journal contains the Report of the Scientific Committee from its Annual Meeting held from 11-26 May 2020. SC68B was unlike any previous IWC Scientific Committee meeting as the COVID-19 pandemic forced the cancellation of international travel and in-person gatherings worldwide. For the first time, the Committee needed to progress key items through virtual sessions and email. Consequently, at very short notice, a revised agenda was drawn up to reflect priority issues that could be dealt with virtually. Plenary sessions were replaced with information distributed by email and sub-committee sessions were used to draft work plans and budget proposals for 2021.

To deal with the wide range of time zones occupied by Committee members, virtual sessions were restricted to just two hours (14:30 to 16:30 GMT+1) a day although this narrow window still imposed early morning or late night work schedules on some participants. Up to three concurrent daily sessions were possible during the two-hour time slot providing a total of 39 virtual sessions, a substantial reduction from the usual 110 sessions available during a typical in-person meeting. This decreased availability for meeting time was reflected in a greatly reduced SC68B agenda. However, the virtual nature of the meeting did also provide opportunities, particularly in terms of participation. A record 350 people attended the meeting with 25% attending for the first time.

With no dedicated plenary sessions the report adoption had to be completed online using shared documents and a meeting of the Heads of Delegation. Nevertheless, the full Committee was provided opportunity to comment on all sections of the draft report. As a result of these challenges the report from the SC68B meeting has a different layout from previous years. Summaries of the sub-group discussions and their recommendations have been combined into the main report text rather than the usual annexes.

SC68B was one the first major international meetings of its kind to be forced into a fully virtual format with very limited time for planning. Despite this, the use of online conferencing software and a positive attitude by all involved meant the meeting managed to deal with a significant proportion of its usual agenda, although some of the more controversial and technical discussions had to be postponed. Lessons learnt during the meeting, and from subsequent feedback by participants, have been used to plan further online meetings by the IWC and advise other IGOs.

The COVID-19 pandemic also presented a number of challenges for ongoing scientific research with many fieldwork projects affected. A particular concern were the many long-term monitoring and research programmes that underpin much of the Committee's work. In contrast, changes in human activity provided many benefits for cetaceans such as reduced ship traffic and underwater noise. These benefits were most obviously demonstrated by observations of species in areas they have previously been excluded indicating at their potential resilience. It is hoped that such information, gathered as a result of this unwelcome but essential global shutdown, may provide scientists with insights into how cetaceans might respond to rapid environmental changes in the future.

Iain Staniland
Editor
Cambridge, 17 March 2021

Cover images
Images 1, 4, 6, 7, 9 and 10: Taken from the IWC Photo-ID Catalogue
Image 2: Penelope Tandy, 'Whale of the Week' competition
Image 3: Jude Stringer, 'Whale of the Week' competition
Images 4 and 8: Taken from the Scientific Committee Report

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*Detailed contents for the Scientific Committee Report section (pp.1-122) are given on the next pages.

Report of the Scientific Committee

Virtual Meeting, 11-26 May 2020

Scientific Committee Report Contents

Report of the Scientific Committee 2020

1. INTRODUCTORY ITEMS

The 2020 meeting of the Scientific Committee (henceforth 'Committee') was originally planned for 12-24 May 2020 in Cambridge, UK, to be preceded by a workshop and two pre-meetings. Due to the global coronavirus pandemic (COVID-19), it was announced on 24 March 2020 (IWC.ALL.372) that the in-person meeting would not take place. The Chair (Suydam) and vice-Chair (Zerbini) of the Committee then proceeded to work with the Convenors and the Secretariat to plan a series of 'virtual' meetings to advance the work of the Committee in 2020, to be held during the period 11-24 May 2020.

Convenors were tasked by the Chair to revise their sub-group agendas in order to address only the most pressing issues for 2020 through a combination of e-mail exchanges and virtual meetings. The revised agendas focused on the tasks requested by the Commission at IWC67, including the draft work plans and budgets that would need to be reviewed by the Commission.

1.1 Chair's welcome and opening remarks

In welcoming participants, the Chair explained that the 2020 Scientific Committee meeting (SC68B) was unlike any previous Committee meeting. The COVID-19 pandemic had forced cancellation of the annual in-person meeting and the Ecosystem Functioning Workshop. For the first time, the Committee needed to progress key items through virtual sessions (using Zoom) and/or email. The Committee leadership, including the Chair, vice-Chair and Convenors and the Secretariat created a new process based on careful discussion and preparation to determine the priority topics that could be addressed through a virtual meeting and revised the SC68B meeting agenda to reflect these priorities.

The typical in-person meeting schedule consists of several days of pre-meetings or workshops, followed by two morning Plenary sessions to set the stage for the two-week Committee meeting. Following the two days of initial Plenary sessions, seven days of sub-group meetings and three days of Plenary are usually held to discuss a variety of issues and agree the Committee's report. This year, the organisation of the meeting was altered to accommodate the unusual circumstances (see Table 1).

There were no Plenary sessions at SC68B. The information typically provided at the early Plenary sessions was instead provided via e-mail. Similarly, the Plenary sessions that are usually held at the end of the Committee meeting were replaced by concluding sub-committee sessions to draft report work plans and budget proposals for 2021.

One of the most important challenges for holding virtual sessions was the wide range of time zones occupied by Committee members. The time available each day for virtual sessions was restricted to just two hours (14:30 to 16:30 GMT+1), which were selected to allow all participants the chance to attend the meeting. However, this narrow window imposed hardships on some participants because of early morning or late night work schedules in their time zones. As many as three concurrent sessions during that two-hour time slot were scheduled each day, for a total of 39 possible virtual sessions. That number of sessions was substantially reduced from the about 110 sessions during a typical in-person meeting. This decrease in the amount of time available to meet in 2020 was reflected in a greatly reduced SC68B agenda.

The Committee's leadership established a plan for developing and agreeing the Committee's 2021 budget and report. The agreed report and budget represent the Committee's decisions and recommendations and are particularly important for seeking endorsement from the Commission and informing other parties about the Committee's priorities and progress. Regarding the 2020 Committee report, each sub-group was directed to summarise their discussions and recommendations in a style similar to a Chair's Summary in a normal year. No sub-group annexes were planned for 2020 although more technical or complicated issues were allowed as annexes. The full Committee was provided the opportunity to comment on all sections of the draft report with the exception of the budget. The report was updated based on those comments. The following report represents the agreed discussions and recommendations of the Committee for 2020. The budget largely followed the normal process but instead of being discussed in Plenary at the end of the meeting, it was reviewed and agreed during a virtual session with the Heads of Delegation (HoD).

Table 1

2020 Scientific Committee meeting schedule.

Date(s)	Topic
11 May	Pre-meetings ASI and E. Regular session - SD-DNA.
12-24 May	Meetings of the sub-groups and one session with Heads of Delegation.
24 May	Reports for each agenda item, including recommendations, work plan and budget were agreed by each relevant sub-group.
25 May	Meeting of the Convenors group to discuss and recommend a budget.
26 May	Meeting of the Heads of Delegation to agree the 2021 budget request and discuss other items as necessary.
25 May-~15 June	Chair, vice-Chair, Secretariat and Convenors edit and finalise the Committee's 2020 report.

IWC Executive Secretary (Lent) thanked the Committee Chair and vice-Chair as well as all the Convenors, rapporteurs, funding request assessors and participants for their efforts to advance the work of the Committee in these challenging circumstances. The IWC Secretariat supported these efforts by being present in the virtual meetings to address audio-visual (AV) and information technology (IT) needs as well as to provide technical assistance for the Convenors, rapporteurs and participants. The Executive Secretary introduced Dr Iain Staniland, the new Lead for Science, who joined the Secretariat on 9 May 2020. On this same date, Greg Donovan moved into a new part-time position as Scientist Emeritus, a one-year position that will promote a smooth transition for the Secretariat's support for the Committee, as well as an opportunity to complete legacy projects (see Item 24.3).

The list of meeting participants is given as Annex A. This year there were over 300 participants, and 33 member countries were represented.

Impact of COVID-19 on cetacean research

The COVID-19 pandemic not only affected the scope and format of the 2020 Committee meeting, it also presents a number of challenges for ongoing scientific research. Of particular concern are the obstacles that the virus creates for continuing many of the long-term monitoring programmes and research that underpin much of the Committee's work. For example, in many cases scientists are prohibited from travelling to field locations to collect data, whether for new or long-standing projects.

The global situation with COVID-19 provides unique opportunities to better understand how cetaceans respond to changes in habitat, particularly when those changes are related to human activities. For example, the pandemic has substantially reduced human presence in many areas and may have contributed to, *inter alia*, reductions in vessel traffic, ocean noise, and stress to individual animals. Assessing how cetaceans respond to these dramatic changes may provide a glimpse into how they respond to future rapid environmental transformation.

Attention: C, SC

The Committee **strongly requests** *governments and research organisations to be as flexible and proactive as possible to ensure that, where feasible and safe, vital long-term monitoring projects are able to continue in a form that protects their value to the SC and the wider research community.*

The Committee also **recognises** *that the substantial reduction in human activities in the aquatic environment in response to the COVID-19 pandemic provides unprecedented research opportunities. Therefore, the Committee* **urges** *governments and the research community to increase efforts to evaluate potential changes in cetacean behaviour and habitat use in areas where human presence has been substantially affected by the pandemic.*

1.2 Remembrances

The Committee remembered colleagues who passed away in the previous year.

(1) Sidney Holt (tribute by Justin Cooke)

Dr Sidney Holt passed away in his adopted home of Italy on 22 December 2019. His career in marine science began in 1946 at the fisheries lab in Lowestoft, UK. Among fishery scientists, he is best known for his 1957 volume, with Ray Beverton, *On the Dynamics of Exploited Fish Populations* (Beverton and Holt, 1957), which became a classic in fishery management. Following some severe bouts of sea sickness, he left Lowestoft to work on nature conservation in Scotland, but soon found the ants and midges to be even worse than the sea. By then, his reputation as a gifted fishery scientist had reached the FAO in Rome, which he joined in 1953. Sidney and his wife, Judy, soon fell in love with their new home country, Italy, where they spent most of the rest of their lives. Sidney's work on whales started in 1961, when he was appointed to the Committee of Three Scientists to assess the rapidly worsening status of Antarctic whale stocks. He continued to submit numerous papers to the IWC Scientific Committee over the next 40 years, attending most meetings of the Committee from 1962 to 2000. He was particularly interested in the development of management procedures, including the New Management Procedure (NMP) adopted in 1975 and the Revised Management Procedure (RMP) completed in 1994, and in the designation of sanctuaries, starting with the Indian Ocean Sanctuary established in 1979. Holt will be remembered by colleagues as a persistent, often challenging, debating partner, with an encyclopaedic knowledge of a wide range of topics.

(2) Ed Mitchell (tribute by Randy Reeves)

Dr Ed Mitchell died on 20 October 2019 at his home in Los Angeles County, California. As a palaeontologist, he had a special interest in the evolutionary relationships of marine mammals and most of his early research concerned fossil pinnipeds. His career changed course in the mid-1960s when he relocated to Canada to lead the government's research programme on North Atlantic large whales. Mitchell joined the IWC Scientific Committee in 1968 and remained an active and influential member of the Committee until Canada withdrew from the Commission in the early 1980s. He published numerous papers on various species including bowhead, humpback, fin, Atlantic right, gray, minke, bottlenose and killer whales. Perhaps his most important contribution to the IWC was to organise and chair the first meeting of the Committee's small cetaceans sub-committee which was held in 1974 in Montreal, Canada. He edited the proceedings, published as a special issue of the *Journal of the Fisheries Research Board of Canada* in 1975 (Mitchell, 1975a) – a benchmark for cetacean science and conservation and in many ways a precursor to the classic *Rep. int. Whal. Commn. (RIWC)* Special Issue on gillnets and cetaceans published in 1994 (IWC, 1994a). Also noteworthy was his 1975 book *Porpoise, Dolphin and Small Whale Fisheries of the World: Status and Problems* (Mitchell, 1975b). Mitchell was a formidable, outspoken and sometimes provocative scientist and an expert on the history of whaling.

(3) Seiji Ohsumi (tribute by Hidehiro Kato and Bob Brownell)

Dr Seiji Ohsumi-san passed away on 2 November 2019. He was one of the leading members of the IWC Scientific Committee for over five decades, serving as Japan's Head of Delegation during the 1990s. Ohsumi's graduate research was one of the first studies using whale earplugs, in this case for age determination, of fin whales. He started his career at the Laboratory of Fishery Zoology of the University of Tokyo, and later moved to the Whales Research Institute and the Far Seas Research Laboratory. In addition to his further earplug studies on fin whales (Ohsumi, 1964), his early career work included studies of sei whales in Bonin waters (Nishiwaki *et al.*, 1954) and the school structure of sperm whales (Ohsumi, 1971). The 1966 Committee and Commission meetings were held in Tokyo, and Ohsumi helped to host the 22 scientists who attended that meeting – including Mitchell who was attending his first IWC meeting. Ohsumi was a prolific researcher with over 500 scientific articles and publications on cetaceans. His work was recognised with numerous awards including the Royal Norwegian Order of Merit and Special Award of the Mammal Society of Japan. The last years of Ohsumi's career were spent at the ICR (Institute of Cetacean Research) where he served as a senior advisor. Even after retirement, he continued to go the ICR office each day until his death.

(4) The Committee of Three Scientists

With the passing of Holt in this past year, all members of the 'Special Committee of Three Scientists' ('Committee of Three') have now passed on. The other two members were Doug Chapman (1920-96), who chaired the Committee, and 'Kay' Allen (Kenneth Radway Allen, 1911-2008). These scientists were active in the very tumultuous period of the IWC in the early 1960s. Members of the Committee who lived through the period can attest to the critically important contribution the Committee of Three brought to the Commission during its most contentious times. The final report of the Committee of Three was completed in 1963 and included in the Report of the 14th Meeting of the International Whaling Commission (IWC, 1963, Appendix V). With the addition of John Gulland (1926-90), the Committee became the Committee of Four, but was sometimes still referred to as the Committee of Three, and produced a further report in 1964, published in the Report of the 15th Meeting of the International Whaling Commission (IWC, 1965). The Committee's reports were instrumental in achieving recognition of the severe over-exploitation of Antarctic baleen whales at the time and helped to ensure that sufficient residual populations of species such as blue and humpback whales remained to seed their subsequent recovery. Whilst in subsequent years the views of the former members of the Committee of Three/Four began to diverge on the best approach to meeting the Convention's mandate, they continued to bring the highest-quality science and their own unique perspectives to inform discussions within IWC.

1.3 Appointment of rapporteurs

Several members of the Secretariat, led by Staniland, were appointed rapporteurs and were assisted by various members of the Committee as appropriate. Chairs of sub-committees and Working Groups appointed rapporteurs for their meetings (see Item 1.5).

1.4 Meeting procedures and time schedule

SC/68B/GEN/03 provided a guide to participants, particularly for those attending for the first time, which outlined the organisation of the Committee. The Chair and vice-Chair provided information to Committee participants about the proposed process for SC68B (SC/68B/GEN/05). A schedule of virtual sessions was established in advance of the meeting and regularly updated on the IWC's web portal. A Zoom instruction video was prepared for Committee participants and posted on the IWC's web portal in advance of the meeting.

1.5 Establishment of sub-committees and Working Groups

The table on the next page contains the various sub-committees and Working Groups of the Committee, the relevant Convenor, Co-Convenor, and rapporteur(s). The Committee is grateful for the commitment by these individuals, without which the Committee could not complete its work.

Two pre-meetings were held on 11 May:

(1) Underwater Noise – discussed by the sub-committees on Environmental Concerns (E) and Human-Induced Mortality (HIM); and
(2) Approach to Provide Advice on Status of Stocks – discussed by the Standing Working Group on Abundance Estimates, Stock Status and International Cruises (ASI).

Committee sub-groups and Convenors/rapporteurs for 2020.

Sub-committees/Working Group name	Convenor	Co-Convenor	Rapporteur
Scientific Committee Plenary	Robert Suydam	Alex Zerbini	IWC Secretariat
Ad hoc Working group on Photo-ID, PH	Paula Olson	-	No rapporteur
Standing Working Group on Abundance Estimates, Stock Status and International Cruises, ASI	Alex Zerbini	Geof Givens	Thomas Doniol-Valcroze
Ad hoc Working Group on Sanctuaries, SAN	Chris Parsons	-	No rapporteur
Sub-committee on *Implementation Reviews* and Simulation Trials, IST	Greg Donovan	John Brandon	Andre Punt Dave Weller Greg Donovan
Sub-committee on Aboriginal Subsistence Whaling, ASW	Lars Walløe	-	Dave Weller
Working Group on Stock Definition and DNA Testing, SD&DNA	Aimee Lang	Ralph Tiedemann	Frank Cipriano
Sub-Committee on In-depth Assessments, IA	Debbie Palka	Helena Herr	Justin Cooke Philip Clapman
Sub-Committee on the Other Northern Hemisphere Whale Stocks, NH	Jooke Robbins	-	Kim Goetz
Sub-Committee on the Other Southern Hemisphere Whale Stocks, SH	Jen Jackson	Elanor Bell	Elisa Seyboth Eric Archer Ana Širović
Sub-Committee on Conservation Management Plans, CMP	Bob Brownell	Jorge Urban-Rámirez	Sarah Mallette Dave Weller
Sub-Committee on Non-deliberate Human-Induced Mortality of Cetaceans, HIM	Russell Leaper	Rohan Currey	Marguerite Tarzia David Mattila Danielle Buss
Sub-Committee on Environmental Concerns, E	Patricia Holm	Danielle Cholewiak	Tilen Genov
Standing Working Group on Ecosystem Modelling, EM	Toshihide Kitakado	-	Doug Butterworth
Sub-Committee on Small Cetaceans, SM	Lindsay Porter	Fernando Trujillo	Randy Reeves Maria Clara Jimenez Frank Cipriano Peter Thomas
Sub-Committee on Whale Watching, WW	Leslie New	-	Naomi Rose

The results of these pre-meetings were included under the relevant Agenda Items.

The following sub-groups met virtually this year during the period 11-24 May 2020. Their reports have been subsumed under the relevant agenda items in the report below after review by the Committee. Sub-groups with an asterix (*) did not meet virtually but addressed agenda items and agreed their sub-group reports via e-mail.

Ad hoc Working Group on Photo-ID, PH*

Standing Working Group on Abundance Estimates, Stock Status and International Cruises, ASI

Ad hoc Working Group on Sanctuaries, SAN*

Ad hoc Working Group on Databases and Related Issues, GDR*

Sub-committee on Implementation Simulation Trials, IST

Sub-committee on Aboriginal Subsistence Whaling, ASW*

Working Group on Stock Definition and DNA Testing, SDDNA

Sub-Committee on In-depth Assessments, IA

Sub-Committee on the Other Northern Hemisphere Whale Stocks, NH

Sub-Committee on the Other Southern Hemisphere Whale Stocks, SH

Sub-Committee on Conservation Management Plans, CMP

Sub-Committee on Non-deliberate Human-Induced Mortality of Cetaceans, HIM

Sub-Committee on Environmental Concerns, E

Standing Working Group on Ecosystem Modelling, EM

Sub-Committee on Small Cetaceans, SM

Sub-Committee on Whale Watching, WW

The following intersessional Workshop reports were presented to the meeting. The reports of these Workshops are published in this volume of the *Supplement*.

Reports of intersessional meetings and their published locations in this volume.

SC/68B/REP/01	Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG), January 2020, Tokyo, Japan	This volume, pp.231-258
SC/68B/REP/02	Report of the Planning Meeting for the 2020 IWC-POWER Cruise, January 2020, Tokyo, Japan	This volume, pp.259-272
SC/68B/REP/03	Report of the IWC Workshop on Marine Debris: The Way Forward, 3-5 December 2019, la Garriga, Catalonia, Spain	This volume, pp.273-310
SC/68B/REP/04rev1	South Asian River Dolphin Task Team Workshop Report, Kuala Lumpur, 19-21 July 2019, University of Nottingham, Kuala Lumpur, Malaysia	This volume, pp.311-332
SC/68B/REP/05	*Sotalia guianensis* Pre-assessment Workshop, 26-28 November 2019, São Paulo, Brazil	This volume, pp.333-378
SC/68B/REP/06	Report of the Workshop on Advancing Efforts to Address Underwater Noise from Shipping, 11 May 2020, Virtual Meeting	This volume, pp.379-386

2. ADOPTION OF AGENDA

The adopted Agenda is given as Annex B.

3. REVIEW OF AVAILABLE DATA, DOCUMENTS AND REPORTS

3.1 Documents submitted

The documents submitted to the meeting are listed in Annex C. All papers were only available at the meeting in electronic format. A total of 185 primary papers and 6 intersessional meeting reports were available.

3.2 National Progress Reports on research

All member nations are urged by the Commission to provide Progress Reports to the Scientific Committee. The National Progress Reports have their origin in Article VIII paragraph 3 of the Convention and Scientific Committee Rule of Procedure E.1.

As agreed at the 2012 Annual Meeting, National Scientific Progress Reports were submitted electronically through the IWC Progress Reports Data Portal. The Secretariat noted that revisions were made to the on-line submission process in order to facilitate the submission of data, including enhanced instructions. Countries were reminded on 17 March 2020 (IWC.ALL.371) of the critical importance of providing the National Progress Reports as well as any data relevant to the work of the Commission. The Secretariat reported that it had received 17 National Progress Reports so far this year (Australia, Brazil, Croatia, Denmark, France, Germany, Italy, Japan, Korea Rep. of, Mexico, Netherlands, New Zealand, Panama, South Africa, Spain, UK and USA), which is an increase from the 13 received in 2019. The Secretariat is investigating ways of making the data entry easier, including the possibility of bulk upload, and welcomes any feedback from countries who submitted data this year.

3.3 Data collection, storage and manipulation

3.3.1 Catch data and other statistical material

Table 2 lists data received by the Secretariat since the 2019 meeting. Details of large whale catches from the 2019 season are listed in document SC/68B/O/08. There were no catches in Icelandic waters in 2019.

Allison reported that she had been in contact with people working on conservation in Indonesia who have supplied unofficial information about catches of sperm whales and small cetaceans. This information is being added to the summary catch database.

3.3.2 Progress of data coding projects and computing tasks

Allison reported that the new version of the catch database had been delayed but is now almost ready and will be released in mid-2020. The previous version of the database is available on request. The abundance master tables have been fully checked and now include all abundance estimates agreed by the Committee over the past five years. The IWC website has been updated with summaries of these revised master tables. Additional estimates have been added from earlier years, although their status needs to be confirmed.

Programming work has concentrated on fully specifying details of the North Pacific common minke whale trials and updating the corresponding control program and data files. In addition, in collaboration with Punt, the North Atlantic common minke whale control program has been updated to incorporate both Greenland *SLA*s and to output the details required to classify population status.

Table 2
List of data and programs received by the IWC Secretariat since the 2019 meeting.

Date received	From	IWC reference	Details
Catch data from the 2019 season			
06/04/2020	Japan: S. Suzuki	E139 Cat2019	Individual data for Japan's catch in 2019 in the North Pacific (NEWREP-NP and commercial).
19/04/2020	USA: R. Suydam	E139 Cat2019	Individual records from USA Alaska aboriginal bowhead hunt 2019.
26/05/2020	USA: R. Suydam and Alaska Beluga Whale Committee	E139	Summary of white whale catches in Alaska, 2010-19.
22/04/2020	Norway: N. Øien	E139 Cat2019	Individual minke records from the Norwegian 2019 commercial catch. Access restricted (specified 14/11/00).
08/05/2020	Russia: D. Litovka	E139 Cat2019	Individual data from Russia aboriginal hunt of gray and bowhead whales, 2019.
04/05/2019	Canada: M. Sweeting-Woods	E139 Cat2019	Details of the Canadian bowhead harvest for the 2015-19 seasons and some information on the 2020 quota.
Catch data from earlier seasons			
18/04/2020	N. Setiasih	E139	An unofficial summary of sperm whale catches in Indonesia 2003-13.
18/04/2020	P.L. Mustika	E139	Unofficial information on catches in Indonesia including a summary of sperm whale catches 1959-2004 and small cetacean catches 1996-2004.
Sightings data			
17/03/2020	Japan: K. Matsuoka	E138	2019 POWER sightings cruise data (including videos and copies of sheets).
14/05/2020	Japan: K. Matsuoka	E140	Data from the 2019 Japanese dedicated sighting surveys including JASS-A (weather, effort, sighting and distance and angle experiment records).

4. COOPERATION WITH OTHER ORGANISATIONS

4.1 Secretariat update on engagement with other organisations
The Secretariat prepared document SC/68B/O/12 which provides detailed information on the Secretariat's activities in collaboration with other organisations. A brief overview based on that document is provided as Items 4.2-4.10 below.

4.2 African States Bordering the Atlantic Ocean (ATLAFCO/COMHAFAT)
The Secretariat has been collaborating with the Executive Secretary of ATLAFCO/COMHAFAT on matters relating to active outreach on the review process for the Working Group on Operational Effectiveness (WG-OE). A planned outreach event to cover WG-OE as well as general information for IWC members from Africa was cancelled due to the pandemic. However, the Secretariat provided written documentation (in English and French) encouraging ATLAFCO/COMHAFAT members to increase their engagement with the IWC, including providing data, National Progress Reports, participation in meetings and taking on leadership roles in the IWC.

4.3 Arctic Council
No report was received under this Item.

4.4 Convention on Biological Diversity (CBD)
As a member of the Liaison Group of Biodiversity-related Conventions (BLG), the IWC has been engaged in the development of the post 2020 framework for biodiversity and associated targets and indicators[1]. Several IWC Circulars (IWC.CCG.1353, IWC.CCG.1361 and IWC.CCG.1338) have highlighted this activity and the opportunities for the IWC to be engaged either through the Secretariat or through national efforts. The IWC Chair and Secretariat participated in a number of events related to the post-2020 process. The Commission was represented by the Committee vice-Chair (Zerbini) at a marine-themed meeting in November 2019 at CBD headquarters in Montreal, Canada. Engagement through the Secretariat, IWC and Committee leadership, as well as through member governments, helps ensure that elements for the future framework take into account the relevant science and stewardship mandate of the Commission.

4.5 Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR)
A University of Cambridge graduate student has prepared a thesis focused on scientific collaboration between the IWC and CCAMLR. The recommendations from this research have been used to develop a joint work plan with input from scientists at the British Antarctic Survey. This work plan includes: improved communication, possibly through the development of a Memorandum of Understanding (MoU); formalising the process for designating observers for other intergovernmental organisations (IGOs); and arranging side events at the respective scientific meetings. A paper addressing this work plan will be submitted to the IWC meeting in 2021.

[1]*https://www.cbd.int/sp/default.shtml.*

4.6 Convention on the Conservation of Migratory Species (CMS)

The Secretariat has continued ongoing co-operation with the CMS and its daughter agreements, ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas) and ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area) on a wide range of common challenges, including bycatch, strandings, CMPs, ship strikes, ecosystem functioning and whale watching. The CMS was engaged in the preparations for the pre-SC68B Workshop on Ecosystem Functioning (now postponed until after SC68B). IWC Executive Secretary (Lent) participated in the CMS COP13 in Gandhinagar, India, 17-22 February 2020. The CMS COP13 addressed a number of issues relevant to the IWC's Scientific and Conservation Committee work, including bycatch, whale watching, important marine mammal areas, marine noise, and aquatic wild meat. Outcomes and decisions at this CMS COP13 can be found on the CMS website[2].

In June 2019 the IWC Strandings Coordinator attended the joint ACCOBAMS and ASCOBANS Workshop on harmonisation of the best practices for necropsy of cetaceans and for the development of diagnostic frameworks. The IWC Bycatch Coordinator is a member of the joint ASCOBANS/ACCOBAMS working group on bycatch. The joint working group is planning to hold its first face to face meeting in October 2020, although this may be delayed.

The Scientific Committee of ACCOBAMS met 26-28 February 2020 in Cap d'Ail, France. Their papers and reports can be found on the ACCOBAMS website[3]. There are considerable synergies with the work of the IWC Scientific Committee and this excellent collaboration with ACCOBAMS was welcomed and encouraged, in particular on the issue of abundance estimation, ship strikes, bycatch, whale watching and the completion of the whale watching handbook developed in conjunction with CMS, the harmonisation of best practices for cetacean necropsy and tissue sampling and marine debris. The IWC is also collaborating with ACCOBAMS on a joint CMP for Mediterranean fin whales.

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

The Secretariat continues to engage with CITES on several issues including the development of a procedure for transboundary transport of diagnostic specimens for cetacean disease investigations in emergency situations. Two related Resolutions exist on: (1) a simplified procedure (SP) for shipping of samples in cases of emergency; and (2) scientific exchange exemptions (SEE). Both the SP and the SEE are available for national CITES management authorities but are so far underutilised procedures. The CITES secretariat is currently drafting guidance which will be presented to the Standing Committee of CITES in October.

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

The IWC continues to strengthen collaboration with the regional and global bodies that address fishery management and in particular, the challenge of cetacean bycatch. The IWC's Bycatch Coordinator participated in an expert Workshop to develop draft FAO Technical Guidelines for reducing bycatch of marine mammals in fisheries (September 2019). Opportunities for further collaboration with the FAO are currently being explored on outreach, capacity building and technical input associated with the Technical Guidelines. IWC representation is planned for the next meetings of the FAO and the Regional Secretariat's Network (dates to be confirmed). The Secretariat plans to intervene in support of the work planned under the new Responsible Fishing Operations Umbrella Programme and on the Technical Guidelines and their implementation, and to promote IWC/FAO collaboration. The draft guidelines can be found on the FAO website[4] and the final version (release date to be confirmed) will serve as an important reference for national and regional fishery management organisations. The IWC has also engaged with staff in the FAO and Regional Fisheries Management Organisations (RFMO) Secretariats involved in the Common Oceans ABNJ Project, in relation to possible IWC involvement in a Phase 2 project relating to improving sustainability of global tuna fisheries.

4.9 Regional fisheries management organisations (RFMOs)

The Secretariat commissioned a review by a US NOAA Knauss Sea Grant Fellow on the activities and management actions of different RFMOs to assist the Bycatch Mitigation Initiative in prioritising which organisations to engage with. Paper SC/68B/HIM/05 was presented at SC68B for consideration and provides important background information and relevant recommendations for the IWC in raising awareness of cetacean bycatch in RFMOs.

The Executive Secretary joined the Bycatch Coordinator at the 1st Joint Tuna RFMO Bycatch Working Group meeting, in December 2019. While the event was focused on bycatch of elasmobranchs in tuna fisheries, the Secretariat organised an IWC side event, in collaboration with other partners, as an opportunity for an overview of the Bycatch Mitigation Initiative and noted IWC's interest in collaborative work to ensure sustainable fisheries.

Indian Ocean Tuna Commission (IOTC) - The Bycatch Coordinator participated remotely in the IOTC Working Party on Ecosystems and Bycatch (WPEB) to present the Report of the IWC Workshop on Bycatch Mitigation Opportunities in the Western Indian Ocean and Arabian Sea. The IOTC WPEB noted that bycatch associated with set and drifting gillnet fishing

[2]*https://www.cms.int/sites/default/files/document/cms_cop13_doc.6.2_rev.1_annotated-agenda_e_0.pdf.*

[3]*https://accobams.org/meetings/thirteenth-meeting-of-the-scientific-committee.*

[4]*http://www.fao.org/3/ca7620en/ca7620en.pdf.*

gear comprises one of the greatest threats to cetaceans in the Western Indian Ocean. It also noted that the IWC Workshop represented the beginning of a process to work collaboratively to better understand and address bycatch of cetaceans in the Western Indian Ocean. The WPEB encouraged active collaboration and data sharing between the IWC, IOTC and other stakeholders to achieve this goal.

International Commission for the Conservation of Atlantic Tunas (ICCAT) - The Bycatch Coordinator has been engaging with ICCAT's Bycatch Coordinator to discuss possible synergies and collaboration.

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

The Secretariat is working with counterparts in SPAW to explore a possible MoU to facilitate collaboration in areas of common interest in cetacean science and stewardship, particularly in small-scale coastal fisheries. A draft MoU will be shared with the IWC Bureau at their 25 May 2020 meeting to obtain guidance on whether this MoU, or a modification thereof, should be presented to the Commission at IWC/68.

Committee members' update on engagement with other organisations

The Secretariat prepared a document (SC/68B/O/07Rev1) which provides the reports of observers representing the Committee at various meetings of other IGOs. Committee observers are named in brackets following each IGO name.

4.11 International Union for the Conservation of Nature (IUCN) (Cooke)

There is a long-standing collaboration between IUCN and the IWC on matters of mutual interest. In recent years these have focussed on the Western Gray Whale Advisory Committee (WGWAP) and the newly formed IUCN Marine Mammal Protected Areas Task Force (MMPATF). The WGWAP progress report to the Scientific Committee is given as SC/68B/CMP/06. The most recent meeting was that of the Noise Task Force, held as a virtual meeting from 7-9 April 2020, focussing on key agenda items related to advice regarding seismic surveys and other noise-related issues off Sakhalin Island, Russian Federation. The report will be available on the WGWAP website[5] in June 2020.

The main objective of the MMPATF is to facilitate mechanisms by which the marine mammal protected areas 'community of practice' can collaborate, share information and experience, access and disseminate knowledge and develop tools for establishing, monitoring, and managing MMPAs to promote effective spatial solutions and best practices for marine mammal conservation. The IWC has provided input to this process and is working with the Task Force to find new ways to identify Important Marine Mammal Areas (IMMAs) on the high seas, through the use of historical, remote and proxy data. The WWF, with input from IWC and the MMPATF, have expanded the analyses of shipping and IMMAs to all currently identified IMMAs and are presenting preliminary results at SC68B (SC/68B/HIM/03).

The IUCN Marine Mammal Protected Areas Task Force held its 4th regional Workshop in Salalah, Oman, in March 2019 to select candidate Important Marine Mammal Areas (IMMAs) for the Western Indian Ocean and Arabian Seas. The 55 candidate IMMAs proposed by the Workshop are currently undergoing independent review. More details are given under Item 20.2.1.

A Joint IWC-IUCN-ACCOBAMS Workshop was held in Messinia, Greece in April 2019 to evaluate how the data and process used to identify IMMAs can assist the IWC to identify areas of high risk for ship strikes. More information is given in SC/68A/HIM/07.

The IUCN Red List web site (*redlist.org*) has been redesigned and restructured. Since the last Committee meeting, new or updated Red List assessments have been published for a further 40 cetacean taxa, in addition to the 29 cetacean taxa that were assessed in the 2017/18 intersessional period. Reassessments for *Kogia* spp., Indo-Pacific bottlenose dolphin, harbor porpoise, Atlantic white-sided dolphin and Longman's beaked whale are nearing completion. Remaining high priorities for re-assessment include Hector's dolphin, tucuxi, sperm whales and the Arabian Sea subpopulation of humpback whales.

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. A new Cumulative Effects Task Force had its first meeting in April 2019.

News items on activities by members of the IUCN Species Survival Commission (SSC) Cetacean Specialist Group (CSG) are posted on the CSG website, *iucn-csg.org*. In particular, there are regular updates of the vaquita situation: the species still survives but hopes for averting its extinction are fading fast.

4.12 Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) (Simmonds)

Several ASCOBANS events took place in 2019 including a joint meeting with ACCOBAMS focused on harmonisation of cetacean necropsy protocols and diagnostic frameworks. In addition, there was the inaugural meeting of the Common Dolphin Group addressing coordination of the Species Action Plan, the 8th meeting of the North Sea Group focused on

[5] *https://www.iucn.org/western-gray-whale-advisory-panel.*

harbour porpoises, and the 25th meeting of the Advisory Committee, which touched on cetacean watching, pollution, ship strikes and climate change, among other topics. A full report is available on the ASCOBANS website[6].

4.13 International Council for the Exploration of the Sea (ICES) (Haug)

The ICES Working Group on Marine Mammal Ecology (WGMME) met at the Institute for Terrestrial and Aquatic Wildlife Research, University of Veterinary Medicine Hannover, Foundation, in Büsum, Germany, 11-14 February 2019. Topics featured included new information on seal and cetacean population abundance and stock structure, management frameworks and anthropogenic threats. The ecological roles of marine mammals were also reviewed, which underscored the complexity and multitude of ecological interactions. Bycatch was also a topic including the challenge of obtaining data from various sources, and the importance of using appropriate bycatch figures for management.

The ICES Working Group on Bycatch of Protected Species (WGBYC) met in Faro, Portugal, 5-8 March 2019. There was extensive discussion of data collection on bycatch and appropriate methods for estimating total bycatch. In addition, compliance with pinger requirements was reviewed with the finding that only one member country is in full compliance.

The 2019 ICES Annual Science Conference (ASC) was held in Gothenburg, Sweden, 9-12 September 2019. The conference included sessions in which marine mammals were included as an integral part. More information is available on the ICES website[7].

4.14 International Maritime Organisation (IMO) (Leaper)

The Secretariat and members of the Committee have continued to work with IMO particularly on underwater noise and ship strikes. Leaper and a member of the Secretariat attended an IMO policy workshop addressing the means for quieting ships, in support of the development of a proposal on underwater noise. Regarding ship strikes, there were no routing proposals specifically related to cetaceans at the meeting of the IMO sub-committee that addresses these issues. The IMO Secretariat also joined Leaper (the Convenor of the IWC's Scientific Committee's HIM sub-committee) in a meeting in London with a high-level representative from Sri Lanka, for discussion of the challenge of blue whale ship strikes in high-risk areas identified by the work of IWC.

4.15 North Atlantic Marine Mammal Commission (NAMMCO) (Haug)

The 26th anniversary meeting of the NAMMCO Scientific Committee (SC) was held 29 October-1 November 2019 in Torshavn, Faroe Islands. A discussion on procedures for generating management advice concluded that both a management procedure approach (e.g. RMP, AWMP and *SLA*s) or stock assessment calculations (HITTER FITTER methods and Bayesian assessment) can be used for all species under NAMMCO's purview. However, stock assessment models appear to have some advantage over the management procedure approach as they can be tailored to stocks and species with less use of time and resources. Therefore, the NAMMCO SC recommends the continued use of stock assessment approaches using population dynamics models as appropriate for generating advice on sustainable harvest levels. The next meeting of the NAMMCO Bycatch Working Group will be in spring 2021.

4.16 North Pacific Marine Science Organisation (PICES) (Tamura)

The PICES 2019 meeting was held in Victoria, BC, Canada, 16-27 October 2019. A future five-year project will focus on interactions between marine birds and mammals (MBMs) and other ecosystem components and stressors, touching on forecasting changes in forage species and the response of top predators. The study will also review marine birds and mammals as ecological indicators and predictors of changing marine ecosystems.

5. GENERAL ASSESSMENT AND MODELLING ISSUES (IST)

Several assessment topics apply to the work of the Committee as whole. This item focuses on general assessment issues, including: (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 $MSYR_{mat}$

There were no papers submitted on this topic this year. It was agreed that next year the topic would be included under the work on Ecosystem Modelling. Should issues relevant to simulation testing under RMP/AWMP arise out of those discussions they would be considered by the sub-committee on *Implementation Simulation Trials* at the relevant meeting.

5.2 Implications of ISTs for consideration of species' and populations' status

This matter is dealt with under Item 11.4.

[6]*https://www.ascobans.org/en/meeting/ac25.*

[7]*http://www.ices.dk/news-and-events/asc/asc2019/Pages/default.aspx.*

Table 3

Work plan for general assessment and modelling issues.

Topic	2020 Annual Meeting (SC68B)	2021 Annual Meeting (SC68C)
Work to evaluate the energetics-based model and hence the relationship between $MSYR_{1+}$ and $MSYR_{mat}$	No papers presented this year	Will be considered in EM
Use of ISTs for consideration of status: Modify control programs to report the three measures of status.	Completed - see ASI discussion under Item 11.4	Will be considered under ASI

5.3 Progress on previous recommendations and on the work plan

Table 3 summarises progress with previous recommendations and the work plan for 2021. No new issues were raised for consideration next year, but the situation will be reviewed intersessionally.

6. AWMP *IMPLEMENTATION*-RELATED MATTERS (IST)

6.1 Common minke whales off Greenland

Last year, the Committee received a paper that tested the *Strike Limit Algorithm* (*SLA)* agreed for common minke whales off West Greenland for trials relevant to the East Greenland hunt (SC/68A/IST/04). Based upon this work, the Committee agreed that the *WG common minke SLA* tested for East Greenland minke whales performed satisfactorily in terms of the Commission's conservation and need objectives for the *Evaluation Trials* and therefore that this '*G-Common minke SLA*' is appropriate to provide management advice to the Commission on both the West and East Greenland common minke whale hunts, subject to final consideration of the results of the *Robustness Trials* at this year's meeting. To enable this, the Committee agreed that a single simulation testing framework for the North Atlantic common minke whales should be developed and a synthesis paper be provided that includes results for all *Evaluation Trials* (i.e. trials used to choose an *SLA* and evaluate its performance) and *Robustness Trials* as well as the evaluation of carryover and interim allowance for the East and West Greenland common minke whales.

6.1.1 Synthesis paper on testing framework and results for the 'G-common minke SLA' for common minke whales off west and east Greenland

SC/68B/IST/06 provided the final trial specifications for the North Atlantic common minke whales tailored to evaluate *Strike Limit Algorithms* (*SLA*s) for aboriginal subsistence whaling hunts off West and East Greenland. These were implemented and used to test the *G-Common minke SLA* based on the agreed *Evaluation* and *Robustness Trials*. Previous evaluations of carryover provisions and the interim allowance approach (IWC, 2019d) were extended to make use of the new trials and to account for both hunts.

The technical descriptions can be found in SC/68B/IST/06. The final set of trials is provided as Table 4 and conditioning was performed satisfactorily (selected diagnostic statistics are available in the paper and the full set from the Secretariat). The code for the '*G-Common minke SLA*' has been lodged with the Secretariat and the Secretariat has checked that the code gives the same results as the executable version used previous for testing purposes.

Although all trials were run and the results are available from the Secretariat, attention was on the most informative performance statistics related to conservation performance (D) and need satisfaction (N):

(a) D1: Final depletion (population size at the end of the 100-years; 1+ population component);
(b) D10: Relative increase (population size at the end of the 100-years relative to that at the start of the projection period; 1+ population component);
(c) N9: Average need satisfaction over 20 years (N9-20);
(d) N9: Average need satisfaction over 100 years (N9-100); and
(e) N12: Mean down step.

The focus in the paper was on the most challenging trials where $MSYR_{1+}$=1% (all trials with $MSYR_{mat}$=4% performed adequately). The authors noted that the results for the Evaluation Trials matched those previously reviewed and agreed by the Committee to perform adequately to meet the Commission's conservation and need objectives[8]. They also noted that performance was adequate for the *Robustness Trials* (i.e. trials used to ensure that an SLA behaves predictably in more extreme trials).

[8]In only one *Evaluation Trial* (M04-1, a trial with MSYR1+=1% and the 'A3' mixing hypothesis) was median D1 less than 0.6 (0.592) and median D10 less than 1.0 (0.890) (SC/68B/IST/06, table 5). For 1% *Evaluation Trials* M01-1 and M11-1, with stock hypothesis 1 (five stocks, including W-1 and W-2 stocks), the lower 5th percentile of the D1 statistic was less than 0.6 (0.574 and 0.576) and the lower 5% percentile of the D10 statistic was less than 1.0 (0.857 and 0.851).

Table 4
The final set of trials (for a full explanation see the Trials specifications, Annex D).

Trial	*MSYR*	Stock hypothesis	Mixing proportions	Mixing	Survey bias	Survey period	Survey CV	Condition
Evaluation Trials								
M01	1% (1+) and 4 % (mat)	1	A1	Independent	1	10	Base	Yes
M02	1% (1+) and 4 % (mat)	2	B1	Independent	1	10	Base	Yes
M04	1% (1+) and 4 % (mat)	1	A3	Independent	1	10	Base	Yes
M06	1% (1+) and 4 % (mat)	1	A5	Independent	1	10	Base	Yes
M08	1% (1+) and 4 % (mat)	2	B2	Independent	1	10	Base	Yes
M09	1% (1+) and 4 % (mat)	2	B3	Independent	1	10	Base	Yes
M11	1% (1+) and 4 % (mat)	1	A1	Density-dependent	1	10	Base	Yes
M12	1% (1+) and 4 % (mat)	2	B1	Density-dependent	1	10	Base	Yes
Robustness Trials								
M03	1% (1+) and 4 % (mat)	1	A2	Independent	1	10	Base	Yes
M05	1% (1+) and 4 % (mat)	1	A4	Independent	1	10	Base	Yes
M07	1% (1+) and 4 % (mat)	1	A6	Independent	1	10	Base	Yes
M21	1% (1+) and 4 % (mat)	1	A1	Independent	0.8	10	Base	Yes
M22	1% (1+) and 4 % (mat)	2	B1	Independent	0.8	10	Base	Yes
M23	1% (1+) and 4 % (mat)	1	A1	Independent	1.2	10	Base	Yes
M24	1% (1+) and 4 % (mat)	2	B1	Independent	1.2	10	Base	Yes
M25	1% (1+) and 4 % (mat)	1	A1	Independent	1	15	Base	
M26	1% (1+) and 4 % (mat)	2	B1	Independent	1	15	Base	
M27	1% (1+) and 4 % (mat)	1	A1	Independent	1	10	Base + 0.05	
M28	1% (1+) and 4 % (mat)	2	B1	Independent	1	10	Base + 0.05	
M29	1% (1+) and 4 % (mat)	1	A1	Independent	1	10	Base - 0.05	
M30	1% (1+) and 4 % (mat)	2	B1	Independent	1	10	Base - 0.05	
M31	4% (1+)	1	A1	Independent	1	10	Base	Yes
M32	4% (1+)	2	B1	Independent	1	10	Base	Yes

Carryover

SC/68B/IST/06 also examined the request from the US Acting Commissioner and the Danish Commissioner to examine a period of accumulation (three blocks), a time until expiration (greater than three blocks), and a limit on usage (total strikes not exceeding 150% of the annual strike limit). An approach to examine this for bowhead whales from the Bering-Chukchi-Beaufort Seas, and bowhead and humpback whales off West Greenland has been developed and agreed (IWC, 2019d). The same approach was used and detailed in SC/68B/IST/06 for the Greenland common minke whale hunts.

None of the lower 5th percentiles for final depletion (D1) for the carryover scenarios exceed those for the scenario with no carryover and the authors note that this confirms previous conclusions by the Committee that carryover provisions are unlikely to lead to poorer conservation performance.

Interim Allowance

Finally, SC/68B/IST/06 also examined the agreed interim allowance approach for the Greenland hunts, i.e. a provision that strike limits are reduced by 50% during a grace period if a recent abundance estimate has not been available for 10 years (IWC, 2019e). Once again, the paper used the same approach used to evaluate the interim allowance approach for Bering-Chukchi-Beaufort Seas bowhead whales. There is no conservation impact of adopting an interim allowance approach if the survey interval is 10 years. The conservation performance statistics for a 15-year survey interval are lower for the interim allowance approach but only for trial M04-1, the D1 statistic is lower than for the 10-year survey period. In contrast to the 10- and 15-year survey periods, a 20-year survey period leads to several instances in which conservation performance statistics are poorer than was the case for a 10-year survey interval.

The paper had been circulated with a request for comments by early May. In response to a question concerning the D10 and N9 statistics for some trials, it was clarified that the results were consistent with those already approved by the Committee. The only other comments received were in accord with the conclusions of the paper (and last year's meeting) with respect to the acceptable performance of the *G-common minke SLA*, the carryover provisions and the Interim Allowance Approach.

In discussion, it was noted the selection of *SLA*s for the West and East Greenland hunts was based on *Evaluation Trials* (see Table 4). In addition, the sub-committee noted that there would be value in examining why need satisfaction was worse for trials M11 and M12 than for the remaining *Evaluation Trials*, and that the results for the interim allocation approach calculations re-emphasised the value of the provision to conduct an early *Implementation Review* if survey estimates of abundance are not available at the anticipated frequency.

6.1.2 Conclusions

The Committee **thanks** Punt, Allison and Witting for their work. The full trial specifications are given as Annex D.

Attention: C, ASW, SC

In response to a recommendation last year, the Committee received a synthesis paper (SC/68B/IST/06) that includes results for all Evaluation and Robustness Trials as well as the evaluation of carryover and interim allowance for the East and West Greenland common minke whale hunts. The Committee **advises** *the Commission that the results confirm that:*

(1) *the 'G-Common minke SLA' is appropriate to provide management advice to the Commission on both the West and East Greenland common minke whale hunts; and*
(2) *the carryover provisions and interim allowance approach have been satisfactorily tested and thus that the AWS provisions should be updated accordingly for the Greenland hunts for common minke whales.*

6.2 *Implementation Review* for North Pacific gray whales (Chukotka and Makah hunts)

The purpose of an *Implementation Review* (IWC, 2019c) is to:

(1) review the available information to see if the present situation is as expected (i.e. within the space tested during the development of an *SLA*) and determine whether new simulation trials are required to ensure that the *SLA* still meets the Commission's objectives; and
(2) 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).

6.2.1 New information

Stock structure

The Committee first considered the available information on stock structure reviewed fully under Item 10.1.3.1, highlighting the recommendation there that the plausibility of some of the stock structure hypotheses should be revised and some of the definitions clarified as part of the rangewide review and assessment. Nevertheless, in the context of the *Implementation Review*, the Committee **agrees** that these changes will not alter its existing advice with respect to the suitability of the either the *Gray Whale SLA* or the Makah Management Plan for the provision of advice on the Chukotkan and proposed Makah hunts.

Abundance Estimates

The Committee received updated abundance estimates of gray whales (SC/68B/ASI/01) for the small Pacific Coast Feeding Group (PCFG). The paper was presented and discussed under Item 11.1.1 where it was agreed that it was suitable for the provision of management advice. The Committee welcomed the updated time series (1996-2017 with the most recent point estimate of 232, SE 25.2) provided in Table 13. It **agrees** that the updated time series will not alter its existing advice with respect to the suitability of the either the *Gray Whale SLA* or the Makah Management Plan for the provision of advice on the Chukotkan and proposed Makah hunts.

The Committee welcomed information that NOAA/SWFSC (Southwest Fisheries Science Center) had: (a) completed an eastern North Pacific gray whale abundance survey in 2019/2020 and is working on the related estimate; and (b) that a repeat survey will be conducted in 2020/21. It **reiterated** its appreciation for this invaluable time series of abundance data.

Removals

The most recent catch data from the Chukotkan hunt are discussed under Item 8.1.3.

The Committee also received updated estimates of bycatch and ship strike data (SC/68B/IST/08) that include new records of non-hunting, human-caused injuries and mortalities (NHHCIM) of gray whales from 2016, 2017, and 2018. The average annual number of mortalities and injuries prorated as mortalities for 2016-18 was 13.2, a large increase from the annual average of 8.3 for the period 1982-2015. The authors found that NHHCIM was variable by year, with 2018 being one of the years with the highest recorded NHHCIM from 1924 through 2018. Strong correlation (R=0.62) was found between ENP gray whale abundance and observed NHHCIM in an analysis of data from 1974 through 2015. It is possible that the increased number of observations per year was driven, at least in part, by high abundance of gray whales during those years.

The Committee thanked the authors for this thorough update and review. In noting that the numbers in the paper represented 'raw' counts (and thus underestimated true removals), it was recalled that in the assessment the uncertainty was captured by scenarios that multiplied numbers by 4 times and 20 times. There was some discussion of the higher than expected number of bycaught animals in 2012 that might have been a result of fishing effort for Dungeness crab. The Committee encouraged the authors in their efforts to model gray whale incidental mortality with abundance, fishing effort and other potential explanatory variables and to present them to future meetings. It **agrees** that the updated time series of incidental mortality will not alter its existing advice with respect to the suitability of the either the *Gray Whale SLA* or the Makah Management Plan for the provision of advice on the Chukotkan and proposed Makah hunts.

Other Information

The Committee received SC/68B/IST/07 that presented the results of a new Bayesian approach for estimating gray whale calf production using long-term data (1994-2019) on mother-calf pairs collected by land-based observers surveying the northbound migration from Piedras Blancas Light Station, in central California. The new approach formally accounts for the uncertainty associated with unsampled periods, and the differences in weekly passage rates of whales throughout the migration. This new approach resulted in slightly higher estimates of calf production across all years compared with the previous approach.

The Committee welcomed this new Bayesian approach and highlighted the great value of this important long-term monitoring effort by NOAA/SWFSC. It **agrees** that efforts should be made to examine ways to directly incorporate these data into future assessment modelling exercises.

The Committee received results of a long-term study on the body condition of Pacific Coast Feeding Group (PCFG) gray whales (SC/68B/IST/03). The discussion of this paper can be found under Item 8.1.3. The authors noted that: (a) predictions for annual body condition were greatly improved by incorporating the Pacific Decadal Oscillation (lagged two years) and September kelp canopy cover along the Washington coast (lagged one year) in the analysis; and (b) the body condition of whales feeding off Sakhalin Island improved faster than was observed for PCFG whales, which returned to a more predictably 'good' body condition by the end of a feeding season.

In SC/68B/IST/02, the Committee received information on carcass sightings (n=60, 2009-19) and probable cause of death for gray whales detected during line-transect aerial surveys in the eastern Chukchi Sea during July-October. Images were obtained for 56 (93%) of the carcasses recorded and 73% had injuries consistent with killer whale predation (cause of death could not be determined for the remaining cases). Further discussion of this paper can be found under Item 8.1.3. The Committee was disappointed to learn that this long-term series of aerial surveys would not be continuing.

Finally, the Committee noted the information presented on an unusual mortality event of gray whales (n=215) along the Mexico/US/Canada coast in 2019 (SC/68B/IST/05) that is discussed under Item 9.1.3. The situation continues to be monitored in 2020.

6.2.2 Conclusions

The Committee **thanks** the authors of the papers presented this year for providing information relevant to the *Implementation Review*.

Attention: C, ASW, SC

The Committee **agrees** *that data on calf production and health (including the long-term aerial survey monitoring of carcases) provided a valuable addition to the 'traditional' information on stock structure, abundance and removals as part of the gray whale Implementation Review this year and* **encourages** *the continued collection of such information for provision to future Implementation Reviews.*

After reviewing this information, the Committee **advises** *the Commission that it has completed its Implementation Review for North Pacific gray whales and* **recommends** *that the Gray Whale SLA and the Makah Management Plan remain the appropriate basis for the provision of advice on the Chukotkan and proposed Makah hunts.*

The Committee also **recommends** *that the Workshop and modelling exercise to finalise the update of the rangewide assessment and scientific aspects of the gray whale CMP be supported.*

6.3 Carryover and interim allowance for Eastern North Pacific gray whales

6.3.1 Results of intersessional work

Gray whales are subject to a hunt off Chukotka (Russia) and a potential hunt by the Makah Tribe off Washington State (USA). An *SLA* for the Chukotka hunt was adopted in 2004 (the *Gray Whale SLA*; IWC, 2005). The USA proposed the Makah Management Plan that was evaluated using a management strategy evaluation that accounted for multiple management units because there is a possibility that the Makah hunt will take animals from the PCFG (Pacific Coast Feeding Group) and/or the WFG (Western Feeding Group). The Committee concluded (IWC, 2019e) that the Makah Management Plan was adequate noting that this is dependent on photo-identification studies continuing into the future.

Last year, the Committee agreed that the carryover and interim allowance approach should be evaluated for the *Gray Whale SLA.* The Makah Management Plan does not include the concept of carryover nor that of interim allowance. Thus, these concepts only apply to the hunt off Chukotka. However, the strike limit for the Chukotka hunt encompasses strikes throughout the eastern North Pacific, including any strikes off Washington State by the Makah Tribe. An approach of implementing a minimum annual strike limit for a Makah hunt (3 whales) for the purposes of the simulations to evaluate carryover and the interim allowance approach for Chukotka was endorsed by the Committee during its 2019 meeting (IWC, 2020b). Given the strike limit envelope for eastern North Pacific gray whales starts at 140 and increases thereafter, the impact of this assumption on conservation performance statistics will be minimal.

The Committee noted that the Makah Tribe's need statement is for 4 whales and that this analysis was completed for the currently proposed plan.

SC/68B/IST/01 examined the carryover and Interim Allowance Approach following the approaches developed for other stocks (e.g. Bering-Chukchi-Beaufort Seas bowhead whales and humpback whales off West Greenland) Five carryover options chosen to encompass any likely actual carryover situations were evaluated using the base-case trials, and all satisfied the Commission's conservation objectives. Simulations for the 'original' phase out rule (a reduction in catch limit of 50% after 10 years without a survey estimate of abundance) and the 'interim allowance' approach (the 50% reduction does not apply) suggest that 'interim allowance' can lead to better need satisfaction than 'original' with no increase in risk to the stocks of gray whales in the North Pacific. Thus, 'interim allowance' satisfies the Commission's conservation objectives for the North Pacific gray whales. The author commented that the Committee may wish to view the performance statistics for the carryover options and 'interim allowance' for some of the sensitivity tests.

The paper had been circulated with a request for comments by early May and the comments received were in support of the conclusions of the paper. Scordino clarified that while the three whales satisfies the hunt management plan that NOAA currently has proposed for the Makah hunt, it does not cover the Makah Tribe request for four whales per year with a maximum of five in any given year. He thus noted that NOAA's proposed management plan should not be seen as the need of the Tribe. The plan is likely to have a lifetime of 10 years after which it will be re-evaluated.

6.3.2 Conclusions

The Committee **thanks** Punt for his work in response to the Committee's recommendation last year.

Attention: C, ASW, SC

In response to the recommendation last year, the Committee received the results of an evaluation of carryover and interim allowance for the Chukotka gray whale hunt (SC/68B/IST/01). The Committee ***advises*** *the Commission that the results confirm that the carryover provisions and Interim Allowance Approach have been satisfactorily tested and* ***recommends*** *that the AWS provisions should be updated accordingly for this hunt.*

6.4 Progress on previous recommendations and work plan

The Committee reviewed its recent recommendations and agreed that all had been met satisfactorily. Table 5 highlights the primary issues for consideration at next year's meeting (SC68C) noting that last year it had identified the need to consider the West Greenland humpback whale *Implementation Review* in light of the need for a new *In-Depth Assessment* of North Atlantic humpback whales (the last Comprehensive Assessment was completed in 2002). It **agreed** that the intersessional group established under Item 8.1.4 (see Annex K for details) to begin to plan the *In-Depth Assessment* would also include members of the sub-committee on IST and that a plan for conducting the *Implementation Review* would be informed by those discussions, particularly with respect to stock structure.

Last year, given the commonality of stocks in some cases and the need to try to undertake only one *Implementation Review* at a time, the Committee had agreed to develop a longer-term *Implementation Review* work plan (IWC, 2020b), recognising that in some cases the period between such reviews may be slightly longer than the target of every six years. The Committee reviewed the plan this year, recognising that it is provisional depending on the time taken to complete each review (1-2 years). An updated proposed schedule is given as Table 6.

Table 5

Work plan for IST *Implementation* matters.

Topic	2020 Meeting	Intersessional 2020/21	2021 Annual Meeting (SC68C)
Final work on *G-common minke SLA,* carryover and interim relief	Completed	n/a	n/a
Implementation Review for the ENP gray whales	Completed	n/a	n/a
Carryover and interim allowance for ENP gray whales	Completed	-	-
Update AWS in light of results at the 2020 meeting	-	Donovan/Staniland will undertake this	Review
Implementation Review West Greenland humpback whales	-	Work with IA Steering Group on matters related to the in-depth assessment of North Atlantic humpback whales and decide how to undertake the *Implementation Review*	Agree plan for review
Implementation Review for common minke whales (RMP)	-	-	Develop plan

Table 6

Potential long term work plan for RMP and AWMP *Implementation Reviews.*

Species/area	Year *Implementation* (*IR*s) completed	Next *Implementation Review*
West Greenland humpback whales (AWMP)	2014	Estimated start 2021
North Atlantic common minke whales (RMP)	1993 (2003, 2008, 2017)	Estimated start 2022
North Atlantic fin whales (RMP)	2009 (2016)	Estimated start 2023
West Greenland fin whales (AWMP)	2018	Estimated start 2023
West Greenland bowhead whales (AWMP)	2015	Estimated start 2024
Alaskan and Chukotka bowhead whale hunts (AWMP)	2000 (2007, 2012, 2018)	Estimated start 2025
Common minke whales off Greenland (AWMP)	2018, 2019	Estimated start 2026
Chukotka and Makah gray whales hunt (AWMP)	2004 (2010, 2013, 2020)	Estimated start 2027

7. STOCKS SUBJECT TO ABORIGINAL SUBSISTENCE WHALING (ASW)

7.1 New information and recommendations

7.1.1 Bering-Chukchi-Beaufort Seas bowhead whales

Two abundance surveys for Bering-Chukchi-Beaufort (B-C-B) bowhead whales were carried out in 2019: (1) an ice-based count in spring near Utqiaġvik (formerly Barrow); and (2) an aerial line-transect survey across the US and Canada Beaufort Sea in August. The resulting abundance estimates are discussed and summarised under Item 11.1.

Data on B-C-B bowhead whale population indices, whale health and hunter observations for 2018 and 2019 were provided in SC/68B/ASW/03. Productivity indices including calf production and body condition of subadults remained within the bounds of previous data and the health of individuals was generally good. Evidence indicating fishing-gear entanglements and injuries from killer whales and ship strikes was evaluated. Rates of entanglement (~12%) and killer whale predation attempts (~ 6%) appear to be constant at low levels over recent years; vessel strikes are rare.

From 2009 to 2019, 44 bowhead whale carcasses (31 at sea and 13 on land) were observed from aerial line-transect surveys during July-October in study areas across the eastern Chukchi and western Beaufort Seas (SC/68B/ASW/02). September had both the highest survey effort and number of carcass sightings in both study areas. During the 11-year study, the probable causes of death were: (a) killer whale predation 55% (24/44); (b) aboriginal subsistence whaling 'struck and lost' 9% (4/44); and (c) undetermined 36% (16/44).

Harvest data from the aboriginal hunt for bowhead whales in Alaska were presented in SC/68B/ASW/01. In 2019, 36 bowhead whales were struck resulting in 30 animals landed (2009-18: mean struck=57.1, SD=10.3; and mean landed=43.5, SD=7.1). Efficiency (no. landed/no. struck) in 2019 was 83%, higher than the average (76.7%; SD=7.1%) for the past 10 years. Of the whales landed, 19 were females (9 presumed sexually mature based upon length) and 11 were males. Three mature females were examined: two were pregnant, one with a term foetus (3.9m long) and one with a small foetus (29cm long), and the third was secreting colostrum. The other mature females could not be carefully examined because they were mostly butchered in the water.

During the 2019 subsistence hunt in Russia, one 18.9m female bowhead whale was struck and landed (SC/68B/ASW/05).

The Committee noted that an annual review of management advice was not required but **agrees** that the new information provided did not require calling for an early *Implementation Review* (IWC, 2019e).

7.1.2 Eastern Canada/West Greenland bowhead whales

SC/68B/ASW/04 reported on the Canadian subsistence hunt of Eastern Canada-West Greenland (EC-WG) bowhead whales that occurs annually within the Nunavut Settlement Area (NSA) and the Nunavik Marine Region (NMR). Oceans Canada licences bowhead whale hunts upon written confirmation that the appropriate Regional Wildlife Organisation has approved the hunt plan. The combined maximum allowed take is seven EC-WG bowhead whales per year. During the 5-year period 2015-19, a combined (NSA and NMR) total of 11 bowhead whales was landed and one whale was struck and lost. In 2019, four bowhead whales were struck and landed. The length of the whales ranged from 8.0m to 14.27m and they comprised three females and one individual of undetermined sex.

The Committee thanked Canada, a non-member nation, for providing this important information, and welcomed Canadian participants at this and future meetings.

No bowhead whales were struck off West Greenland in 2019.

The Committee noted that an annual review of management advice was not required but **agrees** that the new information provided did not require calling for an early *Implementation Review* (IWC, 2019e). The Canadian hunt of bowhead whales is taken into account within the *WG Bowhead SLA*.

7.1.3 North Pacific gray whales

The hunts of North Pacific gray whales were subject to an *Implementation Review* at this meeting and this is discussed under Item 6.2. In addition to the discussion in Item 6.2 and below on matters related to the actual and potential hunts (Chukotkan and Makah), information on gray whales is also considered under Item 9.1.3.

The results of a long-term study on the body condition of Pacific Coast Feeding Group (PCFG) gray whales were provided in SC/68B/IST/03. Whales were photographed during vessel surveys conducted in the feeding season (June-November) from: (a) 1996 through to 2013 in northern Washington; and (b) 1996 through to 2002 off Vancouver Island, and photographs of 181 PCFG whales were examined. Body condition was found to improve through the feeding season and the rates, and the start and finish values varied annually. A multiple regression analysis found that the best-fitting model for body condition by year included the Pacific Decadal Oscillation (lagged by two years) and September kelp canopy cover along the Washington coast (lagged by one year). These factors greatly improved predictive ability for average body condition compared to models that did not include environmental parameters. A comparison with a study on body condition of gray whales off Sakhalin Island, Russia (Bradford *et al.*, 2012), found that the body condition of whales feeding off Sakhalin Island improved faster than PCFG whales and that most of the Sakhalin whales returned to a 'good' body condition by the end of a feeding season. This may reflect life history differences of whales that undertake a long migration (Sakhalin whales) and those with a relatively short migration (PCFG whales).

Carcass sighting and probable cause of death data for eastern North Pacific gray whales detected during aerial line-transect surveys in the eastern Chukchi Sea were presented in SC/68B/IST/02. More information can be found in Item 6.2.1.

Information on the 2019 subsistence hunt in Russia was presented in SC/68B/ASW/05. A total of 135 gray whales (66 males and 69 females) was landed, including three inedible 'stinky' whales that were destroyed. In addition, two whales were struck and lost. Mean body length (10.0m), blubber thickness (122mm) and weight (10.3 tonnes) were recorded (in 2018, mean length and weight were 9.7m and 9.3 tonnes). The largest animal taken was a 14.4m female (31.7 tonnes). No females were lactating and only one had a foetus. Eight whales had evidence of interactions with killer whales. Data on the toxicology of gray whales from Chukotka (SC/68B/E/11) are discussed under Item 14.1.

The Committee noted that an annual review of management advice was not required and noted the conclusion of the *Implementation* under Item 6.2 that the *Gray Whale SLA* and the Makah Management Plan remain the best way to provide management advice. It was noted that 'stinky whales' are accounted for in the *Gray Whale SLA* that calculates the aboriginal subsistence hunting strike limit.

The Committee **welcomes** the information on Russian studies of gray whales off Chukotka and US studies of PCFG whales and the eastern North Pacific in general.

Attention: SC, CG, ASW
With respect to matters related to hunts of North Pacific gray whales, the Committee **reiterates** *previous advice that biological data, genetic samples and photographic data are collected from live and harvested whales and analysed to provide information on stock structure and biology.*

7.1.4 Common minke whales off East and West Greenland

A total of 11 common minke whales (one male, eight females and two of unknown sex) were landed in East Greenland in 2019. None were reported as struck and lost. A total of 153 minke whales (36 males, 116 females and one of unknown sex) were landed in West Greenland. Seven minke whales were struck and lost.

The Committee noted that an annual review of management advice was not required and noted the review of the performance of the *G-Common minke SLA* under Item 6.1.2. The Committee confirms that this SLA is the best way to provide management advice to the Commission on both the West and East Greenland common minke whale hunts.

7.1.5 Fin whales off West Greenland

Seven fin whales (two males, three females and two of unknown sex) were landed in 2019. One fin whale was struck and lost. The Committee noted that an annual review of management advice was not required but **agrees** that the new information provided did not require calling for an early *Implementation Review* (IWC, 2019e).

7.1.6 Humpback whales off West Greenland

Four humpback whales (three males and one female) were landed in 2019. None were struck and lost.

The Committee noted that an annual review of management advice was not required but **agrees** that the new information provided did not require calling for an early *Implementation Review* (IWC, 2019e). As noted under Item 6.4, intersessional work will take place to enable the Committee to agree a plan for the *Implementation Review* of humpback whales off West Greenland at SC68C.

7.1.7 Humpback whales off St. Vincent and The Grenadines

Three humpback whales (one male and two females) were landed in 2019. None were struck and lost.

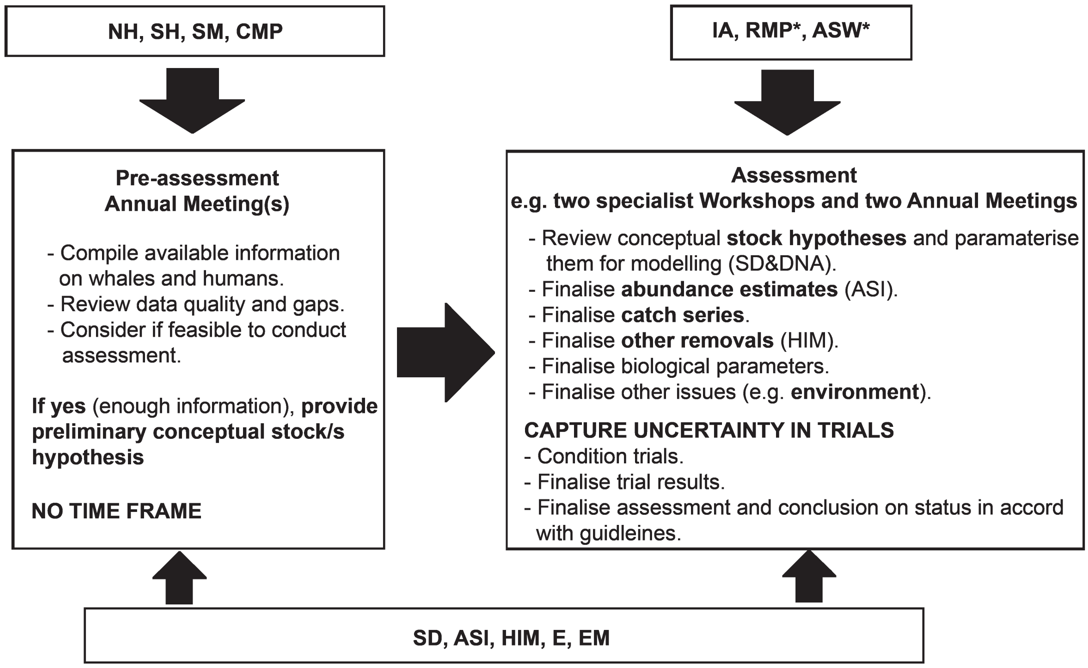

Fig. 1. Comprehensive and In-depth Assessment process. *Now part of IST.

The Committee noted that an annual review of management advice was not required but **agrees** that the new information provided did not require any change to its existing management advice (IWC, 2019e).

7.2 Progress with previous recommendations

SC/68B/ASI/02 presented findings of an ice-based survey of bowhead whales conducted near Utqiaġvik (formerly Barrow) and completed in the spring of 2019. This work addressed the 2017 recommendation that encouraged the funding and completion of a new ice-based survey estimate of bowhead whale abundance.

Paper SC/68B/E/11 noted that a photo-identification catalogue of gray whales was developed for surveys of Mechigmensky Bay, Russia. This work partially addresses the 2019 recommendation to collect photographic data in this area. The Committee recommends continuation of this work and collection of photographs and genetic samples from harvested whales as previously recommended.

Attention: SC, ASW, CG
The Committee ***encourages*** *that whenever possible, biological and genetic samples and photographic data for all species of whales subjected to aboriginal subsistence whaling be collected and combined to help assess stock structure and assessment-related questions.*

8. WHALE STOCKS NOT SUBJECT TO DIRECTED TAKES[9]

8.1 Comprehensive or *In-Depth Assessments* (IA)

An updated process for undertaking Comprehensive (the first time an assessment is completed for a species/region) and *In-Depth Assessment*s (subsequent assessments for a species/region) was agreed in 2018. The full process is described in Donovan (2018) and (IWC, 2020a, p.15) and is summarised in Fig. 1.

8.1.1 Comprehensive Assessment of North Pacific humpback whales

Work towards a Comprehensive Assessment of North Pacific humpback whales began in 2016. An intersessional Workshop was held in April 2017 (IWC, 2018a). In 2018, a simplified age-aggregated assessment model and four potential stock structure hypotheses were proposed (IWC, 2019c). However, there were still questions about the connections among the proposed breeding and feeding areas. In 2019, Cheeseman was able to improve an automated photo-ID matching algorithm that became the technical basis for his website *https://happywhale.com*. As a result, in 2019, the *Comprehensive Assessment* was postponed until the completion of a large-scale photo-ID matching exercise. This exercise was to incorporate a substantial quantity of new data from many regions across the North Pacific, including some from areas that had been under-represented during the ocean-basin-wide SPLASH project in 2003-05 (Calambokidis *et al.*, 2008).

[9]North Pacific common minke and sei whales are subject to direct catches by a non-member nation. At SC68C, the Committee will discuss which agenda item is the best for reviewing these two stocks.

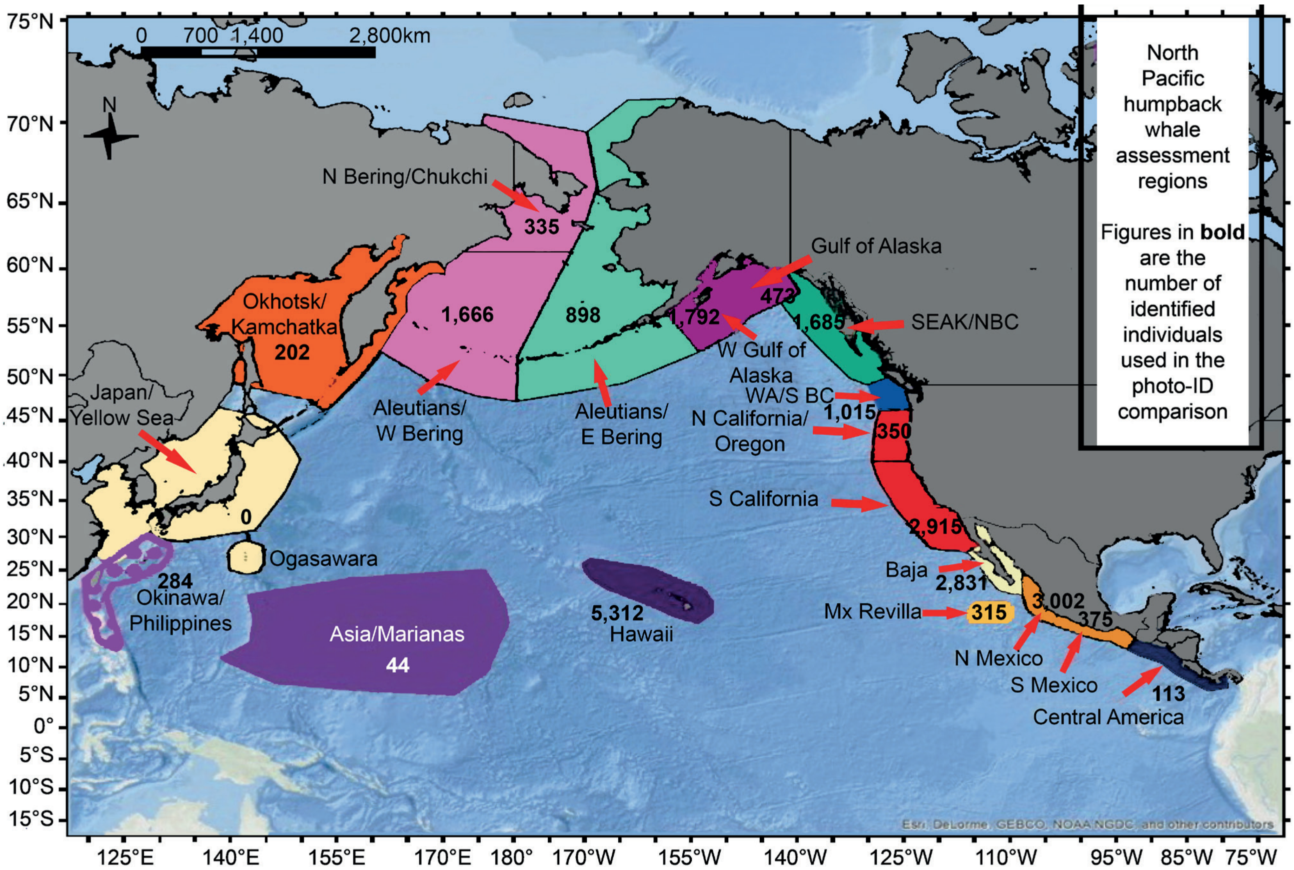

Fig. 2. North Pacific humpback whale assessment regions representing feeding and breeding areas. Numbers in each area are the identified individuals used in the preliminary photo-ID comparison.

8.1.1.1 Stock Structure

Understanding of stock structure, which is essential for the modeling process of the Comprehensive Assessment, is being refined using results from the large-scale photo-ID matches and genetic analyses. Analyses of historical 'Discovery' mark data are ongoing and will be presented to the Committee when completed; overall, the sample sizes concerned are relatively small. These data may not add meaningfully to the existing picture of movements and stock structure, but this will be assessed when the analyses are completed.

8.1.1.1.1 Photo-ID Matching

The matching exercise represented a substantial undertaking requiring extensive discussions with numerous photo-ID catalogue holders, and the development of a Memorandum of Understanding (MoU) governing the terms of data submission and use. This was undertaken by Cheeseman with assistance from Clapham and was finally concluded to the satisfaction of all parties. The MoU stresses that the data and preliminary results summarised in SC/68B/ISG/01 were to be used solely for the purpose of assisting the Committee's Comprehensive Assessment process; they should not be used for any other purpose, and should not be shared or published without the written permission of the photo-ID catalogue holders concerned.

The existence of what is now an essentially fully automated system has revolutionised humpback whale photo-ID matching. Freely available to anyone, it has facilitated fast matching across the very large photo-ID collection (now numbering >35,000 individuals in one consolidated global catalogue) and has detected even very challenging matches that have gone unnoticed, sometimes for many years.

Using the large volume of information submitted by collaborators through mid-April 2020, Cheeseman and Clapham initiated a preliminary photo-ID comparison (SC/68B/ISG/01). This matching exercise involved 38 photo-collections in 18 previously defined regions. The only change was to the region previously defined as 'Aleutians/Western Bering Sea', which encompassed all of the western Bering Sea. It became clear from newly acquired Russian data that there are two distinct areas within this region, separated at about 61°N. Consequently, the region was split, and the northern portion designated a separate area, entitled 'North Bering/Chukchi'. Other than for Okinawa, there were no current contributions from Japan and the Committee **encourage**s the submission of photos and data. Fig. 2 shows the regions used for this comparison.

This preliminary comparison involved 66,055 encounters of 17,230 unique individuals and resulted in the interchange index for all pairwise comparisons reported in table 1 of SC/68B/ISG/01, where more details of this comparison exercise can be found. There are several outstanding gaps in the data and it would be beneficial if they could be addressed soon. In particular, there is a lack of samples from the 'unknown' breeding area (postulated to be the Mariana Islands), the Aleutians and Bering Seas, Central America, Okinawa and Ogasawara.

The Committee welcomes the progress made on this substantial exercise and thanked the many photo-ID holders who have already submitted images.

Attention: SC, CG
The Committee **encourages** *other photo-ID holders to contribute, and that the analyses can be completed using a more comprehensive set of photographs, with the results to be presented to SC68C.*

A separate but complementary effort to the Comprehensive Assessment, known as 'SPLASH-2', is a follow-on to the successful 2004-06 SPLASH project. NOAA is providing seed funding to initiate this project by bringing collaborators together (through one or two workshops, e.g. virtual in autumn 2020, and in-person in summer 2021) to identify humpback ID photographs from each region of the North Pacific that are potentially available for analysis, to prepare as many photographs as possible for computer-assisted matching, and to identify gaps in the distribution of data that, if filled, could contribute substantially to a better understanding of North Pacific humpback whales.

The Committee **welcomes** this new project and looks forward to collaborating with this effort.

8.1.1.1.2 Genetic Analyses

SC/68B/IA/02 assessed the temporal stability and geographic differentiation of mitochondrial DNA (mtDNA) control region haplotypes from humpback whales on the eastern North Pacific feeding grounds using thirty-one years (1988-2019) of biopsy sampling effort (n=951), which resulted in the identification of 777 unique individuals. Pairwise comparisons of mtDNA haplotype frequencies across three temporal strata showed no significant differences for Central California, the geographic region with the most extensive temporal sampling coverage. Tests of geographic differentiation considered six regional strata: Northern British Columbia, Southern British Columbia/Washington, Oregon, Northern California, Central California and Southern California. All pairwise comparisons were significant, except the comparison between Northern California and Oregon and revealed a greater degree of geographic structure in these feeding grounds than previously assumed. The results also provided new evidence for the temporal stability of fine-scale maternal fidelity of humpback whales to feeding grounds along the eastern North Pacific. Further analyses are underway to improve the assignment of individuals from feeding grounds to breeding grounds using nuclear genetic markers.

SC/68B/IA/03 used mitochondrial sequence data to characterise and compare two 'migratory herds' (meaning whales using the same feeding and breeding grounds) that use the California/Oregon (CA/OR) feeding ground. This involved two new datasets. One dataset consisted of the full mitochondrial genome sequences (16,384 base pairs) from the herd that feeds off CA/OR and winters in Central America (the CentAm-CA/OR herd; n=65), and the herd that also feeds off CA/OR but winters off mainland Mexico (the MMex-CA/OR herd; n=50). The second dataset consisted of mtDNA control region sequences (389 base pairs) from humpback whales sampled off CA/OR during the 2018 California Current Ecosystems Studies survey (n=227). These new datasets were compared to published mtDNA control region datasets collected from the MMex wintering aggregation (n=62), the CA/OR feeding aggregation in 2004 (n=123), and the CA/OR feeding aggregation in 1988-1989 (n=49). The results showed that the CentAm-CA/OR and MMex-CA/OR herds are genetically differentiated from each other (F_{ST} = 0.054 and 0.044 for full mitogenome and control region sequences, respectively). However, because the herds shared a high proportion of haplotypes, even when using full mitogenome sequences, many individuals could not be reliably assigned to a herd using only mitochondrial data. Consequently, further analyses are underway to add nuclear loci to this analysis.

SC/68B/CMP/26Rev1 used genetic and photo-ID data to analyse the relationship of the humpback whales from southern Mexico with whales from other Pacific regions off Mexico and Central America. The photo-ID matching included 7,250 individuals from six regional catalogues of the Mexican Pacific (BCS; Sinaloa; Nayarit-Jalisco; Colima; Guerrero; and Oaxaca). The highest Recapture Index was among the whales from Colima, Guerrero and Oaxaca in southern Mexico. The mtDNA control region haplotype frequencies sequenced from 51 skin samples collected in Oaxaca (48) and Guerrero (3) showed significant differences with the other three breeding sites studied in Mexico (Baja California, Bahía de Banderas and Revillagigedo Archipelago). In contrast, there were no significant differences with the humpback whales from Central America. The photo-ID results indicated that the whales from Colima to Oaxaca belong to the same congregation, and the genetics show that these whales are part of the same population unit as the whales of Central America. In summary, the humpback whales from southern Mexico belong to the Central American population; there is no clear boundary between the northern and southern coastal humpback whales in the Mexican Pacific, and the northern area may include a mixture of coastal and offshore whales. Future steps include comparisons of the photo-ID catalogues from the Central America humpback whales and Mexico to better understand the movement of the whales in the region and develop an abundance estimate.

The Committee emphasised the importance of the three genetic analyses above to the Comprehensive Assessment of North Pacific humpback whales and encourages the authors to continue their work and present an update to the intersessional Workshop and subsequently to the Committee next year, for review by the SD/DNA sub-group.

The DNA register for North Pacific humpback whales now has a total of 3,225 individuals, including pre-SPLASH samples dating back to 1987 and post-SPLASH samples up to 2019. As a result of the collaborative effort to investigate stock structure for the SPLASH program, the Cetacean Conservation and Genomics Laboratory at Oregon State University adopted a standard DNA profiling system that includes sequencing of mtDNA control region haplotypes, molecular analysis of sex and genotyping at 10 microsatellite loci. DNA profiles were used to identify 1,805 individuals from 2,193 biopsy samples collected as part of the SPLASH program in 2004-06. Comparison of genotypes provided 90 matches between breeding grounds and feeding grounds. Patterns of interchange were particularly complex for whales sampled in the three regions off Mexico. A compatible DNA profiling system has also been used for a DNA register of humpback whales from Oceania, where it has been applied to estimate abundance as well as to investigate stock structure.

The Committee noted that all DNA profiles, which include microsatellite genotypes, are suitable for population assignment procedures and those with mtDNA haplotype information are suitable for mixed-stock analyses (Albertson *et al.*, 2018). If the requirement for individual identification of samples is relaxed, then there is also the potential to include a larger number of samples from the Russian Far East and Mexico for a mixed-stock analysis using mtDNA haplotype frequencies only. A mixed-stock analysis could apportion feeding ground genetic samples to breeding grounds and estimate the probability of an individual from a feeding ground originating from a defined breeding ground; these assignments could be used as proxies for catch allocation in the assessment model. The Committee **reiterates** that such a mixed-stock analysis be funded using existing funds (see Item 22).

8.1.1.2 Abundance and Trends

At the first Workshop for this Comprehensive Assessment, a list was compiled of abundance estimates and data that could be used to generate such estimates, in addition to proposed future work related to these estimates (IWC, 2018a). All abundance estimates that will be used in the assessment model need to be reviewed by the ASI sub-group of the Committee and must also be re-stratified or otherwise re-calculated to align with the stock structure hypotheses.

Inai *et al.* (2020) calculated abundance estimates for humpback and other baleen whales from the 2010-18 IWC-POWER cruises dataset and presented this work at the IWC-POWER Technical Advisory Group meeting in Tokyo in January 2020 (SC/68B/REP/01). The abundance of humpback whales migrating to the southern Aleutian archipelago (2010-12 survey areas: north of 40°N, south of the Alaskan coast including both the US and Canadian EEZs between 170°E-135°W) in summer (July-August) was estimated as around 9,900 (CV=0.53) under the hazard-rate model with explanatory variables of the year of survey, school size and visibility. The abundance to the north of the Aleutian archipelago (2017-18 survey areas: eastern Bering Sea) in summer (July-August) was estimated as about 13,000 (CV=0.41) under the hazard-rate model with visibility, cue and wind speed variables. In total, abundance in the 2010-12, 2017-18 survey areas was given as around 23,000 (CV=0.60). Additional work to improve the CV of this and other estimates is currently underway and will be submitted to ASI for evaluation and endorsement.

It was noted that abundance estimates for Japanese surveys from the northwestern North Pacific (including the area south and southeast of Kamchatka, incorporating survey work from the Emperor Seamounts region) could be an important input to the assessment. Kitakado advised that he would attempt to provide this information.

It is noteworthy that there have been recent major changes in the apparent abundance of humpback whales in both Southeast Alaska and the West Coast of the USA. The former region features low relative abundance and is 'missing' well-known whales, a phenomenon which has also been observed in the Hawaiian breeding grounds. This is likely to be related to a major oceanographic event (Cartwright *et al.*, 2019). On the US West Coast, abundance appears to be increasing. Calambokidis and Barlow (2020) present new abundance estimates for recent years; these show major increases in abundance (including at a rate of increase beyond the plausible biological maximum) for California/Oregon as well as for Washington State/southern British Columbia.

In addition, analysis of the 2018 US west coast line-transect sighting data is being finalised and will be shared with the IWC when complete. The humpback whale abundance estimate from this survey could provide an important input to the assessment.

Palacios reported on a 13-day sighting and acoustic survey of Northern Hemisphere humpbacks that he and Rasmussen conducted in February 2018 in the Gulf of Chiriqui in Panama. This area is thought to be used by both Northern and Southern Hemisphere humpback whales, though at different times (Rasmussen *et al.*, 2007; 2012). There was only one sighting (a mother/calf pair), but numerous acoustic detections of singing whales. The survey supported the hypothesis that the occurrence of Northern Hemisphere humpbacks in the southern area of Central America is declining, whereas Southern Hemisphere whales are increasing there; however, the survey was conducted in a year with major oceanographic changes in the North Pacific, when (for example) far fewer whales were observed in other parts of Central America as well as in Hawaii (Cartwright *et al.*, 2019).

The Committee welcomed these new abundance estimates and encourages all abundance estimation analyses to be completed and presented to SC68C to be reviewed by the SWG on ASI.

8.1.1.3 Removals

Ivashchenko has continued to collect new catch data for humpback whales from Soviet sources and to submit them for inclusion in the IWC catch database; although they represent relatively minor additions to the existing catch series. The Committee thanked Ivashchenko for contributing the new data to the IWC catch database.

It was noted that the assessment needs to incorporate an estimate for bycatch as well as direct catch removals, since bycatch has become an important issue in some areas (e.g. the West Coast of the US). Robbins *et al.* (2009) proposed an approach for estimating entanglement mortality from scar-based studies of entanglement, using Gulf of Maine humpback whales as an example. Entanglement scarring rates in some North Pacific areas are comparable to the Gulf of Maine (Neilson *et al.*, 2009; Robbins *et al.*, 2007), so that those results could be considered as a proxy in the absence of direct information. However, if there were to be a follow-up to the SPLASH project, then it could also be possible to collect the data necessary to quantify entanglement rates on an annual basis in some North Pacific areas, as is needed to estimate mortality by the proposed method.

In view of the importance of bycatch and ship strikes, as well as catches, in the assessment models, a strategy needs to be developed to enumerate the bycatch and ship strikes to be used in this Comprehensive Assessment.

8.1.1.4 Biological Parameters

The first Workshop (IWC, 2018a) compiled and reviewed the available information on biological parameters for humpback whales in all oceans. There has been no new work on biological parameters.

8.1.1.5 Assessment

The general underlying structure of the assessment model has been developed, but before the model can be run the input data (e.g. removals and abundance estimates) need to be updated, reviewed by the Committee, and allocated/disaggregated for each stock structure hypotheses. In addition, mixing matrices need to be developed and parameterised.

The Committee **agrees** that the Intersessional Steering Group be re-established to further the work towards this assessment including planning for the intersessional Workshop (funding for this and modelling work was already endorsed by the Committee, see Item 22).

Attention: SC, R

The Committee is undertaking a Comprehensive Assessment of North Pacific humpback whales. In particular this year, it **recognises** *the great contributions of many research organisations across the North Pacific which made the large-scale photo-ID matching effort possible and* **reiterates** *its previous strong encouragement for all catalogue holders to contribute photographs to participate in this exercise, after the appropriate data sharing agreements have been reached.*

In order to complete the assessment expeditiously, the Committee **agrees** *that:*

(1) *the Intersessional Steering Group under Clapham, should be re-established including the work plan outlined in SC/68B/ISG/01;*
(2) *the breeding/feeding subareas should be re-evaluated to be consistent with the new results from the matching effort;*
(3) *ongoing genetic analyses should be completed and reviewed by the Committee;*
(4) *abundance estimates should be completed and reviewed by the Committee;*
(5) *options to quantify bycatch and ship strikes should be developed;*
(6) *the proposed mixed-stock analysis should be funded and conducted to apportion feeding ground genetic samples to breeding grounds, and to estimate the probability of an individual from a feeding ground originating from a defined breeding ground as proxies for catch allocation in the assessment model;*
(7) *the abundance and removals should be re-calculated to correspond to the new subareas, mixing matrices developed, and input into the assessment model; and*
(8) *the intersessional Workshop should, progress permitting, focus on finalising the stock structure hypotheses, abundance and removals and their appropriate allocation by stock hypotheses.*

8.1.2 Comprehensive Assessment of North Pacific sei whales

Last year, the Committee reviewed preliminary results from an assessment model, which had encountered difficulties in reconciling all the available types of data: absolute abundance estimates from POWER and other surveys; relative abundance data from scouting vessels and some further surveys; and mark-recovery data. An Intersessional Correspondence Group was established to review the data used and to oversee the further development of the population model. Its report is provided in SC/68B/ISG/04.

The intersessional group refined the input data in several respects: replacing minimum estimates of abundance with best estimates; improving the breakdown of survey strata to subareas of the population model; and incorporating additional variance. The population modelling proceeded on the basis agreed last year of two main stock structure hypotheses: (i) a single breeding stock in the North Pacific; and (ii) five breeding stocks. The group explored a range of variations on the two basic hypotheses but found no variants that could fit all the available data in a satisfactory manner. It concluded that the work could not be considered complete at this stage. The current version of the population model and its variants is specified in SC/68B/IA/04. The group listed several further variants of the population model, including the incorporation of more seasonal structure that should be considered. It put forward a work plan to develop and review these variants.

In light of Japan withdrawing from the IWC and thus becoming an observer at the Committee meeting, Japanese scientists confirmed their general stance that their highest priority had become data collection and analytical work related to their national research programmes on assessments and management of large whale species such as sei, Bryde's and common minke whales, noting that participating in scientific discussions in general at Committee meetings (including participation in Steering Groups) would also strengthen its assessment of whales and management of whaling. They clarified that on a voluntary basis they may submit relevant results of their work to future Committee meetings. In a spirit of collaboration, they also agreed to the use of the data held by Japan which have been already incorporated into the current population dynamics modelling framework of the Comprehensive Assessment of North Pacific sei whales. Should it become necessary to use the previously collected data for purposes other than this assessment or new data to be collected by Japan for any purpose, Committee members would need to apply for the use of those data through the standard procedures of the Institute of Cetacean Research or the National Research Institute of Far Seas Fisheries (standard data related to catch and bycatches are and will continue to be publicly available). The Committee thanked the Japanese scientists for these clarifications and was pleased that two Japanese experts will be involved with the Intersessional Steering Group for the purpose of responding to questions regarding the data held by Japan that are already being used.

Attention: SC
To progress work on the Comprehensive Assessment of North Pacific sei whales the Committee:
(1) **agrees** *to re-establish the intersessional group under Cooke, and* **endorses** *its work plan, which is designed to enable completion of the assessment by the Committee next year; and*
(2) **endorses** *the continuation of the assessment modelling work by Punt with its associated budget.*

8.1.3 Progress on In-Depth Assessment of western North Pacific common minke whales

Donovan presented the report of the Intersessional Steering Group on western North Pacific common minke whales (SC/68B/ISG/05). It had been agreed last year (IWC, 2020b) that, with the withdrawal of Japan from the IWC, it was not appropriate to continue with the ongoing RMP *Implementation Review* for common minke whales in the western North Pacific. However, given the levels of bycatch of common minke whales in the western North Pacific, particularly adjacent to Korea and Japan, as well as Japan's resumption of commercial whaling within its EEZ, it was considered important for the Committee to examine the conservation implications of removals throughout the region. It was agreed that the appropriate process to follow was that of an *In-Depth Assessment*, with a particular focus on the levels of bycatch from and the status of the J-stock.

An intersessional Workshop had been planned to further the *In-Depth Assessment*, but it had not been possible to hold it this year. The Committee **reiterates** its support for holding the Workshop prior to SC68C. Intersessional progress had focussed on working on the details of the assessment specifications (based upon the RMP trial specifications but no longer using the Revised Management Procedure in projections) and validating the computer code to implement the three stock structures and other scenarios already agreed (IWC, 2020b). The Committee was pleased to hear that this work, essential for holding a productive workshop, was almost complete, noting that there are a small number of issues to be resolved within the Steering Group prior to the workshop (SC/68B/IA/05). The final specifications for the population model will be published as an Annex to the Workshop report.

The Committee noted that the clarification regarding the participation of Japanese scientists in the Comprehensive Assessment of North Pacific sei whales (Item 8.1.2) also applied to the *In-Depth Assessment* of common minke whales in the western North Pacific, both with respect to data held by Japan which have been already incorporated into the current simulation framework, the use of new data (and the process to obtain them) and the level of participation of two Japanese scientists in the Intersessional Steering Group. The Committee **encourages** scientists from Korea and Japan to provide recent information on fishing effort (as well as bycatch numbers) to Allison to assist with the modelling of bycatches for the assessment. It notes that an intersessional working group will finalise abundance estimates for use in the assessment as discussed. It was pleased that two Japanese experts will be involved with the Intersessional Steering Group and **encourages** Japanese experts to participate in the intersessional Workshop, if possible.

Table 7
Work plan for Comprehensive and In-depth Assessments.

Topic	Intersessional 2020/21	2021 Annual Meeting (SC68C)
Comprehensive Assessment of North Pacific humpback whales	Re-establish the ISG to further data preparation, development of the assessment model and hold a Workshop	Review progress of intersessional work and continue the assessment
Comprehensive Assessment of North Pacific sei whales	Re-establish the ISG to further data preparation and development of the assessment model	Review progress of intersessional work and continue/finalise the assessment
In-depth Assessment of western North Pacific common minke whales	Re-establish the ISG to further development of the assessment model and hold a Workshop	Review progress of intersessional work and continue/finalise the assessment
In-depth Assessment of North Atlantic humpback whales	Re-establish the ICG to further data preparation for the assessment	Review progress of intersessional work and continue the assessment

Attention: SC
The Committee **reiterates** *the need to conduct an In-Depth Assessment of western North Pacific common minke whales with a focus on the bycatch levels from and the status of J-stock. Recognising the difficulties in holding the Workshop agreed last year prior to SC68B, the Committee* **reiterates** *the importance of the Workshop and:*

(1) **recommends** *that the funds allocated last year are used to hold a Workshop prior to SC68C when it is safe to do so, and supports the request for computing support;*
(2) **agrees** *that the primary objectives of the Workshop are to: (a) build upon the work undertaken thus far on finalising and conditioning the assessment models; (b) review the results of the initial conditioning and determine the necessary scenarios to consider including for future projections; and (c) develop a work plan that will allow for results to be presented to SC68C, ideally enabling the In-Depth Assessment to be completed at SC68C; and*
(3) **establishes** *a Steering Group under Donovan to: (a) oversee the preparations for the Workshop including finalising the agenda, the pre-Workshop preparations, the venue, the date of the Workshop and the list of invited participants; and (b) examine the most appropriate way to incorporate minimum, maximum and zero estimates of abundance in the modelling framework (taking into account discussions of similar issues in other assessments).*

8.1.4 Preparation for In-Depth Assessment of North Atlantic humpback whales (and see Items 7.1.7 and 7.1.8)
Due to the Covid-19 disruption and no new papers having been submitted this year, discussion of this topic was postponed until next year's meeting and in the meantime will be advanced by an Intersessional Correspondence Group, convened by Robbins (see Annex K). The Intersessional Correspondence Group will continue its work to identify existing and forthcoming information on North Atlantic humpback whale stock structure, abundance, biological parameters and human impacts. A report of these activities will be provided at next year's Committee meeting.

Other discussions on North Atlantic humpbacks include preparations for an *Implementation Review* of West Greenland humpback whales (and see Item 6.6), bycatch in the Scottish creel fishery (and see Item 12.2), and the unusual mortality event of humpbacks in the western North Atlantic (and see Item 14.3.2).

8.1.5 Work plan
Table 7 provides the work plan for Comprehensive and *In-Depth Assessment*s. For details of Intersessional Correspondence Groups, see Annex K.

8.2 Potential new assessments: progress on previous recommendations and prioritised work plan (SH and NH)

8.2.1 Non-Antarctic Southern Hemisphere blue whales (SH)
The Committee is preparing for a Comprehensive Assessment of non-Antarctic Southern Hemisphere blue whales, which is anticipated to be finalised by 2022. Pre-assessment of the available data was planned to be conducted at the 2020 and 2021 meetings. In 2020, the Committee received new information on acoustic population structuring, regional catch allocations and photo-ID matching.

The Committee welcomed two papers on pygmy blue whale demography (SC/68B/SH/10 and SC/68B/SH/12), which have been translated into English from Russian, and provide useful information on blue whale morphometric variation between subspecies, by sex and demographic status.

8.2.1.1 Southeast Pacific Ocean Blue Whales
Obtaining a new abundance estimate for southeast Pacific blue whales remains a high priority for the Committee, requiring finalisation of catalogue matching across the region and quality coding of images to obtain a regional mark-recapture dataset. An update of photo-ID catalogue matching within this region (SC/68B/PH/02) is discussed under Item 20.2.4. Intersessionally, photo-identifications from the eastern tropical Pacific and South America (838 individuals) were compared. Ten matches were

found within Chile. But no matches were detected between the eastern tropical Pacific and the southeast Pacific (SC/68B/PH/02), although a match between Chile and the Galápagos had been found previously (Torres-Florez *et al.*, 2015). In 2019, the Committee advised that additional photo-ID catalogue holders for the Costa Rica Dome be invited to join the Southern Hemisphere blue whale catalogue (SHBWC), to assess whether there is any direct overlap between this northeast Pacific blue whale wintering ground, and the southeast Pacific blue whale wintering area. A further dataset from Chile (Centro Ballena Azul and Universidad Austral de Chile) has not yet been catalogued due to lack of funds for dedicated personnel.

The Committee welcomed this update. In discussion, it was noted that additional spatial coverage is provided by photo-ID images from the 1997/98 IDCR-SOWER cruise (Findlay *et al.*, 1998), which are already part of the SHBWC and included in SC/68B/PH/02. While no matches have been found between these images and those in the SHBWC southeast Pacific catalogue to date, it was agreed that additional photos are available prior to 2003 in Chile which have not yet been submitted to the SHBWC and may reveal matches to IDCR-SOWER data as they are closer in time to this period. These should be added to the catalogue (and see Item 8.2.9). Priority intersessional work for this catalogue should be finalisation of southeast Pacific matching, quality coding and creating of mark-recapture datasets for analysis, with the appropriate analysis time determined by review.

A good understanding of population structure and connectivity is necessary to conduct population assessments. Last year (IWC, 2020a), the Committee proposed comparisons of catch length data and mitochondrial DNA patterns between the southeast and northeast Pacific in order to establish the level of population connectivity because a recent study suggested that these populations have some genetic interchange on their low-latitude wintering grounds (LeDuc *et al.*, 2017). The Committee was informed that this work will be completed in 2021.

Attention: SC, R

To assess blue whale population connectivity across hemispheres in the eastern Pacific, the Committee **reiterates** *that it* **encourages** *a comparison of: (1) morphometric; (2) genetic data between northeast and southeast Pacific whales; and (3) completion of photo-ID catalogue matching and quality coding in the southeast Pacific, to enable regional abundance estimation.*

To finalise the southeast Pacific blue whale pre-assessment, the Committee **agrees** *that the southeast Pacific photo-ID dataset should be quality coded and matched to 2018, and mark-recapture analyses conducted.*

8.2.1.2 Southeast Indian Ocean Blue Whales

No new information was received. Additional metadata for year of collection are required to finalise the SHBWC Australian photo-ID dataset for mark-recapture analysis. Additional photo-IDs may be forthcoming from the Philippines, Timor Leste and Indonesia and these should be submitted (as should any new photo-IDs) to the SHBWC. An assessment of the suitability of the data already submitted to the SHBWC for mark recapture analysis should be conducted intersessionally after updating tasks have been completed.

Population trend data from southeast Indian Ocean blue whales are available from Australia, derived from acoustic recordings (McCauley *et al.*, 2018). However, caution was advised because these trend data are derived from the instantaneous number of singers. The analyses assumed that: (i) song production rate was constant over time and the area monitored; and (ii) detectability was the same each year; however, small changes in ambient noise levels (e.g. 1-2 dB) can affect the area monitored and detectability drastically. The Committee was informed that the IWC-SORP Acoustic Trends Working Group is developing a method to obtain acoustically-derived time series of abundance estimates for Antarctic blue and fin whales (see SC/68B/SH/04 and Item 8.2.2), based on the more standard distance-sampling approach. Whilst acoustic analyses focused on song are unlikely to yield reliable estimates of absolute abundance, they may inform on general population trends in places with long term acoustic time series. It is important that the analyses minimise the effect of the biases inherent in these data, including accounting for behavioural complexities involved in the use of a male-limited breeding display (song) for assessing parameters to describe an entire population.

Attention: SC, R

To finalise the Southeast Indian Ocean blue whale pre-assessment, the Committee **recommends** *that the Australian photo-ID dataset be reconciled with location and time metadata urgently, and mark recapture analyses conducted.*

The Committee also **agrees** *that the abundance trend analysis for southeast Pacific blue whales conducted by McCauley et al. (2018) be reviewed by the ASI working group, with acousticians included in that discussion.*

8.2.1.3 Southwest Pacific Ocean Blue Whales

In 2018, the Committee received a mark-recapture based estimate of southwest Pacific blue whale abundance (Barlow *et al.*, 2018). In 2019, the ASI Working Group cautioned that the abundance estimate might only represent whales using the South Taranaki Bight region and recommended further exploration and modification of the models used in the analysis (Item 2.1.3; IWC, 2020j).

Attention: SC, CG, R

To complete pre-assessment of the Southwest Pacific blue whale population, the Committee **reiterates** *that it* **strongly encourages:**

(1) *further work to update the abundance estimate of blue whales in New Zealand (Barlow et al., 2018) and presentation of an updated estimate to SC68C;*
(2) *New Zealand photo-ID catalogue holders to submit images to the Southern Hemisphere Blue Whale Catalogue (IWC, 2019c, p.21) and that catalogue submissions, matching and quality coding of the SHBWC dataset for New Zealand are finalised intersessionally; and*
(3) *these data are used to provide an abundance estimate to SC68C spanning the widest possible area over which data have been collected.*

8.2.1.4 Southwest Indian Ocean Blue Whales

Blue whales in the southwest Indian Ocean are poorly understood with few data available on their movements and abundance (including photo-ID and genetic data).

SC/68B/SH/08 summarised seasonal song patterns from acoustic monitoring off northwest Madagascar, southwest Indian Ocean (SWIO). Pygmy blue whale song detection was bimodal, peaking in activity during May-July and October-January, suggesting the area represents a migratory corridor between winter breeding and summer feeding habitats north and south of Madagascar, respectively. Central Indian Ocean blue whale song-type (CIO, *aka* Sri Lanka song), and a blue whale song-type attributed to the northwest Indian Ocean (NWIO) population (Oman song-type described by Cerchio *et al.* (2020) were detected for short periods between January and May. Winter breeding habitat for the SWIO blue whales is hypothesised to be the equatorial region off Kenya to the Seychelles. This is based on the timing of recent sightings off Kenya being congruent with the migratory timing off NW Madagascar, and the Soviet catches near the Seychelles providing foetal length data which indicate a Southern Hemisphere breeding cycle, in addition to the timing of the catches. Summer habitat is proposed to be the Madagascar Plateau/Ridge based upon Best *et al.* (2003).

The Committee noted that this work addresses a previous IWC recommendation to better understand population movements of pygmy blue whales in the southwest Indian Ocean (item 5.3.3 in IWC, 2017e). These data have also been used to inform the catch allocation models during the Southern Hemisphere blue whale pre-assessment (Item 8.2.1.6).

The Committee discussed the availability of photo-IDs from the Madagascar region, including some from an IDCR-SOWER cruise (Best *et al.*, 2003), and others from Gardline and Committee participants. Work is required to organise the IDCR-SOWER photographs into a catalogue prior to submission.

Attention: SC, G, CG, R

The Committee notes that the distribution and population isolation of blue whales is poorly understood in the northern and western Indian Ocean (IWC, 2019g, p.21). The Committee therefore **encourages** *submission of photos from the southwest Indian Ocean region to the SHBWC. Submissions should include information on the date of collection (to assist in determining the population of origin given their different usage of the area). Once compiled, matching of this photo-ID catalogue with the catalogue being compiled in the NWIO should be a priority activity to assess connectivity. The Committee also* **reiterates** *its strong encouragement for the collection and analysis of available tissue samples for the analysis of genetic population structure in this region to assist with characterising these populations.*

8.2.1.5 Northwest and Central Indian Ocean Blue Whales

Cerchio *et al.* (2020) describes the new 'Oman' blue whale song-type, (hereafter the NWIO song) recorded off Oman, the equatorial central Indian Ocean (Chagos Archipelago) and the SWIO (northwest Madagascar). Spatiotemporal variation at these sites suggests that the main distribution is centred in the northern Indian Ocean/Arabian Sea west of 70°E, with a minor presence in the SWIO. The distribution of this distinct song-type suggests that two pygmy blue whale populations occur in the northern Indian Ocean (the other with the CIO song-type, see Item 8.2.1.4). Intensive Soviet whaling probably took whales from the NWIO population, and the lack of prior detection of this song-type suggests that this may be a small, vulnerable blue whale population.

Given the current acoustic evidence, the Committee agreed that the Oman blue whales should be recognised as a distinct population, and thus 'North Indian Ocean blue whales' need dividing into NWIO and CIO. The methods and results in Cerchio *et al.* (2020) have been used to inform the catch allocation model for NWIO and CIO for the upcoming Comprehensive Assessment (Item 8.2.1). However, the distribution of these two types throughout the Indian Ocean is still poorly understood, with for example few data available from the eastern Arabian Sea and some caution is needed. Genetic data are required to support these acoustic identifications and analysis of genetic population structure including sloughed whale skin and faecal samples (the latter are not subject to CITES restrictions). Concurrent collection of acoustic and genetic data would be of particular value to help establish the relationship between acoustics and population identity more directly.

The Committee **encourages** a project to conduct passive acoustic monitoring off Oman to establish the seasonal presence and distribution of NWIO whales better this work to be conducted, noting that this has financial implications (see Item 8.2.9).

Since there are no abundance and trend data for the NWIO population, a population assessment cannot be conducted. The Committee therefore **strongly encourages** collection of abundance data, either via mark-recapture (genetic or photo-ID) or line transect survey. While acknowledging the small number of sightings in this area, the Committee **encourages** the submission of existing photo-ID data (<10 whales) to the SHBWC. Matching with photo-IDs from Madagascar would also be valuable because of potential spatial overlap, and for possible further confirmation of absence of temporal overlap between this and the SWIO population (see Item 8.2.9).

Attention: SC, CG, G, R, CC

The Committee **reiterates** *that the distribution, population structure and taxonomy of blue whales is poorly understood in the northern and western Indian Ocean (IWC, 2019c, p.21). The Committee* **recommends** *that IWC member and non-member governments and regulatory bodies support scientists in the important research priorities given below and adopt management measures in core areas of habitat for blue whales in the Arabian Sea to ensure the conservation of this poorly understood population. The Committee* **agrees** *the following research priorities:*

(1) *continued photo-identification and increased genetic sampling and analysis of blue whales off Oman and throughout the region;*
(2) *passive acoustic monitoring to determine seasonal presence and if possible, population abundance and trends; and*
(3) *comparison of blue whale photographic catalogues with other blue whale catalogues in Oman, India, Sri Lanka and any others available in the Indian Ocean (and possibly the Antarctic).*

8.2.1.6 Progress Towards Comprehenisve Assessment

In preparation for the Comprehensive Assessment of non-Antarctic Southern Hemisphere blue whales in 2022, the Committee has supported ongoing work compiling the SHBWC to identify re-sightings for capture-recapture analysis of abundance (SC/68B/SH/11). In order to have sufficient time for the Committee to review these abundance estimates, catalogue matching needs to be completed by the 2021 meeting.

The SHBWC is a long-term initiative which has been financially supported by the Committee in order to deliver regional photo-ID based mark-recapture estimates of blue whale abundance. It currently comprises 1,773 blue whales, including 188 identifications added since 2019. Last year (item 3.2 in IWC, 2020c), the Committee agreed to focus catalogue matching within regions and on the southeast Pacific (eastern tropical Pacific, Chile, Peru and Ecuador) and southeast Indian Ocean (Australia, Indonesia and Timor-Leste) catalogues. Photo-ID upload and matching is complete for the southeast Indian Ocean catalogue and nearly complete for the southeast Pacific (SC/68B/PH/02). Additional metadata are required to prepare the southeast Indian Ocean catalogue for mark-recapture analysis. Some additional photo-ID upload is still anticipated for the southwest Pacific (New Zealand) catalogue. Quality coding of photo-IDs within these two catalogues is the next priority before mark-recapture analysis can be conducted. Progress on the migration of this catalogue to IWC servers is almost complete but has been delayed in part by IT personnel changes in the IWC Secretariat. The Committee welcomed the update. Further details are given in Item 8.2.9.

Attention: SC, S

In order to progress the Comprehensive Assessment in this region, the Committee **agrees** *that southeast Indian, southwest and southeast Pacific catalogue data should be matched only up to 2018, with the choice of timespan for each determined once the spread and density of each mark recapture dataset has been reviewed by an Intersessional Correspondence Group, who will review the development of the mark-recapture dataset, the choice of years and regions to include within each dataset, and to advise on the subsequent analysis framework.*

It also **agrees** *that photo-ID matching should continue as high priority via the following intersessional tasks: (i) addition of missing metadata (year/location) where not yet available (June to December this year); (ii) quality coding of regional catalogues (June to September); (iii) finalising any outstanding matching within the southwest and southeast Pacific catalogues (June to December); (iv) construction of mark-resight datasets for left and right sides (January to February); and (v) conducting mark recapture analyses of abundance (February to April). Recognising that a substantial software update would be required in order to continue maintaining the SHBWC, the Committee also* **recommended** *that the Secretariat provide IT support to help resolve the server migration delays and software and computing issues. This work has financial implications for the Committee.*

An assessment is also planned for central Indian Ocean (CIO) blue whales. Photo-ID information from this region has been uploaded to the SHBWC, but substantial work with regional collaborators is required to produce a comprehensive

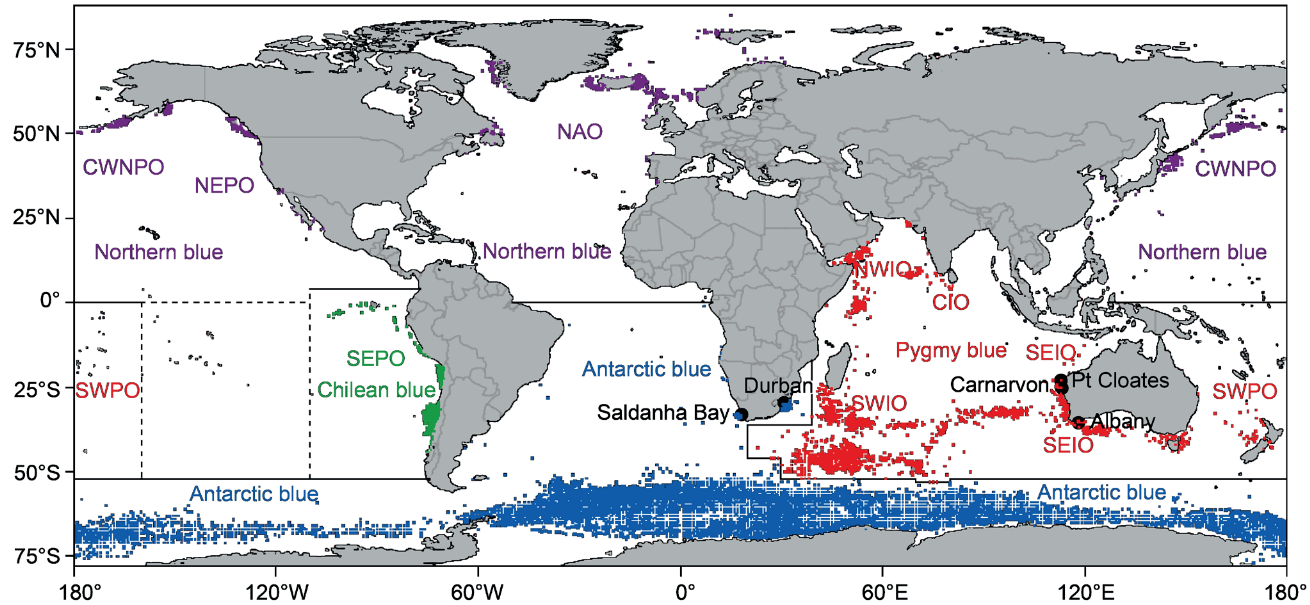

Fig. 3. Global blue whale catches of each of the four generally accepted subspecies (northern blue, Chilean blue, Antarctic blue, and pygmy blue), showing assumed boundaries in black used to enclose the catches of each. Dashed boundaries enclose an area in the South Pacific with no known blue whale data. Individual populations are shown by acronyms for pygmy blue whales: north-west Indian Ocean (NWIO, Oman), central IO (CIO, Sri Lanka), south-west IO (SWIO, Madagascar), south-east IO (SEIO, Australia/Indonesia), south-west Pacific Ocean (SWPO, New Zealand); Chilean blue whales (SEPO); and 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.

CIO photo-ID catalogue (this includes submission of photo-IDs, addition of metadata to existing submissions and, for some contributors, reconciliation of their photographs prior to upload). The Committee therefore acknowledged that mark-recapture data are unlikely to be available for the CIO population within the planned Comprehensive Assessment timeline. Nevertheless, recognising the conservation concerns associated with this population (IWC, 2019c, p.21), further work should be carried out intersessionally to assess the CIO photo-ID catalogue for potential mark-recapture analysis.

Since Southern Hemisphere blue whale songs vary amongst regions (IWC, 2019f), the Committee has supported a web-based Southern Hemisphere blue whale song library (item 3 in IWC, 2020c) to assess blue whale population distribution and structure. which will enable researchers to compare their blue whale acoustic recordings with validated song archetypes. The library is close to completion and should be launched on the IWC website (*https://iwc.int/blue-whale*) in mid-2020.

Work towards a Comprehensive Assessment of non-Antarctic Southern Hemisphere blue whales began in 2017, with initial results presented in 2018 (item 3.1 in IWC, 2019f). The southeast Pacific blue whale population is geographically more distant, and the Committee agreed to assess this population as a single unit (IWC, 2016b). As the other populations include areas of geographic overlap, pre-assessment analyses have focussed on using acoustic data to delineate populations (Širovič *et al.*, 2018) and to assign catches based on acoustic patterns (Branch *et al.*, 2019). Catch estimates for each population were presented in 2019 for the southwest and southeast Indian Ocean, southwest Pacific and northern Indian ocean as a single unit (item 3.2.2 in IWC, 2020c). However recent identification of a second song type in the northern Indian Ocean suggested that this area contains two acoustically distinct populations: the northwest Indian Ocean and central Indian Ocean (Cerchio *et al.*, 2020; IWC, 2019f).

Intersessional work was therefore conducted using acoustic patterns to allocate catches between these two northern Indian Ocean populations (Fig. 3; SC/68B/SH/09). The regional acoustic datasets were expanded, a neural network model was developed in collaboration with Microsoft AI for Earth to detect and identify blue whale songs within the Indian Ocean hydrophone data, and account was taken of song seasonality in the spatial catch allocation model. Catch allocation was also improved via modifications to the model fitting and bootstrapping, to assign catches to the five putative blue whale populations (southwest Pacific SWPO, southeast Indian SEIO, southwest Indian SWIO, northwest Indian NWIO and central Indian CIO). This work is anticipated to be completed by 2021 and the finalised catch series can be used to conduct a Comprehensive Assessments where abundance and trend data are available. Continued development of new methods for rapid analysis of large acoustic datasets is welcomed, with a recommendation to ensure the efficacy and performance of the approach, are well documented via a peer-reviewed paper that quantifies false positive and false negative performance, variation in performance in different ambient noise regimes and acoustic habitats, as well as the speed of the method and the usability of the tool to a diverse group of researchers.

Table 8

Available abundance and trend estimates for Southern Hemisphere non-Antarctic blue whales.

Location	Method	Time-series	Demographic parameters	Citation	Consider for Comprehensive Assessment?
Southeast Pacific					
18°30'-38°S	Line transect survey	1997/98	Abundance: spatial model used to estimate 303 whales (95% CI 176-625)	Williams *et al.* (2011); Williams *et al.* (2017)	Used in 2011 population assessment. Survey spanned broad area north of Gulf of Corcovado, the current main concentration area (item 5.3.1.1 in IWC, 2017d). Remains primary abundance estimate for Comprehensive Assessment unless SHBWC catalogue yields spatially representative abundance estimate.
Northern Gulf of Corcovado 41°45'-42°12'S (includes also Chañaral 26°S but no re-sightings between areas)	Mark recapture analysis	2006-12	Abundance: POPAN super-population estimate for 2012: 762 (95% confidence intervals, CI=638-933) and 570 (95% CI=475-705) for left and right-side datasets respectively	Galletti Vernazzani *et al.* (2017)	No re-sights between Gulf of Corcovado and Chañaral suggests abundance may be area specific (Item 5.3.1.1, (IWC, 2017d). Not likely representative of whole population.
Dataset above	Mark recapture framework including residency/ transience components	2006-12	Abundance: for mid-year of 2008, open population estimate=450 (CV 0.17), closed population estimate=576 (CV 0.16). Uses Cooke *et al.* (2016) model	Appendix 6, IWC (2017d)	Analysis yielded abundance estimates very similar in magnitude to those presented by Galletti Vernazzani *et al.* (2017) but accounts better for differing proportions of residents and transients using the area in each year (item 5.3.1.1 in IWC, 2017d). More optimal mark-recapture modelling approach but not likely to representative of whole population.
Gulf of Corcovado 41-46°S	Line transect surveys	2009, 2012, 2014	Abundance: for 2009 (year with most data available), preferred species distribution model estimate: 373 (95% CI: 191-652)	Bedrinana-Romano *et al.* (2018)	Represents density of animals within region rather than of Chile more broadly. Not likely representative of whole population.
Southwest Pacific					
South Taranaki Bight, New Zealand	Mark recapture analysis	2004-17	Abundance: closed model in multimark (using both right and left side data), estimate: 718 (SD=433, 95% CI 279-1926)	Barlow *et al.* (2018)	ASI review group suggested additional analyses of the data (item 2.1.3 in IWC, 2020j). Request additional analysis and use if SHBWC updated abundance estimate is not available.
Southeast Indian Ocean					
Perth Canyon, Australia	Mark recapture analysis	2000-05	Abundance: best fitting open population model estimate was 791 (95% CI: 569-1,147)	Jenner *et al.* (2008)	Perth Canyon may not be representative if there is substructure between different areas (Item 5.1.3 in IWC, 2009). Use if SHBWC updated abundance estimate is not available.
South of SW Australia	Line transect survey	1993	Abundance: distance-sampling estimate was 671 (CV=0.45, 95% CI 279-1,613)	Kato *et al.* (2007)	Covers only a portion of total habitat 35-45°S, 115-125°E. Mark-recapture estimate likely to be more representative of whole population.
Exmouth, NW Australia (21°30'S)	Acoustic detections	2004	Abundance: based on number of individual whales calling during southward migration from Indonesia to Australia: 1,110 with a range of 662-1,559	McCauley and Jenner (2010)	Based on satellite tracking, this location covers most or all SEIO blue whales, but many assumptions involved in converting calls to abundance. Better to use mark-recapture estimates.
Portland, South Australia (141.2°E)	Acoustic detections	2004-16	Trend: regression of instantaneous number of singers through time yielded 4.3% ± 6.9%	McCauley *et al.* (2018)	Suggest review of the approach (see Item 8.2.1.2). Encourage re-analysis using approach developed by SORP Acoustic Trends Working Group.
Southwest Indian Ocean					
Madagascar Plateau (25-35°S, 40-45°E)	Line transect survey	1996	Abundance: estimate was 424 (CV=0.42), or 472 (CV=0.48) whales when 'like blue' sightings were included	Best *et al.* (2003)	Yes. Only estimate available. Data collected during December. At this time there are also many animals in NW Madagascar so this is likely an underestimate – it may not reflect peak density. As this is small portion of likely area, perhaps extrapolate to other areas to obtain something more representative? Spatial models from acoustic data may be useful for scaling.
Central Indian Ocean					
Sri Lanka (5°28'N-5°53'N)	Line transect survey	2014-15	Abundance: 270 blue whales (CV=0.09, 95% CI 226-322) within survey area	Priyadarshana *et al.* (2016)	Yes. Only estimate available. Represents a very restricted area and area of high blue whale concentration.

For the populations that overlap spatially, SC/68B/SH/09 proposed to focus on conducting full Comprehensive Assessments of the southeast Indian Ocean and southwest Pacific Ocean populations, and 'minimum-level' assessments of the southwest Indian Ocean and central Indian Ocean (because available abundance data represent minimum values rather than being representative of abundance of the population). At present it is not possible to assess the northwest Indian Ocean as there are no survey or abundance data available; additionally, the range of this population is poorly understood. The Committee **agreed** with this proposal, noting that most abundance estimates are from surveys of small areas within the larger range of each population, and are therefore expected to represent minimum estimates, and not necessarily represent the whole population. The abundance estimates summarised in Table 8 will be reviewed by the WG on ASI to assist with determining suitable inputs for the Comprehensive Assessment. Recognising the importance of the catch allocation process for conducting regional blue whale population assessments, further work should be conducted to finalise catch allocations and trial preliminary population assessment models in order to determine appropriate models for the Comprehensive Assessment. This has financial implications for the Scientific Committee (see Item 8.2.9).

Attention: SC, G
To complete pre-assessments of Southern Hemisphere pygmy and southeast Pacific blue whales, the Committee **agrees**:

(1) *that development of the Southern Hemisphere Blue Whale Catalogue continue, with a priority focus on: (i) finalisation of photo-ID matching within the southeast Pacific; (ii) addition of southeast Indian Ocean (Australian) metadata to associate photo-IDs with sighting date and location; (iii) quality control of southwest Pacific, southeast Pacific and southeast Indian Ocean photographs to finalise datasets for mark recapture analysis and estimation of regional blue whale abundance; (iv) assessment of the suitability of the central Indian Ocean blue whale dataset for mark recapture analysis; and (v) review and compilation of photo-ID data from Madagascar within the SHBWC; and*
(2) *with the finalisation of regional catch scenarios and the construction of preliminary population assessment models for pygmy and southeast Pacific blue whales, to proceed to a Comprehensive Assessment of these populations.*

8.2.2 Antarctic blue whales (SH)

The Committee is preparing for a new *In-Depth Assessment* of Antarctic blue whales; the last assessment (Branch, 2008) concluded that, whilst increasing, Antarctic blue whales were at only 0.9% (95% Probability Intervals 0.7-1.0%) of their pre-exploitation level (IWC, 2009, p.237). In 2019, the Committee developed a four-year timeframe for the *In-Depth Assessment*, due to conclude in 2023 (IWC, 2020c). In 2020, the Committee received updates on blue whale population structuring and information on biological parameters which can inform the *In-Depth Assessment*.

The Committee were informed that multiple recent Antarctic voyages have conducted concurrent sighting and passive acoustic surveys of Antarctic blue whales (SC/68B/CMP/22; Double *et al.*, 2015; Jackson *et al.*, 2018; Miller *et al.*, 2014; 2017; 2019; Olson *et al.*, 2013). The data from those voyages can be used to test and/or quantify the relationship between singing-rate and local male abundance. Such information would greatly assist in interpretation of long-term high latitude acoustic trends. Furthermore, voyages in 2013, 2015 and 2019 also contained focal follows of Antarctic blue whales. Analysis of these tracks will allow for testing/quantifying the relationship between whale acoustic behaviour and visually observed behaviours. Concurrent collection of biopsies and acoustic recordings during these voyages may also help to test the links between acoustic and genetic population identity. This is relevant since acoustics are being used as a proxy for the population identity of non-Antarctic blue whales (IWC, 2019f).

SC/68B/ASI/17 reported the results of 2019/20 JASS-A dedicated sighting survey program, conducted in the western part of Area III (000°-015°E; south of 60°S). The total searching distance was 1,447.9 n.miles during which 19 schools (20 individuals) of Antarctic blue whales were observed. A total of 20 individuals was photographed and 10 biopsy samples (individuals) was collected. The data will be analysed for abundance estimates and stock structure studies at the Institute of Cetacean Research.

The Committee were informed about a cetacean survey in waters around sub-Antarctic islands between about 53-55°S and 35-39°W in January and February 2020. The survey focussed on southern right whales (see Item 9.1.2) but which opportunistically collected other whale sightings during 1,147 n.miles of visual transect (SC/68B/CMP/22). During 23 survey days blue whales were encountered 38 times (~59 individuals), with 25 photo-IDs and 9 biopsies collected. This unprecedented number of sightings of blue whales suggests that these waters are becoming an important summer feeding ground for this species again.

The Committee were also informed that an annotated library of underwater acoustic recordings for testing and training automated algorithms for detecting Southern Ocean Antarctic blue and fin whales was now complete (SC/68B/SH/05).

The Committee welcomed these updates and encouraged the continuation of these surveys to understand blue whale occurrence, density, population identity and movements better.

8.2.2.1 Population Structure

To progress preparation for assessment, in 2019 the Committee requested a review of Antarctic blue whale population structuring to determine whether they should be assessed as a single entity, or as multiple population units. This review considered available genetic, acoustic, photo-ID, satellite tagging, sightings, catch and Discovery Mark data (SC/68B/SH/03), concluding that there is not currently conclusive evidence that breeding population structure exists within the Antarctic blue whale subspecies, and highlighting that small sample sizes in some areas (e.g. Antarctic Areas I, II and VI, see Sremba *et al.*, 2018) also limit the power to detect structure even if it were present. Noting that a new single nucleotide polymorphism (SNP)-based analysis of circumpolar population structure is underway (Bell, 2018, p.21), the Committee suggested that redundancy analysis using nuclear genotypes as the response variable and mitochondrial DNA (mtDNA), stable isotopes, skin microbiome data or possibly acoustics as explanatory variables could be a useful means of exploring these data for evidence of breeding ground population structure. The Committee invited updates on these topics at the 2021 meeting.

Genetic evidence shows that pygmy blue whales are present at high latitudes in Antarctic Area III (Attard *et al.*, 2012); this information may need to be factored into the In-Depth assessment. Catch allocations for Antarctic blue whales should be correct as they are assigned using length data and ovarian corpora (Branch *et al.*, 2007; 2009), but abundance estimates might include a small proportion of non-Antarctic blue whales particularly in Area III. Attard *et al.* (2012) reported genetic evidence of both hybrids (suggesting shared wintering areas) and migrant individuals in Antarctic Area III using a comparison of Antarctic blue whales and southeast Indian Ocean (Australian) blue whales. However non-Antarctic blue whales using Antarctic Area III are likely to be from the southwest Indian Ocean population, also associated with a feeding area off Madagascar (Best *et al.*, 2003). IDCR-SOWER samples from the Madagascar plateau have been analysed (LeDuc *et al.*, 2007) and an additional sample collected recently. Comparison of these southwest Indian Ocean samples with Antarctic samples using multiple nuclear genotypes (e.g. via the upcoming circumpolar SNP study, or further investigation of the dataset analysed by LeDuc *et al.*, 2017) would be useful to investigate evidence of non-Antarctic blue whale migration into the Southern Ocean and hybridisation rates with Antarctic blue whales. Additional genetic samples from the northern Indian Ocean will also be important in establishing the genetic identity of blue whales in the region and possible movements into the Southern Ocean (see Item 8.2.1.5). In discussion, the Committee also agreed that intersessional review of all photo-IDs collected in Antarctic Area III is required; morphologically, non-Antarctic blue whales appear to have heavier lesion loads, and differences in proportion can also be seen if the tail stock has been photographed. This review is important because Antarctic blue whale photo-IDs are being used to generate a new abundance estimate for the assessment, so exclusion of possible non-Antarctic blue whales would be valuable in this process.

Antarctic blue whales show significant differentiation in mtDNA between some IWC management areas (SC/68B/SH/03, Sremba *et al.*, 2012). Current patterns suggest that Antarctic blue whales range widely across the Southern Ocean in the summer, and there are few if any data available from most high-latitude oceanic areas to evaluate fidelity to wintering grounds. No wintering ground data are available to inform abundance, trend or population identity, so even if there are distinct population units, they cannot be assessed separately. Similarly, given the poorly defined differentiation of feeding grounds, assessment by regional feeding ground abundance and catch data is unlikely to provide biologically meaningful results. The Committee will therefore proceed with a circumpolar-only In-Depth assessment of Antarctic blue whales.

There is a single song type for Antarctic blue whales (Širovič *et al.*, 2009), with no evidence for the degree of dialectical variation seen among songs of Southern Hemisphere non-Antarctic blue whale populations (McDonald *et al.*, 2006; Širovič *et al.*, 2018). However, it is possible that there are subtle diagnostic differences within songs. To detect these if they occur would require a quantitative comparison of Antarctic blue whale songs from different low-latitude regions using recordings with high signal-to-noise ratios, and most low-latitude data are available from distant animals only (and see Item 8.2.9). Such an analysis must be designed to account for sources of variability and with sample sizes to allow for sufficient statistical power. These data should be combined with other relevant data (e.g. genetics, isotopes) in a redundancy analysis to assess structure.

Combined genetic and stable isotopic analyses to investigate blue whale population structuring are underway separately for: (i) blue whale bone samples from the early whaling period in the Antarctic Peninsula (Area I) and the southwest Atlantic[10] (Area II - see SC/68B/SH/06); and (ii) a large collection of baleen plates from Areas V and VI (IWC, 2019f). SC/68B/SH/06 examined genetic differentiation patterns of 'pre-whaling' Antarctic blue whales (*n*=30 bones) from the southwest Atlantic and the western Antarctic Peninsula (26 mitochondrial, mtDNA, haplotypes) compared to 'post-whaling' Antarctic blue whales (*n*=183 individuals, 52 haplotypes). Patterns showed a significant loss of diversity over time and revealed significant differentiation between early and post-whaling samples across Areas II-VI.

[10]Waters around Antarctic islands between about 53-55°S and 35-39°W.

In discussion, it was noted that additional early whaling material from Norwegian museums may be available. Researchers working on these collections are encouraged to combine datasets and conduct a circumpolar analysis of these data to identify any regional patterns. Historical samples from the early whaling period can be informative about population structure prior to exploitation, the Committee **encouraged** further collection of bone material from this period for such analyses, particularly from high latitude whaling grounds.

Differences in mtDNA frequencies of pre-whaling samples from the island at 54°15'S 36°45'W and post-whaling samples from IDCR/SOWER surveys may be attributed to a circumpolar loss of haplotypes due to a population bottleneck or to local extinction of a population showing some fidelity to that area; these two explanations are not mutually exclusive. The small sample sizes available from Antarctic Areas I and II were also highlighted and it was suggested that: (1) circumpolar studies try to harmonise sample sizes where possible; and (2) the use of nuclear markers (e.g. single nucleotide polymorphisms, SNPs) could improve the power to assess structure. A circumpolar SNP-based analysis of blue whale population structure is underway and presentation of these results in 2021 is encouraged as is further biopsy collection from Areas I and II (e.g. recent collection of n=9 contemporary samples in Area II reported in SC/68B/CMP/22, Area I biopsy collection n=1 by Bob Pitman).

In 2019, the Committee noted the possibility that southeast Pacific blue whales may also visit that area of the southwest Atlantic, based on a small number of acoustic detections of their song there (Pangerc, 2010). While the detections suggested the caller was a vagrant (it was briefly and faintly detected during winter, in August), genetic analysis of blue whale bones also revealed a mtDNA haplotype identified within both the southeast and northeast Pacific populations (LeDuc *et al.*, 2007; 2017). To examine this further, the Committee had encouraged: (1) matching of photo-IDs between Chile (n=478) and the southwest Atlantic; and (2) assessment of length data in catches made near the island at 54°15'S 36°45'W, to estimate the potential proportion of southeast Pacific blue whales in the catch record.

No photo-ID matches were found between these areas (SC/68B/SH/13) but the genetic data suggested only 1-2% non-Antarctic blue whales (LeDuc *et al.*, 2017) so a lack of matching with only 23 photo-IDs is not conclusive. Therefore, any new photo-IDs available from this region (e.g. SC/68B/CMP/22) should be recorded within the catalogue and reviewed for Antarctic blue whale morphological indicators for any future matching effort with lower-latitude catalogues.

SC/68B/SH/16 reported a mixture model analysis of the lengths of sexually mature female blue whales, conducted using southwest Atlantic catch data from the island at 54°15'S 36°45'W from 1923/24 onwards (earlier estimates were considered to be unreliable) and found that around 3.3% (95% CI 1.6-5.1%) of catches were southeast Pacific blue whales although if the analysis took into account rounding in reported lengths, estimates were not statistically different from zero (mean 0.6%, 95% CI 0.0-2.6%).

In discussion, it was noted that the although the southeast Pacific haplotype was found in the southwest Atlantic bones, whole mitogenome sequencing of those bones showed other genetic differences (Sremba *et al.*, 2018), so may not necessarily be southeast Pacific in origin. Some Antarctic and southeast Pacific haplotypes are genetically similar (LeDuc *et al.*, 2007). Thus this sample may represent:

(1) an Antarctic blue whale haplotype not yet detected due to low levels of genetic survey of this subspecies (or loss of haplotypes during the whaling period); or
(2) a hybrid (Attard *et al.*, 2012) with a southeast Pacific mtDNA haplotype but nuclear profile shared with Antarctic blue whales.

Further sequencing of more nuclear markers for comparison between the Antarctic and southeast Pacific region, to distinguish whales in the two areas and better establish the population identity of this bone is encouraged and genomic sequencing is underway for the southwest Atlantic bone to address this question.

The Committee noted that while acoustic, catch, and genetic data suggest it is most likely that southeast Pacific blue whales are occasional vagrants in the southwest Atlantic, a geographic overlap cannot be fully excluded. However, the historical evidence suggests southeast Pacific blue whales did not commonly occur there during the early whaling period, and the Committee **agreed** that the base case catch allocation for the upcoming assessment should assign all catches from the area around the island at 54°15'S 36°45'W to Antarctic blue whales.

Blue whales are flexible in their seasonal distributions, which are particularly associated with areas of high productivity. The available photo-ID data do not support a Chilean blue whale presence in the southwest Atlantic but lack power; acoustic monitoring may provide greater power to identify any contemporary overlap. Further acoustic monitoring in the Scotia Arc to characterise blue whale seasonal patterns, particularly during winter, is encouraged as is nuclear genome-wide analysis of the southwest Atlantic blue whale bone containing the southeast Pacific haplotype (Sremba *et al.*, 2018), to better identify population origin. An isotope analysis of the southwest Atlantic and the Antarctic Peninsula blue whale bones is underway that may inform population structure analysis further. These data could also be compared with contemporary isotopic data from the Southeast Pacific area, with appropriate correction for the difference in time and source material.

Attention: SC, G, CG
The Committee **encourages**: *(i) further collection of biopsy samples from Antarctic blue whales in order to resolve population structuring better, particularly in under-sampled Antarctic areas; (ii) 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; (iii) circumpolar analysis of stable isotope data from bone and baleen to assess evidence for population structuring; (iv) genomic sequencing of the southwest Atlantic blue whale bone that contains a southeast Pacific blue whale haplotype, to establish its population identity; and (v) a review of Antarctic blue whale photo-IDs to identify any whales that visually resemble non-Antarctic types.*

To highlight the importance of integrated analyses using multiple lines of evidence to detect subtle structure, the Committee **strongly encourages** *combined analyses of genetic, isotopic, acoustic and other data types to establish if there is any evidence for breeding population structure in Antarctic blue whales.*

The Committee **encourages** *year-round acoustic data collection from the Scotia Arc in order to assess seasonal blue whale occurrence.*

8.2.2.2 Wintering Grounds

Antarctic blue whale wintering grounds are poorly known but acoustic records suggest a widespread presence at lower latitudes of the Southern Hemisphere (Širovič *et al.*, 2018). Many offshore acoustic recorders are placed in Sound Fixing and Ranging (SOFAR) ocean channels, which facilitate sound propagation over great distances and consequently can result in detection of very distant calls. The months shown indicate peak presence, and times when Antarctic blue whales are likely within 200km of the recording location (Fig. 4).

SC/68B/SH/08 reported the acoustic detection of Antarctic blue whale song in the northern Mozambique Channel off northwest Madagascar. During 28 months of monitoring, song was detected consistently (sometimes several individuals) during the Austral late autumn/early winter, with a yearly unimodal peak between May and September; the high signal-to-noise ratio suggested a distribution relatively near to the coast. The region may thus represent wintering breeding habitat and be near the northern extent of the wintering range, probably for whales coming from Antarctic Area III.

Other potential Antarctic blue whale wintering grounds include the greater Galápagos region (acoustic detections, Stafford *et al.,* 2004), offshore South Africa, Namibia and Angola based (historical catches, Best, 1994), the Lau Basin off Tonga and Samoa (Balcazar *et al.*, 2017) and recent sighting reports from Brazil (Fábio Daura Jorge, pers comm.; Rocha *et al.* (2019). Most locations are sufficiently remote to make surveys logistically challenging, and in some areas (e.g. Galápagos, southwest Pacific region) a predominance of southeast Pacific or pygmy blue whales at the same time may make visual identification more difficult.

The Committee also discussed the potential value of environmental DNA (eDNA) sampling to improve understanding of blue whale presence patterns (i.e. collection and genetic analysis of water samples); eDNA can yield mitochondrial DNA (mtDNA) control region fragments of sufficient length (~360bp; Baker, unpublished data) to allow Antarctic and non-Antarctic blue whales to be differentiated with some degree of confidence based on haplotype frequencies (LeDuc *et al.*, 2007; Sremba *et al.*, 2012). However, specific non-Antarctic blue whale populations would be hard to distinguish in some

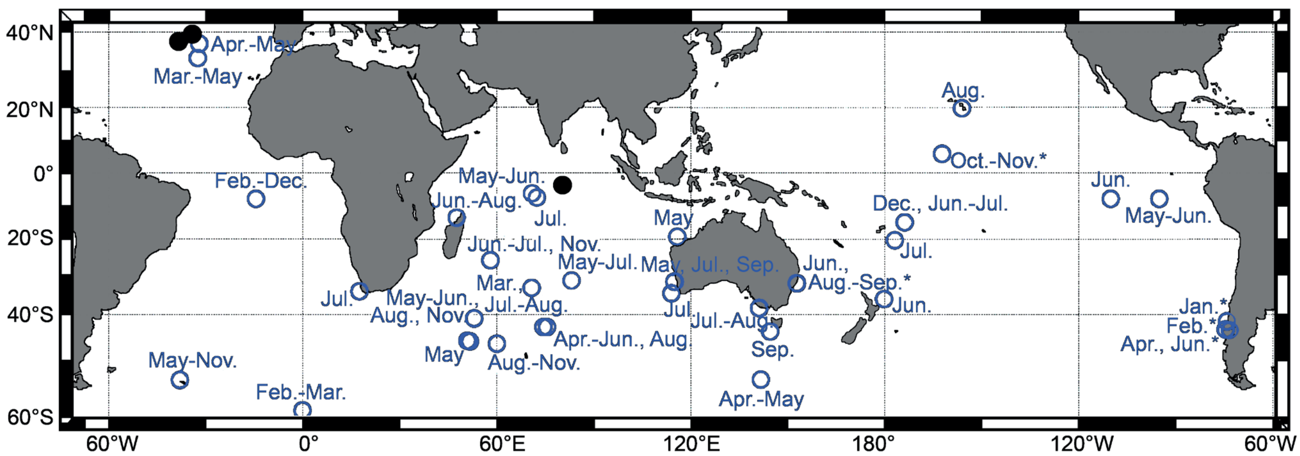

Fig. 4. Locations of Antarctic blue whale songs reported between 40°N and 60°S are marked with blue circles. Months included for each site indicate peak months of detection. In most cases year-round recordings were available. If three or more months of recording were missing per year, those peak months are marked with an asterix. A black dot marks location where full year of recording exists and no Antarctic blue whale songs were recorded. [Reproduced from Širovič *et al.*, 2018).

areas (e.g. in the Indian Ocean) because data to genetically identify populations are lacking and levels of differentiation between neighbouring populations are likely low (Barlow *et al.*, 2018). While eDNA samplers can be attached to acoustic moorings and programmed to collect samples, whales usually have to be very close for genetic detections to be made and an understanding of local oceanography is important as water mass movements have a strong influence on eDNA detection patterns (Pinfield *et al.*, 2019). There is some evidence that eDNA yields may be affected by water temperature, and that this approach may be more successful in cold waters where DNA degradation is less (Cowart *et al.*, 2017; Harrison *et al.*, 2019; Strickler *et al.*, 2015). A direct comparison of eDNA and acoustic detections is underway for northeast Pacific whales, and a similar study is underway for Omura's whales.

Attention: SC, R

Given the significant data gaps in current understanding of Antarctic blue whale wintering grounds, the Committee **strongly encourages** *further research to identify and characterise these lower-latitude wintering grounds, noting that they were likely to be associated with areas of elevated oceanic productivity, including:*

(1) *vessel surveys off northwest Madagascar to collect photo-ID and genetic samples from the whales wintering in these waters (acoustic data suggest this is feasible) for comparison with similar datasets available from Antarctic Area III (e.g. SC/68B/PH/04; Sremba et al., 2012);*
(2) *better characterisation of Antarctic blue whale temporal density and distribution patterns off the west and south coast of South Africa (which may also provide useful occurrence information on other species such as Bryde's whales); and*
(3) *efforts to collect and analyse eDNA samples.*

8.2.2.3 Abundance and Trends

In 2019, the Committee had strongly encouraged further work to update the abundance estimate for Antarctic blue whales derived by photo-ID matching of images submitted to the Antarctic blue whale catalogue. An update on matching of newly acquired images within this catalogue (SC/68B/PH/04) is discussed under Item 20.2.5. No new abundance estimate was presented, but one will be forthcoming in 2021.

The IWC-SORP Acoustic Trends Working Group aims to deliver a robust regional estimate of trends in Antarctic blue whale song density to the Committee in 2021, and a circumpolar estimate of Antarctic blue whale trends by 2022 (SC/68B/SH/04). Currently the Group is: (1) working towards improving coverage of circumpolar acoustic recordings of blue (and fin) whales; (2) standardising analysis methods to move beyond regional analyses and towards circumpolar analyses (see project reports in SC/68B/SH/05); and (3) developing a robust method for measuring long-term, regional and circumpolar trends in male song abundance.

Attention: SC, R

In order to conduct a new In-Depth Assessment of Antarctic blue whales within the next four years, the Committee **reiterates** *(IWC, 2019c, p.22) that it* **strongly encourages** *further work to update the abundance estimate and trend estimates for Antarctic blue whales from mark-recapture analyses and acoustic data.*

The Committee **strongly encourages** *the provision of acoustically derived circumpolar trend data for Antarctic blue whales.*

8.2.2.4 Progress Towards *In-Depth Assessment*

Extensive sex data from blue whales (21,542 foetuses and 311,901 postnatal individuals) were used in SC/68B/SH/01 to calculate patterns in the sex ratio across sub-species, time, space, age and length. Both data types showed a slight but significant male skew. Historically, Antarctic catches shifted from slight male-dominance before 1951 (52.4% male) to slight female-dominance thereafter (48.0% male), even though females are larger and were hence preferentially selected by whalers. Overall, blue whale sex ratios were very close to equality across time, space, and length; deviations from equality were explained best by the larger sizes attained by females, together with size selectivity in whaling due to economics and regulations.

The Committee noted that these patterns suggest that *In-Depth Assessment* models of Antarctic blue whales do not need to model sexes separately and therefore agreed that the Antarctic blue whale *In-Depth Assessment* should be conducted using sex-aggregated models.

Attention: SC, R

The Committee **agrees** *that the In-Depth Assessment of Antarctic blue whales should focus on a single circumpolar population, using sex-aggregated models, with all the catches from the island at 54°15'S 36°45'W assumed to comprise Antarctic blue whales.*

8.2.3 Southern right whales not the subject of CMPs (SH)

In 2016, the Committee agreed to start the process of gathering pre-assessment information (e.g. population structure, abundance, trend, catches) in order to conduct regional *In-Depth Assessment*s of southern right whales (item 10.8.1.5 in IWC, 2017e). This year, new information was received on regional population abundance, trends and population demography.

8.2.3.1 South Africa

The Committee welcomed the results of the 2019 survey of southern right whales flown along the coast of South Africa, part of an uninterrupted, long-term monitoring programme since 1979 (SC/68B/SH/02). It recorded the second lowest number of cow-calf pairs (*n*=94) along the South African coastline in October since 1995, in contrast to the record numbers (*n*=536) seen during the 2018 survey. For the third consecutive year, data indicated a clear shift in peak presence of cow-calf pairs to earlier in the year. Photo-ID data again indicated high levels (20%) of females with 5-year calving intervals in 2019. The second lowest number of unaccompanied adults since the commencement of the aerial surveys was also recorded.

Analyses based on a refined demographic model for South African southern right whales (including data up to 2019) will provide updated estimates of demographic parameters and is now nearing completion (SC/68B/SH/15). An assessment of South African population dynamics in relation to foraging ecology based on stable isotope data and habitat modelling is also underway (SC/68B/SH/15) and the Committee looks forward to an update at the 2021 meeting.

Attention: SC, CG, R

The Committee **reiterates** *(IWC, 2019c, p.27) the value of and its* **strong support** *for the South African long-term right whale monitoring programme to understand right whale population trends and dynamics and* **recommends** *that this monitoring continue. In addition, the Committee:*

(1) **encourages** *early planning for the upcoming season to take account of potential COVID-19 lockdown measures and identify ways to conduct the 2020 aerial surveys safely so as to avoid interruption of this crucial long-term programme;*

and reiterates that it:

(2) **encourages** *further work to understand and assess the impact of climate drivers underlying South African southern right whale population dynamics including calf productivity; and*

(3) **recommends** *further development of the South African southern right whale population dynamics model in order to provide a good representation of the underlying population dynamics.*

8.2.3.2 Australia

The Committee welcomed an update on two projects funded by Australia's National Environmental Science Programme (SC/68B/SH/15). The first is an initiative to collate photo-ID catalogues collected across Australia (southwest and southeast calving grounds) into the Australasian Right Whale Photo Identification Catalogue (ARWPIC), so as to assess regional abundance and population connectivity patterns. Most catalogues have been collated but further funds are needed for some outstanding datasets (including from a major aggregation area at Head of Bight that is ~40% outstanding), and to collate data on small or emerging calving grounds in southwestern Australia and historical surveys.

The second project is the long-term aerial survey in southwest Australia, led by the Western Australian Museum (1975-current), which provides information on regional abundance trends. An aerial survey of the 'Western' subpopulation was successfully conducted over six days in August 2019, adding to the annual, long-term survey data set started in 1993 by John Bannister. Current funding allows for another survey planned for August 2020; funding beyond 2020 is currently uncertain. The 2019 survey recorded 221 cow/calf pairs and a total count of 557 right whales. Due to considerable annual variation in whale numbers and cycles in population growth, reliable estimates of long-term changes in abundance, fecundity and survival require a long-term data series. Continued annual surveys will also strengthen capacity to identify ongoing and emerging threats that may impede recovery of this population. The Committee invited a full report on these surveys for the 2021 meeting.

The Committee also welcomed an update on long-term southern right whale cliff-based research at the major aggregation area at the Head of the Great Australian Bight, South Australia (1991-current) which assesses relative abundance, distribution, health and life histories. The 2019 survey spanned 21 days (15 July-31 August). Overall, high inter-annual variation was evident with 2019 representing the smallest cohort of breeding females visiting the site. The major Head of the Bight calving ground appears to have reached saturation capacity based on maximum packing density, and immigration and emigration to and from the site (Charlton *et al.*, 2019), leading to increased abundance at small and emerging calving grounds (Charlton *et al.*, 2019). An increase in 4 and 5-year calving intervals has been observed in recent years. Modelling of calving intervals and assessment of links to climate variables is needed to better understand drivers of these recovery patterns. Population modelling is underway using models developed for southern right whales in South Africa by Brandão *et al.* (2018). The Committee looks forward to an update at SC68C.

Assessments of health and body condition (through photogrammetry and visual health assessment) in relation to reproductive patterns are underway in Australia, following Christiansen *et al.* (2018). Further information is given under Item 8.2.3.5 and the Committee looks forward to an update at SC68C.

The southeast Australian right whale population differs genetically from the south and western Australia population (Carroll *et al.*, 2011), and, as it is much smaller (*ca* 68 breeding females; Stamation *et al.*, 2020) probably more vulnerable to anthropogenic threats. Consequently, the Committee welcomed news that new population abundance and trend estimates for the southeast of Australia has been developed by Stamation *et al.* (2020). Noting that insufficient time was available to review this information during the 2020 meeting, an intersessional review of this abundance estimate will be undertaken by the Working Group on ASI. An assessment of calving intervals, site fidelity and long-range movements in southeast Australia is being finalised and will be presented at SC68C.

Attention: SC, G, CC, CG

The Committee **reiterates** *(IWC, 2019c, p.27) its* **strong support** *for the Australian systematic long-term right whale monitoring programmes, to understand right whale population trends and dynamics, and* **recommends** *that this monitoring continue. The Committee also* **encourages**:

(1) *the ongoing work to establish levels of population connectivity between the two Australian calving grounds and to estimate regional abundance and* **recommends** *that Australian catalogues be combined into a single database in order to achieve this;*
(2) *further work to model population demography across Australia and to investigate potential links between the increase in calving intervals, health and climate; and*
(3) *the collection of biopsy samples and systematic aerial survey data from the small southeastern population to complement the long-term dataset from southwestern Australia to significantly enhance understanding of population trends, habitat use and constraints to recovery, thereby improving conservation and management.*

8.2.3.3 New Zealand

A summary of ongoing work on aerial photogrammetry, estimates of demographic parameters and genetic monitoring for New Zealand southern right whales (SC/68B/SH/15) was received and detailed reports are anticipated at the 2021 meeting.

Fieldwork planned in the sub-Antarctic Auckland Islands (austral winters 2020 and 2021) includes: (1) satellite tagging to understand habitat use; (2) photogrammetry to assess whale health; (3) collection of biopsies for stable isotope analysis and genetic sexing; (4) collection of individual life-history data to facilitate assessment of linkages between health, reproduction and climate; and (5) continued genetic monitoring of the population in order to develop mark recapture based abundance and growth rate estimates for the New Zealand population using close-kin methods.

The Committee welcomed this update, noting the strong links between the planned research and IWC-SORP Theme 6 priorities (Item 8.2.3.5) and **endorsed** the Auckland Islands research plan.

8.2.3.4 Feeding Grounds

Updates on southern right whale habitat use in their southwest Atlantic feeding grounds (SC/68B/CMP/19 and SC/68B/CMP/22) are discussed under Item 9.1.2 and new information on migratory routes is given in SC/68B/SH/04. The Committee was also advised of opportunistic (but nevertheless systematic) sightings surveys, led by the Alfred Wegener Institute, Germany, aboard *RV Polarstern* during which southern right whales were occasionally recorded in the southwest Atlantic.

The intersessional southern right whale IWC-SORP Workshop (SC/68B/SH/07) proposed that opportunities for assessing southern right whale distribution, using the Southern Ocean hydrophone network (SOHN) and Australian Ocean Data Network - Integrated Marine Observing System, should be investigated with high priority. In this regard, it was noted that Australia's Integrated Marine Observing System (IMOS) includes acoustic observations on the southern continental shelf edge of Australia and that these data have been analysed to assess presence/seasonality of whales including blue (McCauley *et al.*, 2018) and fin whales (Aulich *et al.*, 2019). Although southern right whale detections are rarely made via the SOHN in the high latitudes of the South Atlantic, some detections may have been made via this network close to Elephant Island. Further analysis of acoustic data collected in the area (including IWC-SORP voyage data collected by Argentina) is required. An Intersessional Correspondence Group was formed to progress this topic intersessionally (Item 8.2.9, and see Annex K) including encouraging communication between: (i) the IWC-SORP right whale theme members; (ii) Committee participants interested in this topic; and (iii) the IWC-SORP Acoustic Trends Working Group, to assess what southern right whale call data exists offshore and at high latitudes (including both IMOS and SOHN data) and to consider an appropriate analysis framework for using these data to assess southern right whale offshore distribution.

8.2.3.5 Progress Towards an *In-Depth Assessment*

SC/68B/PH/03 reports on the development of artificial intelligence (AI) tools to assist the automated matching of right whale photo-IDs. Auto analysis of overhead images is now implemented within the online platform Flukebook[11], and analysis of side-on images is under development. Matching between overhead and side-on images has not yet been developed. Multiple southern right whale photo-ID catalogues have been analysed within this framework and this is encouraged (and see Item 20.2.1).

In 2019 (IWC, 2020a, p.28, item 9.2.4.5), the Committee funded the matching of photo-IDs from Brazil and Argentina to progress the pre-assessment of southwest Atlantic right whales. This completed work (SC/68B/CMP/20) is discussed under Item 9.1.2. Within the Brazilian catalogue, around 14% of whales were matched to the Argentine catalogue up to 2017, a similar level to previous matching exercises extending to 2010 (see table 1 in SC/68B/CMP/20).

The Committee noted the importance of this matching effort towards a better understanding of connectivity and recent growth in the southwest Atlantic right whale calving grounds and encouraged ‘multi-state’ mark-recapture modelling to estimate movement rates between Argentina and Brazil compared to re-sight rates within regions.

The Committee also expressed continued support for a multi-ocean, collaborative initiative that is underway to integrate up to 50 years of southern right whale demographic data from all the calving grounds into a common modelling framework. This aims to investigate correlations between southern right whale abundance trends, calving intervals and environmental variables in the Southern Ocean, and assess population trends in parallel (SC/68B/SH/15). The regional populations with long-term photo-ID and genetic databases available to be included are the southwest Atlantic (Brazil/Argentina); southeast Atlantic (South Africa); Australia and New Zealand. The work contributes to IWC-SORP Theme 6 (SC/68B/SH/04).

The Committee welcomed the report of an intersessional Workshop held to discuss priority research and recommendations for proceeding with the newly formed IWC-SORP Theme 6 (SC/68B/SH/07). The Workshop objectives were to: (1) generate discussion with experts on tools that could be used to address the IWC-SORP Theme 6 objectives; (2) develop a tool to identify research priorities to achieve the IWC-SORP SRW theme objectives; and (3) form working groups[12] under each of the four objectives to increase communication and outreach within the IWC-SORP community and enhance the network for collaborative research.

The Workshop identified the five high priority tasks, summarised below.

(1) *Data collation/collection*: regions which still show limited or no recovery but were historically considered to be calving or nursery grounds, including Tristan Da Cunha/Gough Island, Namibia, Mozambique/Madagascar, Southeast Australia, Uruguay and Chile-Peru.
(2) *Foraging ecology*: (i) research to identify links to foraging grounds via satellite telemetry, particularly in Brazil, New Zealand, and Australia; (ii) collation of candidate prey datasets to increase the power of stable isotope data to identify prey sources and foraging grounds; and (iii) develop links with high and mid-latitude acoustic networks to better specify whale movements and distribution.
(3) *Demography*: (i) continuation of long-term photo-ID and genetic studies in Australia, Argentina, New Zealand and South Africa that permit linkages between demographics, health and climate; (ii) development of a common model to assess demographics within a comparative, multi-ocean framework - further development of this has been recommended for funding by the IWC-SORP Research Fund (SC/68B/O/01).
(4) *Health*: (i) continued assessment of southern right whale health off Argentina, in light of recent die-offs; (ii) for all wintering grounds, photogrammetry work, collection of biopsies for stable isotope analysis and genetic sexing and collection of individual life-history data to facilitate assessment of linkages between health, reproduction and climate; and (iii) development and funding of stranding, necropsy and pathology testing protocols across all regions.
(5) *Climate*: literature reviews to: (i) assess which demographic parameters or indices could be used as climate response variables based on work in other baleen whales or species with similar niches; and (ii) identify what prey database or collection resources are available, and relevant collaborators.

In relation to the planned demographic analyses (3), the inclusion of epigenetic approaches (see item 5.5 in IWC, 2019f) to measure whale age was suggested. To provide age assignments with sufficient accuracy (e.g. for population demographic models), epigenetic approaches require species-specific calibration, using, for example, a ‘test’ population where the ages of many whales are known (such as the Gulf of Maine humpback whales; Polanowski *et al.*, 2014). It was noted that epigenetic analyses are underway with samples collected on the Auckland Island calving ground, to inform close-kin mark recapture assessments of abundance.

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[11]*https://www.flukebook.org/.*

[12]Three IWC-SORP Working Groups are now active: (i) a circumpolar southern right whale photo-ID consortium, which aims to develop standardised processes and protocols for photo-ID matching and sightings databases, to enable southern right whale photo-ID data to be rendered comparable on a circumpolar level; (ii) the Southern Hemisphere Committee working group through the ‘multi-ocean assessment of demographics and links to environmental correlates’ (SC/68B/SH/15); and (iii) the right whale necropsy working group, which collates existing necropsy and sample archive protocols for North Atlantic and southern right whales and develops guidelines for conducting necropsies at different levels of local capacity.

The Committee noted that this approach is of greatest value where relative, rather than absolute, age is required. For example, information on age order between related individuals, rather than absolute age, can provide information useful for both close kin and kinship analyses (see item 6.2 in IWC, 2018e). The Committee looked forward to further updates on the development of this method.

Regional health assessments, identified as a high priority during the recent southern right whale Workshop to better understand the links between health, reproduction and climate, are in progress (see Items 8.2.3.2, 8.2.3.3 and 8.2.3.5 and SC/68B/SH/07). In 2019, recognising that health assessments are most effectively conducted in a standardised manner, e.g. Christansen *et al.* (2020), the Committee encouraged development of a global, standardised, IWC-endorsed body condition assessment protocol (IWC, 2020a). An Intersessional Correspondence Group (see Annex K) will provide a report at the 2021 meeting (see Item 8.2.9).

In discussion, the value of collecting southern right whale photo-IDs from high latitude non-calving areas was also highlighted. Opportunistic photo-IDs are regularly collected by national research programmes and tour operators and the Committee encouraged submission of these photo-IDs to platforms such as *http://www.happywhale.com*, so that they can then be shared with low-latitude right whale catalogues for matching.

The catch history Workshop to update regional pre-modern catch estimates for southern right whales and estimate pre-exploitation levels supported by the IWC could not be held in 2020 and work on pre-modern catch estimates will now be progressed via an Intersessional Correspondence Group (Item 8.2.9, and see Annex K).

Attention: SC, G, R

The Committee **endorses** *the priorities identified for the IWC-SORP Theme 6 on southern right whales given in the Workshop report (SC/68B/SH/07), noting in particular the value of the data collection and demography-related activities for informing the upcoming In-Depth Assessments of southern right whales, and the importance of understanding threats via health assessments. The Committee also* **encourages** *further development of the common population dynamic model for discussion at SC68C in 2021.*

As last year (IWC, 2019c, p.28), to progress regional population and health assessments of southern right whales, the Committee **encourages**: *(i) the ongoing development of a common life-history model whose aims include the estimation of demographic parameters and facilitating the investigation commonalities in southern right whale population dynamics on their wintering grounds; and (ii) the development of a global, standardised, IWC-endorsed health assessment protocol to assist a synoptic assessment of southern right whale health across calving grounds.*

8.2.4 North Pacific blue whales (NH)

The Committee is at the pre-assessment stage for blue whales in this large region (the full process is described in IWC, 2019c, pp. 18-19). There are at least two populations of blue whales in the North Pacific, and possibly three, based mainly on song type. The status of the eastern North Pacific population was assessed by the Committee in 2016 as 'almost recovered' (IWC, 2017d). In recent years, the Committee has been evaluating the data available to assess blue whales in the less studied central and western North Pacific. Given the time constraints this year and the existence of an Intersessional Correspondence Group to advance the work, discussion of this topic is postponed until SC68C.

Attention: SC, R

The Committee is continuing its work to assess blue whales in the North Pacific, especially in the central and western areas. The Scientific Committee **agrees** *that this work should continue intersessionally under Branch. The Committee also* **reiterates** *its previous recommendations (IWC, 2020a, p.29) for data and analyses to be reported at the next Annual Meeting.*

8.2.5 North Atlantic sei whales (NH)

The Committee is at the pre-assessment stage for sei whales in this area (the full process is described in IWC, 2019c, pp.18-19). Given the time constraints this year, discussion of this topic is postponed until next year. Information gathering for a future Comprehensive Assessment will continue through the Intersessional Correspondence Group convened by Cholewiak and which will report at SC68C (see Annex K).

Attention: SC

The Committee is advancing its work to ascertain when sufficient information is available to assess sei whales in the North Atlantic. The Committee **agrees** *that the Intersessional Correspondence Group under Cholewiak should continue to review data needs for a Comprehensive Assessment.*

8.2.6 North Atlantic right whales (NH)

In response to the Committee's request (IWC, 2020a), an update was provided by the US National Marine Fisheries Service regarding North Atlantic right whale population status and management initiatives. As reported in SC/68B/NH/05, North Atlantic right whales continue to decline, with a best population estimate of 412 individuals at the start of 2018. Ten calves were documented in the winter of 2019-20; however, one calf was injured from a vessel strike and is presumed dead. The Unusual Mortality Event declared in 2017 is ongoing; ten deaths were documented between the USA and Canada in 2019. Of particular concern is that females aged 5 years and older are estimated to have lower survival rates than males, and survival rates have declined since 2010. A population viability analysis is being developed to characterise extinction risk based on reduction in human-related mortality by different percentages. It indicates that a large reduction in entanglement-related and vessel-related deaths and serious injuries is necessary to see positive population growth.

With regard to management initiatives (SC/68B/NH/04), the US Atlantic Large Whale Take Reduction Team reached near consensus in 2019 on a suite of measures that are estimated to reduce right whale mortality by up to 60%; these include: (i) measures to reduce vertical buoy lines; and (ii) gear modifications to reduce the breaking strength of line. NOAA Fisheries is currently developing a proposed rule to implement the recommendations of the team, which is expected to be published in summer 2020. NOAA Fisheries continue to review the North Atlantic right whale vessel speed rule, which includes assessments of biological effectiveness, compliance, economic impacts, and navigational safety impacts, as well as the effectiveness of the Dynamic Management Program. The US Northeast and Southeast Implementation Teams convened a meeting in 2019, with the primary objective of providing input on coast-wide priorities for a 5-year action plan under the US Endangered Species Act (ESA) and the new right whale 'Species in the Spotlight' designation. In addition, two Workshops were convened in 2019, one on Health Assessment and the other on Monitoring and Surveillance. Reports from both are forthcoming, and NOAA is working to develop a longer-term science health assessment plan, as well as assess its surveillance effort strategy. A US/Canada Bilateral Working Group continues to meet up to twice yearly, to advance collaboration on research and management topics.

In response to the apparent change in North Atlantic right whale distribution, Canada's Department of Fisheries and Oceans (DFO) has provided significantly more funding and personnel in research and monitoring to protect and support the recovery of this species. SC/68B/NH/02 summarises the monitoring and research initiatives that have been underway for multiple years and are planned to continue in 2020. Efforts include: aerial and vessel surveys, passive acoustic monitoring, underwater noise impact studies, assessment of risk of entanglements in fishing gear and vessel strikes, prey studies, satellite tagging, habitat modelling, and investigations of novel right whale detection technologies. Right whale monitoring and research includes multiple government, university and stakeholder partners across four Atlantic regions.

Palka reported that there are forthcoming updates to the spatio-temporal habitat-based density models produced by Roberts *et al.* (2016). These primarily cover North Atlantic right whales in US waters and existing maps are available online[13]. Eight individuals (both sexes) were observed feeding off the coast of Virginia in April 2018 during aerial and vessel surveys conducted as part of the US Navy Marine Species Monitoring efforts[14]. This area is thought to be a migratory corridor between primary feeding and calving grounds (Cotter, 2019).

The Committee thanks the US and Canada for providing updates about North Atlantic right whales, recognising the intensity, breadth and collaborative nature of efforts underway to study and protect those animals.

Attention: C, CG, G, SC, R, S

The Committee **strongly reiterates***: (1) its* **serious concern** *over the status of right whales in the western North Atlantic, noting that it is probably the only viable population of this species; and (2) that the US and Canada make every effort to reduce human-induced injury and mortality in the population to zero, recognising that two primary threats to North Atlantic right whale recovery are entanglement in fishing gear and vessel strikes.*

Whilst noting that the COVID-19 situation may have unavoidable impacts on population monitoring efforts in 2020, the Committee:

(1) **recognises** *the significant efforts underway in both the USA and Canada to understand North Atlantic right whale status and to mitigate human impacts and* **encourages** *the submission of further updates on these efforts and their outcomes at SC68C in 2021;*
(2) **encourages** *continued US/Canada collaborations to understand the seasonal movement and distribution of North Atlantic right whales and the ecological factors driving these; and*
(3) **requests** *that the IWC Executive Secretary notify the US and Canada of the Committee's willingness to share expertise and to participate in on-going or planned processes to assess North Atlantic right whales and their threats.*

8.2.7 Gulf of Mexico Bryde's whales

The Gulf of Mexico Bryde's whale is a small, isolated population that was listed as an Endangered subspecies of *B. edeni* under the US Endangered Species Act (ESA) in 2019. SC/68B/NH/02 provided an update on US field research, restoration

[13] *https://www.northeastoceandata.org/.*

[14] *https://www.navymarinespeciesmonitoring.us/.*

projects and management advances that occurred during 2019-20. As part of the NOAA RESTORE Science Program study on trophic ecology and habitat use, a research cruise was conducted during the summer of 2019 in the north-eastern Gulf of Mexico. In addition, a variety of passive acoustic studies are ongoing. There are two restoration projects planned in the Gulf of Mexico that have direct bearing on Bryde's whales: the Open Ocean Marine Mammal Vessel Collision Mitigation and the Noise Mitigation projects. Regarding management advances, a draft recovery outline has been developed, NOAA has been conducting ESA Section 7 consultations on several projects, and preparations are underway for two Workshops.

The Committee noted its on-going interest in the outcome of genetic studies on evolutionary relationships and taxonomic status, and Leslie reported that a new phylogenetic study was expected to be available next year. The Committee also discussed Federal protections to these whales related to oil and gas development in the Eastern Gulf of Mexico and the potential expiration of restrictions under the Gulf of Mexico Energy Security Act in 2022.

Attention: SC, CG, R

The Committee **reiterates** *its serious continuing concern (IWC, 2019c, p.26; 2020a, p.31) about the possible impacts of anthropogenic threats on this small and isolated lineage of Bryde's whales in the Gulf of Mexico, numbering approximately 30 animals and thus far known to occur only in US waters. The Committee:*

(1) **welcomes** *the information received from the USA this year and* **encourages** *the USA to provide any new information on population abundance, status and critical habitats at SC68C in 2021, including an update on research on phylogenetics and taxonomic status;*
(2) **emphasises** *the importance of maximising protection for this population, including reducing human-induced injury and mortality to zero, given their precarious status; and*
(3) **encourages** *further updates on legal protections afforded in regard to seismic surveys and other anthropogenic threats - including information on the potential expiration in 2022 of oil and gas lease restrictions in the Eastern Gulf of Mexico under the Gulf of Mexico Energy Security Act (GOMESA).*

8.2.8 Work plan

The Committee continues to prioritise North Pacific blue whales and North Atlantic sei whales for intersessional work to accumulate data for future assessments. The Committee also plans to review any new information on North Atlantic right whales and Gulf of Mexico Bryde's whales in the light of concerns about their population status and recent implementation of protective management efforts. The work plan for these two stocks involves two Intersessional Correspondence Groups under Branch (North Pacific blue whale stock structure) and Cholewiak (North Atlantic sei whale data evaluation) (see Annex K).

8.2.9 Work plan and budget requests for 2020/21

For the work plan see Table 9. For details of Intersessional Correspondence Groups, see Annex K.

8.3 New information and work plan for other northern stocks (NH)

8.3.1 North Atlantic blue whales

No new information was received on this topic.

8.3.2 North Atlantic common minke whales

New information on Unusual Mortality Events (UMEs) is discussed under Item 14.3.2. The common minke whale is one of three species in the western North Atlantic that are currently experiencing unusual levels of mortality[15] - the others (the North Atlantic right whale and the humpback whale) are already being closely scrutinised for potential assessment. For other Northern Hemisphere populations, UMEs may warrant further work to determine possible population effects (the modelling work undertaken as part of the RMP and AWMP work focuses mainly on West Greenland and the Central and north-eastern Atlantic, e.g. see Item 6.1). It is also conceivable that one or more UME warrant changes in assessment priorities.

Attention: SC

The Committee **expresses concern** *about the Unusual Mortality Events affecting North Atlantic common minke right and humpback whales in the western North Atlantic. Information from such events is important for assessments and may have implications for assessment priority. The Committee:*

(1) **encourages** *additional information on the North Atlantic common minke whale UME at SC68C; and*
(2) **agrees** *to form an Intersessional Correspondence Group under Cholewiak to further examine available information on UMEs involving Northern Hemisphere populations and prepare to discuss them in the context of population status and assessments at the next Annual Meeting.*

[15] *https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2020-minke-whale-unusual-mortality-event-along-atlantic-coast.*

Table 9
Proposed work plan for SH: blue and right whales.

Item	Intersessional 2020/21	2021 Annual Meeting (SC68C)
Southern Hemisphere non-Antarctic blue whales (Item 8.2.1)		
Population structure (Item 8.2.1.1)	Compare morphometric blue whale data between northeast and southeast Pacific to assess overall similarity (Branch).	Report
	Compare blue whale genetic data between northeast and southeast Pacific to assess population connectivity (Lang).	Report
Catalogue matching (Item 8.2.1.6)	(i) Finalise photo-ID matching within the southeast Pacific; (ii) add metadata from Australian catalogues to associate photo-IDs with sighting date and location; (iii) quality control southwest, southeast Pacific and southeast Indian Ocean photographs; (iv) assess suitability of central Indian Ocean blue whale dataset for mark recapture analysis; and (v) review and compile photo-ID data from Madagascar within the SHBWC (Galletti and Olson). Funding is required to complete this work.	Report
Catalogue matching (Item 8.2.1.1)	Reconcile Blue Whale Center blue whale catalogue from Chile for intersessional submission to SHBWC (Torres Florez and Hucke Gaete). Funding is required to complete this work.	Report
Acoustic monitoring (Item 8.2.1.5)	Conduct passive acoustic monitoring off Oman in order to characterise the distribution and seasonal movements of the NWIO blue whales (Cerchio). Funding is required to complete this work.	Report
Abundance estimation (Item 8.2.1.6)	Generate population abundance estimate using southwest Pacific Ocean (New Zealand) mark resight data from SHBWC (Jackson).	Report for ASI review at SC69A
	Generate population abundance estimate using southeast Indian Ocean (Australian) mark resight data from SHBWC (Jackson).	Report for ASI review at SC69A
	Generate population abundance estimate using southeast Pacific Ocean (Chilean) mark resight data from SHBWC (Jackson).	Report for ASI review at SC69A
Prepare for in-depth assessment (Item 8.2.1.6)	Finalise regional catch scenarios and construct preliminary population assessment models for southwest and southeast Indian Ocean, southwest Pacific and central Indian Ocean blue whales (Branch). Funding is required to complete this work.	Report
Antarctic blue whales (Item 8.2.2)		
Population structure (Item 8.2.1.1)	Review Antarctic blue whale photographs from Antarctic Area III and SG/GS to identify any that visually resemble non-Antarctic blue whales (Olson).	Add information to SHBWC; report
	Compare frequency and temporal features of Antarctic blue whale song at mid to low latitudes to assess regional variation (Buchan). Funding is required to complete this item.	Report
Acoustic monitoring (Item 8.2.1.2)	Conduct passive acoustic monitoring off the west coast of South Africa and off Durban, in order to characterise the density, distribution and seasonal movements of Antarctic blue whales (Shabangu). Funding is required to complete this item.	Report
Population abundance (Item 8.2.2.3)	Capture recapture modelling work to update Olson *et al.* (2018) (Olson).	Report one month ahead of SC68C for ASI review
Population trend estimation (Item 8.2.2.3)	Provide regional Antarctic blue whale trend estimates using song density patterns (Miller).	Report for ASI review at SC68C
Southern right whales (Item 8.2.3)		
Population structure (Item 8.2.3.5)	Multi-state mark recapture and population dynamic analysis of Brazil-Argentina photo-ID data to assess movement rates between regions (two-year project led by Agrelo including Groch, Rowntree, Sironi, Vilches, Cooke).	Progress report
Population abundance (Item 8.2.3.5)	Population modelling of South African right whale abundance and trend (Brandão, Butterworth)	Report for SH/ASI review at SC68C
	Development of a common model to jointly assess population dynamics of multiple calving grounds (pending availability of IWC-SORP funding) (Butterworth, Brandão, Ross-Gillespie, Cooke).	Report for SH/ASI review at SC68C
Body condition (Item 8.2.3.5)	Develop a protocol to use for conducting body condition and visual health assessments of southern right whales using overhead images (Vermeulen, Christiansen)	Protocol in report, requesting endorsement by IWC at SC68C
Catch records (Item 8.2.3.5)	Right whale catch series discussion to update regional catch estimates from IWC (2013b) (Jackson and Carroll)	Report

8.3.3 East Greenland-Svalbard-Barents Sea (Spitsbergen) bowhead whales

The East Greenland-Svalbard-Barents Sea (Spitsbergen) population of bowhead whales is endangered and poorly understood. SC/68B/NH/03 reported on the acoustic presence of bowhead whales in eastern Fram Strait (78-79°N, 0-7°E). Passive acoustic data recorded in 2012 and 2016/17 revealed that bowhead whales were present from autumn, throughout the winter months (October-February) and occasionally in spring (March-June), supporting the hypothesis that Fram Strait is an important overwintering area. Peak acoustic presence occurred between mid-November and mid-December, coinciding with the presumed mating period of bowhead whales and indicating that Fram Strait may also serve as a mating area. Detailed analyses of recordings for a single year and location revealed eight distinct bowhead whale song types comprising simple songs and call sequences. No bowhead whales were recorded in summer (July-September), indicating that they either were not vocalising or had migrated to summering areas. In comparison to earlier studies in western Fram Strait, bowhead whale detections were less frequent and the sounds less complex. The observed regional differences may represent the eastern boundary of bowhead whale overwintering.

The Committee welcomes this new information, which complements other recent research in western Fram Strait (e.g. de Boer *et al.*, 2019; Stafford *et al.*, 2018). The Committee encourages further acoustic, sighting and satellite telemetry research to provide a synoptic picture of the year-round seasonal distribution of this population throughout its range.

8.3.4 Work plan

The Committee will continue to receive new information on other Northern Hemisphere stocks that are not subject to directed takes. It will also review information available on Unusual Mortality Events involving Northern Hemisphere populations in relation to population status and potential implications for assessment priorities. The work plan for UMEs involves an Intersessional Correspondence Group under Cholewiak (see Annex K).

8.4 New information for other southern stocks

8.4.1 Southern Hemisphere fin whales

The Committee is currently conducting a pre-assessment of Southern Hemisphere fin whales.

8.4.1.1 Population Structure

To date, genetic evidence received by the Committee does not suggest that fin whale populations are structured within the Southern Hemisphere, (item 4.1 in IWC, 2019f). The Committee was informed that the IWC-SORP Acoustic Trends Working Group (see SC/68B/SH/04) has been working on a coordinated analysis approach to investigate fin whale song characteristics, in an attempt to identify song features that could help distinguish population biogeographic patterns for this species (SC/68B/SH/05). The group has already identified several datasets from across the Southern Ocean (collected during 2010-20) to start this analysis. Additional data sets from lower latitudes in the Southern Hemisphere will be identified in the future (additional details in SC/68B/O/01). When available, pre-2010 data will also be analysed to evaluate persistence of these song features. A fuller update on progress will be presented to the Committee in 2021.

A sample of the *B. physalus patachonica* holotype held at the MACN in Buenos Aires is being sent to Archer for genetic comparison to the current set of Southern Hemisphere fin whale mtDNA sequences. The Committee looks forward to an update on this analysis.

In 2018, the Committee agreed that a review of all Discovery mark data published on fin whales should be conducted, to assess population connectivity patterns (item 4.1 in IWC, 2019f). This review has not yet been provided and was encouraged for the 2021 meeting.

Attention: SC, CG, R, S

Knowledge of population structure is essential to future efforts to assess Southern Hemisphere fin whales. The Committee **reiterates** *its* **recommendations** *from 2018 and 2019 regarding: (i) analysis of fin whale acoustic recordings to assess song variation; (ii) strategic biopsy sampling and analysis to measure fin whale genetic differentiation; and (iii) a review of all Discovery mark data published on fin whales, to assess population connectivity patterns.*

8.4.1.2 Distribution and Abundance

The Committee was informed that data on fin whales have been compiled for a joint analysis of fin whale occurrence along the Western Antarctic Peninsula and the Scotia Sea region, and that analyses are now underway. The Committee **agreed** that this should also include additional fin whale distributional information provided by Japanese Scouting Vessels (Butterworth and Geromont, 1995). In April/May 2019 a dedicated survey for fin whales was conducted around the islands at 54°-55°S, 36°-38’W and those at 56°18’-59°27’S, 26°23’-28°08’W on *RV Polarstern*, contributing additional data to the collection (SC/68B/SH/05).

SC/68B/ASI/17 reported the results of the 2019/20 JASS-A dedicated sighting survey program, which was conducted in the western part of Area III (000°-015°E; south of 60°S). The total searching distance was 1,447 n.miles during which 72 schools (136 individuals) of fin whales were observed. A total of 11 biopsy samples (individuals) was collected and 10 satellite tags were deployed during the entire cruise (see Appendix 2, SC/68B/ASI/17). Data obtained will be analysed for abundance estimate,and stock structure studies at the Institute of Cetacean Research.

SC/68B/SH/08 reported on the low latitude occurrence of baleen whale song off northwest Madagascar at 13.3°S over 28 months, indicating that fin whale song was present yearly during the late austral winter, from early August to mid-September. The timing of fin whale song suggests a later arrival than Antarctic blue whales and a lower rate of occurrence and occupancy in the same region, and potentially indicates the northern extent of breeding habitat.

The Committee was informed about research recently published by the Brazilian Antarctic Program (PROANTAR) on fin whale distribution across the Drake Passage and northern Antarctic Peninsula (Bassoi *et al.*, 2020) and contaminant loads in the Peninsula region (Taniguchi *et al.*, 2019). PROANTAR conducted cetacean surveys off the Antarctic Peninsula from 1997-2019, but funding for this program was discontinued in 2019.

Table 10
Proposed work plan for SH: fin and humpback whales.

Item	Intersessional 2020/21	2021 Annual Meeting (SC68C)
Southern Hemisphere fin whales		
Population structure	Review available published and unpublished Discovery mark data on fin whales (Pastene and Jackson).	Report
Catch densities	Update fin whale catch model to include Soviet catch data (de la Mare).	Report
Population abundance	Abundance estimate using IDCR-SOWER data (Matsuoka).	Report one month ahead of SC68C for ASI review
	Develop common survey protocol to assist comparable future data gathering via IWC-SORP fin whale theme (Herr, Convenor).	Report
Southern Hemisphere humpback whales		
Survey feasibility for Breeding Stock D (west Australia)	Reanalyse pilot study to assess feasibility of future West Australia surveys (Kelly).	Report

A new circumpolar fin whale abundance estimate using IDCR-SOWER data is being finalised. The Committee **agreed** that this should be reviewed by the ASI SWG at the 2021 meeting.

Attention: SC, CG, R
The Committee notes the great value of the fin whale (and other species) data received over the years from the Brazilian Antarctic Program. It **expresses concern** *about the loss of funding for the cetacean programme and* **strongly encourages** *continued work towards the understanding of fin whale population structure, movements and habitat use.*
In order to estimate fin whale abundance for the upcoming assessment, the Committee **reiterates** *(IWC, 2019c, p.23) that it* **encourages**:

(1) *the completion of a new circumpolar fin whale abundance estimate;*
(2) *analysis of fin whale distribution and geographic aggregations using catches; and*
(3) *completion of the meta-analysis of the Antarctic Peninsula and Scotia Sea sightings data, to measure contemporary fin whale distribution and density patterns.*

To maximise the value of fin whale sightings datasets, the Committee also **recommends** *that a sightings survey protocol be developed to assist researchers to collect sightings data in a comparable way across survey platforms.*

8.4.2 Southern Hemisphere humpback whales
An assessment of the Breeding Stocks D (West Australia), E1 (East Australia) and Oceania was completed in 2014 (IWC, 2015b), but there were difficulties in obtaining a reliable estimate of absolute abundance for Breeding Stock D (IWC, 2017e; 2018e). Assessment of the feasibility of a new survey is underway, and a report is anticipated for the 2021 SC meeting.

Attention: SC, G, CG
The Committee **agrees** *that obtaining a reliable estimate of absolute abundance for Breeding Stock D (west Australia) is a priority for any future In-Depth Assessment of humpback whales. The Committee therefore* **reiterates** *(IWC, 2019c) its recommendation that an evaluation of survey feasibility be carried out, with a view to implementing a new survey of this population.*

8.4.3 Work plan for 2020/21
For the work plan see Table 10.

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

Conservation Management Plans (CMPs) are an important conservation initiative of the IWC. They provide a framework for countries within the range of vulnerable cetacean populations to work together, and in collaboration with other relevant stakeholders, to protect and rebuild those populations. 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 addressed stocks that have previously been considered as potential CMPs, recognising the Commission's interest that range states support IWC CMPs.

9.1 Stocks with existing CMPs: new information and progress with previous recommendations

9.1.1 Southeast Pacific Southern right whales (CMP, SH)

The Committee received new information about Southeast (SE) Pacific southern right whales, including advances on the CMP Implementation Strategy during 2019-20. SC/68B/CMP/18 provided updates on the Passive Acoustic Monitoring project, photo-ID matching efforts, new insights into the genetic identity of the population, educational lectures and Workshops, and media outreach programs. The Government of Peru offered to host the third coordination meeting and Workshop exchanging information about experiences with whale watching and research permits. Due to COVID-19 these activities are on hold. The Workshop on whale watching and research permits has been identified as a priority action under the CMP and is discussed in more detail under Item 17.6.

Since 2016, the Committee has been supporting passive acoustic monitoring (PAM) of SE Pacific right whales to identify potential breeding areas along the coast of Chile and Peru, given the small population. Progress made under this project (SC/68B/CMP/12) included successful collection of one year of data from southern Chile. Acoustic monitoring is ongoing off central Chile, but equipment maintenance was not possible in April 2020 due to COVID-19. Therefore, data will stop being collected when the instruments run out of battery power. PAM is expected to start at the third selected location site (Mejillones, in northern Chile) in January 2021. The authors suggest it is critical to continue to collect data at the selected sites along the range of this population's known distribution to better understand its distribution. Between site comparisons are needed to document spatio-temporal patterns of occurrence and possibly generate acoustic-based density estimations. An automatic detector for southern right whale calls is under development and the first southern right whale calls have been documented in December 2019 from the southern Chile site. The performance of the detector requires improvements, which will be made in 2021 by adding more right whale example calls to the call library and by including a humpback whale call detector to avoid call misclassification.

The Commissioner from Peru commended the ongoing efforts by the authors of SC/68B/CMP/12 and highlighted the importance of the protection of this species to both Chile and Peru, exemplified by the Memorandum of Understanding and close collaboration between the two countries. The Commissioner also expressed the need for the Workshop on impacts from whale watching and research, and specifically noted expanding capacity with IMARPE, fisherman, and Government authorities. The Committee expressed strong support for the collaborative efforts between Chile and Peru. Funding is necessary to continue the PAM fieldwork and acoustic data analysis, thus this will have funding implications to the Committee. It was noted that there are upcoming plans to identify Important Marine Mammal Areas (IMMAs) in South America and the Committee highlighted the importance of the work presented and research proposed for SE Pacific right whales that will help inform the IMMA process.

Attention: SC, CC, CG

The Committee **reiterates** *the importance of the CMP for the conservation of the critically endangered SE Pacific right whale population (IWC, 2019c, p.28). The Committee* **welcomes** *the progress made and* **draws attention** *to the need for funding to continue the passive acoustic monitoring study.*

The Committee:

(1) **commends** *the efforts made by Chile and Peru to advance the conservation and management of this population and* **encourages** *the continued coordination between Peru and Chile under the Memorandum of Understanding to protect SE Pacific southern right whales in line with the CMP; and*
(2) **commends** *the scientific work and international cooperation involved in the passive acoustic monitoring project and* **looks forward** *to receiving additional results that could assist in designing future research and providing baseline information on the location of breeding grounds.*

9.1.2 Southwest Atlantic southern right whales (CMP, SH)

The Committee received new information on southwest (SW) Atlantic southern right whales and welcomed an update on progress with CMP actions (SC/68B/CMP/19). A satellite telemetry study was initiated in 2014 (Zerbini *et al.*, 2018). In 2019, a total of 23 satellite tags were deployed on southern right whales in Golfo Nuevo, Península Valdés, Argentina. A new design of transmitters resulted in improvement in tag retention (median duration=164 days). In addition, a new 'blubber-only' tag is under development and first deployments of this design were attempted (median duration 16 days). Tagged whales were followed for a period of 10 weeks post tag implantation to assess effects of both tag designs and the results of this study will be presented in the future. This research continues to provide novel information on movements of southern right whales along the coast of eastern South America and towards their feeding destinations in the western South Atlantic and Antarctic Ocean. Satellite tracks for southern right whales tagged in 2019 in Argentina can be found online[16].

[16]*http://siguiendoballenas.org/en/home/.*

Comparisons between photo-ID catalogues from Brazil (1,021 individuals, period 1987-2019) and Argentina (3,813 individuals, 1971-2017) resulted in 124 matches from 1971 to 2017 (SC/68B/CMP/20). No whales were seen on both the calving grounds within the same year. The proportion of whales in the Brazilian catalogue that was seen off Argentina is 13.8% and the proportion of whales in the Argentine catalogue that was seen off Brazil is 3.25%. In 2019, new individuals (*n*=99) were added to the Brazilian catalogue described in SC/68B/CMP/20. Three aerial surveys conducted off Brazil in each year in 2018 and 2019 documented 408 individuals, including 176 calves (includes possible double counting). A total of 273 different individuals were sighted in September 2018, the highest number of sightings for the species since 1982. In Brazil a total of 13 and 2 right whale strandings were recorded in 2018 and 2019, respectively.

The Committee received new information on aerial surveys conducted to monitor trends in abundance, document distribution, and to collect photo-identification data (SC/68B/CMP/03 and SC/68B/CMP/20). Although the number of whales around Península Valdés tripled from 1999 to 2019, the rate of population growth decreased from approximately 8% in 2007 to 0.61% for the total number of whales and from 7.5% in 2007 to 3.09% for calves. Aerial surveys flown in September 2019 documented 607 sightings (214 calves) and 74 sightings (50 individuals photographed) in Golfo Nuevo and Golfo San José, respectively. More information on the aerial surveys and other research projects in Argentina can be found online[17].

In September 2019, 944 gull attacks were recorded on 206 mother/calf pairs around Península Valdés (84% on calves and 16% on mothers). In 2019, *ca* 1,700 body condition measurements were carried out and the data are being analysed. Measured levels of glucocorticoids (CG) and thyroid hormone T3 in southern right whale calves revealed that the former correlated positively with kelp gull wounding and harassment, while the latter did not. During discussion, an update was provided on a pilot experiment underway for gull management with the aim to determine whether there was a significant difference in frequency of attacks when gulls were culled. It was noted that additional reports of gulls attacking whales have been documented from New Zealand (humpback whales), South Africa (southern right whales) and the Azores (sperm whales).

In 2019, a total of 17 stranded dead whales were recorded around Península Valdés by the Southern Right Whale Health Monitoring Program (SRWHMP), including ten calves (59%), six adults (35%) and one juvenile (6%). The total number of dead calves was similar to those seasons with the lowest mortality (13, 15 and 18 in 2004, 2016 and 2006, respectively). This is significantly lower than the average 55/year occurring over the past decade. However, the six adults represent the highest mortality for this age class recorded around Península Valdés since 2005.

The Committee received information on a 23-day cetacean survey conducted in waters around the Antarctic islands between about 53-55°S and 35-39°W in January/February 2020 (SC/68B/CMP/22). As part of this study, directional acoustics and visual surveys were used to localise right whales. A total of 10 encounters with 11 individuals were documented. Multiple skin biopsies, photographs for individual identification, and blow samples were collected. Two right whales were instrumented with satellite tags. Southern right whale sightings were scarce during the 2019 and 2020 summer surveys there compared to some other years.

In discussion it was noted that in Brazil, with support of the government, a right whale week and season was instituted. Systematic land-based research continues in Torres, southern Brazil and results from the 2018 and 2019 calving seasons is expected to be presented to the Committee next year. The continuation of this work in the 2020 season will depend on the situation with COVID-19. The Committee also welcomed news of an ongoing project focused on reconstructing the population trajectory of southern right whales. Additional work will use modelling to investigate population expansion and results will be available over the next two years.

Finally, the Committee was pleased to be informed about two disentanglement Workshops held in Puerto Madryn and Mar del Plata in 2019 with 72 participants, including researchers from Uruguay. The Workshops were supported by the IWC, the Government of Argentina, and the Cetacean Society International (CSI).

Attention: SC, CC, CG
The Committee **reiterates** *the importance of the CMP for SW Atlantic southern right whales and* **welcomes** *the progress made since its implementation. The Committee therefore:*

(1) **commends** *the impressive array of research being undertaken and the collaborative efforts of the researchers that highlight the impact of the CMP and the extensive collaboration among CMP member countries to undertake this research;*
(2) **recommends** *continued collaboration among range states to generate new information and* **encourages** *additional effort from Brazil given the additional funding received;*

[17]*https://ballenas.org.ar/investigar/proyectos-cientificos/.*

(3) **reiterates** *the importance of continuing the long-term monitoring programme, noting that the COVID-19 pandemic is causing major problems for such long-term programmes and* **encourages** *governments to do all they can to avoid interruptions to these important long-term efforts;*
(4) **encourages** *the continuation of existing aerial coastal surveys and* **recommends** *expanding the surveyed area to include deeper waters to assess whether whales are using new habitats, and that a monitoring programme and aerial surveys are developed for Uruguay;*
(5) **encourages** *the continuation of telemetry studies in Argentina and* **recommends** *satellite tagging in Brazil, Uruguay and Chile; it* **respectfully requests** *that the IWC Commissioners for these countries facilitate the internal permit process for the right whale tagging programme;*
(6) **encourages** *studies of stress hormones in baleen and the presentation of results to the Committee when they become available;*
(7) **encourages** *comparisons of photo-identification catalogues between Argentina, Brazil, Chile, and Uruguay; and*
(8) **recognises** *that coordination and staff time for disentanglement trainings is voluntary and* **encourages** *agencies involved to continue to allow their employees to participate.*

9.1.3 North Pacific gray whales

The Committee has a long-standing cooperation with the IUCN Western Gray Whale Advisory Panel (WGWAP) and there is a joint IUCN/IWC draft CMP for western gray whales. Reeves provided a summary of work conducted by the IUCN Western Gray Whale Advisory Panel (WGWAP) since the last Committee meeting (SC/68B/CMP/07Rev1). In brief, the work of the WGWAP continued by way of several formal meetings and the drafting of a suite of 'legacy papers' including publication of the population assessment modelling that has also been reported to the Scientific Committee. The importance of the ongoing work of the Russian Gray Whale Project (RGWP) has provided the long time series of photo-identification and genetic data used in the assessments. Unfortunately, Alexander Burdin, who leads the Russian project, had reported earlier this month that his team could not go into the field this year because of the lack of funding.

WGWAP also reiterated its disappointment at the reduction of the Sakhalin Energy and Exxon Neftegas Limited (ENL) joint monitoring programme for gray whales off Sakhalin Island. This includes ceasing work on three key annual elements: (i) behaviour monitoring; (ii) acoustic monitoring; and (iii) benthic sampling in the near-shore (Piltun) feeding area. Recent amphipod biomass in the Piltun feeding area was in steep decline, yet no sampling has been done since 2016. In July 2019, the Panel posted an Open Statement of Concern, noting two concerns likely related to the decline in amphipod biomass : (i) a continued decrease in the number of whales using the Piltun feeding area; and (ii) a southward shift in whale distribution.

Reeves noted that the Panel and the IWC Scientific Committee has repeatedly emphasised the great value of ensuring that a 'joint catalogue' and associated database on western gray whales is finally established and functioning as intended under the auspices of the IWC; this would provide a valuable and enduring legacy of the entire Panel process.

In April 2020, an updated status was assigned in the Red Data Book of the Russian Federation the 'Okhotsk Sea population of the gray whale'. The population is considered Critically Endangered and with a conservation status of 'Priority 1', which calls for immediate implementation of comprehensive conservation measures including the development and implementation of a species conservation strategy, species recovery program and an action plan.

Donovan briefly reported on issues related to the CMP and the Memorandum of Cooperation on western gray whales signed by several range states. Considerable monitoring research actions have been undertaken on gray whales throughout the range as well as past work related to mitigation actions. Last year, the Committee supported a Workshop (including some modelling to focus on particular conservation questions) to be held during the year to finish working on the update to the scientific components of the joint IWC/IUCN CMP and associated actions. The plan had been for that work to feed into a proposed stakeholder Workshop to be co-sponsored by the IWC and IUCN after the Committee meeting and before the 2020 Commission meeting. Because it proved impossible to hold the Committee Workshop (and thus the associated modelling), limited progress was made with respect to the subsequent stakeholder Workshop although informal and positive discussions had begun with Japan about hosting the stakeholder Workshop.

Discussions were also held this year (Items 6.2 and 10.4.1) with respect to the gray whale *Implementation Review* including clarifying some issues on stock structure hypotheses. As noted under Item 6.2, it was agreed that the postponed Workshop/modelling proposal (funds are already available) should be supported and the work be undertaken as soon as the COVID-19 situation is resolved. The idea is to continue working with range states, IUCN and the CMP group within the Conservation Committee to develop plans for the joint stakeholder Workshop towards the end of 2021, ideally, if virus circumstances permit, in time for the report to be submitted to the Commission meeting that is now expected for Autumn 2021.

In discussion, Moronuki explained that although Japan had been willing to consider hosting a stakeholder Workshop it had not been possible to follow through with this with the IWC and IUCN given the postponement of the scientific Workshop noted above. He explained that the possibility of holding such a Workshop in 2021 would have to be re-examined by Japan in light of its budget and the aftermath of the COVID-19 situation.

Attention: C, CC, IGO, S, I, R
In light of the continued importance of the joint IUCN/IWC CMP for western gray whale, the associated research at Sakhalin and elsewhere in the range and the long-standing co-operation with the IUCN Western Gray Whale Advisory Panel, the Committee:

(1) **supports** *the updated plans to update the scientific components of the CMP via a scientific Workshop that will report to SC68C;*
(2) **encourages** *the range states and signatories of the Memorandum of Co-operation on Western Gray Whales to continue to work with the CMP Steering Group and the Secretariats of IWC and IUCN to facilitate the holding of a stakeholder Workshop after SC68C in light of the results of the above scientific Workshop;*
(3) **notes** *with concern the reported benthic biomass declines in the gray whale feeding area in Piltun, and potentially related changes in whale numbers and distribution, and* **reiterates** *previous recommendations that the benthic sampling programme be reinitiated by the oil and gas companies (or other capable parties) working in the area;*
(4) **strongly reiterates** *its previous recommendation for a consolidated photo-identification catalogue for the western North Pacific under the auspices of the IWC and urges the relevant data holders to finalise this process with the IWC and IUCN; and*
(5) **recommends** *that every effort be undertaken to try and facilitate the continuation of the Russia Gray Whale Project so as to preserve the several decade time series upon which the assessment of the population relies including the provision of partial funding by the IWC for 2020.*

The Committee was pleased to receive recent information from long-term studies of gray whale on the wintering grounds in Mexico (SC/68B/CMP/09; SC/68B/CMP/13; SC/68B/CMP/14). The authors reported high mortality rates, poor body condition and low calf production of the gray whale in the breeding lagoons in Mexico, similar to the previous winter season in 2019. The Committee also received recent information about body condition and photo-identification from the summer feeding grounds off Sakhalin Island, Russia (SC/68B/CMP/24) and sightings and stranding records from Japan (SC/68B/CMP/15).

The Committee was informed that no signs or symptoms of Unusual Mortality Event related impacts on gray whales off Sakhalin were reported in 2019 as were observed off the west coast of North America. NOAA/SWFSC successfully completed an abundance survey of eastern North Pacific gray whales in 2019/20 (December-February) and had planned to repeat this survey again in 2020/21. Unfortunately, the NOAA/SWFSC calf production survey, conducted annually (1994-2019) was not undertaken in 2020 to due to concerns related to COVID-19.

Several sightings from platforms of opportunity (SC/68B/CMP/15) were reported from the coast of Ishikawa Prefecture, in the Sea of Japan in May-June 2019 including a resighting of one individual during March 2019 in Ishikawa and Fukui Prefectures. No new cases of strandings or anthropogenic mortality due to entanglement were reported.

Attention: CG-R, SC, G, I, CC
The Committee **reiterates** *the importance of long-term monitoring of gray whales,* **strongly recommends** *that Range States and others support this work and* **welcomes** *the new information provided by Mexico, Russia and Japan. In particular, the Committee:*

(1) **commends** *the work in the wintering lagoons of Mexico,* **urges** *its continuation and* **expresses** *concern about the high number of strandings, poor body condition and low calf counts observed off Mexico in 2019-20 as related to the broader population-level mortality event;*
(2) **commends** *work on the feeding ground off Russia by the Russian Gray Whale Project and urges its continuation;*
(3) **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 photographs; and*
(4) *highlights the importance of data collected on gray whale abundance and calf production off central California, particularly in light of the ongoing 2019-20 unusual mortality event and* **recommends** *that these two long time series surveys continue in 2020/21 and into the future as possible.*

9.1.4 Franciscana (CMP, SM)

Progress to complete the review of the status of the franciscana dolphin included an initial assessment of population structure (Item 10.4.2) and of abundance estimates (Item 11.1.4). A funding proposal to organise a Workshop to complete the review was received by the Committee (see Item 22).

Attention: SC, CC
The Committee **agrees** *that the review of the franciscana continue during the intersessional period and at next year's meeting. The Committee* **recommends** *that a Workshop to advance the review be organised prior to SC68C.*

9.2 Progress with identified priorities

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

Humpback whales in the Arabian sea are non-migratory, genetically distinct, endangered (Minton *et al.*, 2008), and are believed to number <100 animals off the coast of Oman (Minton *et al.*, 2011). The population is subject to multiple threats, including ship strikes, entanglement in fishing gear, and coastal development. These whales have been identified as a candidate for a future CMP (IWC, 2019e, p.31).

The Committee welcomed information on the activities of the Arabian Sea Whale Network (ASWN) that coordinates humpback whale research and conservation efforts across the Arabian Sea. Progress and recent developments under the umbrella of the ASWN was reported in SC/68B/CMP/11Rev1. At the regional level, progress included refining work on the Flukebook regional online data platform, maintenance of a website and email group to foster exchange among group members, and progression and extension of the CMS Concerted Action on Arabian Sea humpback whales. Work conducted by ASWN members at local and national levels in Oman, Pakistan, India, Sri Lanka, Iran, and the UAE, ranged from awareness-raising activities and reporting networks to dedicated research efforts using passive acoustic monitoring, photo-identification, and Unmanned Aerial Systems (UAS) and other techniques. Of particular note is the acoustic work that has commenced, with a recorder in place, and already recording humpback whale song off of Netrani Island on the west coast of India.

In discussion it was noted that one year of deep water passive acoustic monitoring was planned (2020-21) off Oman, with the aim to clarify temporal distribution of NWIO blue whale song (Oman song-type), and assess potential presence of other song-types such as CIO (the Sri Lanka song-type was highlighted and this is discussed in more detail under Item 8.2.1.5, and see Cerchio *et al.* (2020).

An annual update on baleen whale sightings (SC/68B/CMP/08) reported by crew members on board tuna gillnet vessels operating out of the port of Karachi in Pakistan was presented. Sightings included blue whales, Bryde's whales, sperm whales, Cuvier's beaked whales, and seven Arabian Sea humpback whales (ASHW). There were fewer sightings reported in 2019 than in previous years, due to a number of factors including a shorter fishing season related to low tuna prices, reduced catch per unit of effort (possibly linked to sea surface temperature anomalies and a jellyfish bloom), and the termination of the funding that supported the project in recent years. While 45 observers have agreed to continue collecting data on a volunteer basis, it is uncertain how long they will be able to continue doing so without compensation.

Results of an IWC-SC funded study (SC/68B/CMP/16Rev1) assessing over 33,000 images of humpback whales from Oman obtained between 2000 and 2018 were presented. Tattoo-like skin disease was detected in 43.4% of 83 adult whales, while killer whale tooth rakes were detected on the tail flukes of only 12% of 77 whales examined. Of 42 whales represented by suitable caudal peduncle photos, 67% bore scarring assumed to be consistent with entanglement, and prevalence of propeller scars and other vessel strike injuries in 96 examined whales was 4.16% and 2.1%, respectively. Unlike Southern Indian Ocean humpback whale populations that the authors have worked with, 97.5% of ASHW had <10% of the ventral surface of their tail flukes covered by barnacles or barnacle scars, potentially providing a proxy measure to distinguish between ASHW and Southern Hemisphere populations.

A study (SC/68B/CMP/23Rev1) used UAS photogrammetry to compare the body condition of nine adult ASHWs, measured in Oman with migratory humpback whales from Western Australia (Breeding Stock D). The ASHWs were in similar condition to Australian adult whales at the beginning of the breeding season, with Omani females (n=3) being similar to Australian lactating females shortly after birth. The authors highlight the importance of continued research towards assessing the health of ASHWs, together with continued monitoring of scarring rates and skin disease to determine the relationship between anthropogenic stressors, body condition and reproduction.

During discussion, it was clarified that the photos collected opportunistically from Pakistan fishing vessels were generally not of high enough resolution for individual identification, but that a few opportunistically collected photos from Pakistan and India had been compared to the Oman catalogue. Only one positive photo-ID match was made between Oman and Netrani Island, India (see SC/68B/CMP/11Rev1). It was noted that managing threats to ASHW requires improved understanding of human activity, including fishing effort, in this region, through, for example the use of tracking devices on vessels in the Pakistan Observer Programme, or the use of AIS and satellite imagery to map vessel density.

Efforts by the Government of India (GoI) to promote ASHW conservation in India were presented. In 2018 ASHW were placed on the Endangered Species Recovery List. The GoI has requested west coast Indian States and Union territories to develop Action Plans that are aligned with the CMS Concerted Action on ASHW. India's Government-led ASHW efforts focused on: (1) addressing data gaps; (2) awareness programmes; (3) capacity building; and (4) bycatch monitoring and mitigation. Furthermore, the GoI welcomes the identification of several Important Marine Mammal Areas (IMMAs) in Indian waters and hopes to incorporate these under a Maritime Act.

Rosenbaum informed the Committee that genetic analyses from a humpback whale baleen sample collected in Pakistan in the early 2000s was analysed to compare to mtDNA data of Oman samples. The Pakistan sample matched the most common Oman haplotype, but this was also a haplotype found in 9 of 12 sampling sites in the Indian Ocean.

The Committee noted that images of Oman ASHW that were deemed to be indicative of ship strike injury be submitted to the IWC ship strikes database for review and inclusion in the database. Data holders confirmed that this should be possible, and that the assessment (SC/68B/CMP/16Rev1) included a distinction between injuries consistent with blunt-force trauma from large vessels and propeller scars more likely inflicted by small vessels.

Only four calves were documented in the ASHW catalogue during 2000-18. Combined with the small population estimate (*ca* 100 individuals off Oman), this raised questions related to body condition, an assumed low reproductive rate or high adult mortality. Abundance estimates are being updated and may shed more light on current abundance and trends. These results will be reported at SC68C.

In apparent contrast to the results reported (SC/68B/CMP/23Rev1), experienced researchers conducting tagging work in Oman noted that ASHW appeared to have a thinner blubber layer than whales they had tagged elsewhere, because tags were difficult to implant. Possible explanations were considered, including a reduced need for fat stores in a population that does not undertake long migrations or fast for long periods, and fluctuating prey availability. It was noted that future hormone studies would be of interest to assess pregnancy rates and to allow integration of a bioenergetic framework to determine how anthropogenic stressors may affect population and individual health.

There was strong support for continued collaboration under the ASWN. The Committee highlighted the immense value of data being collected that can inform ASHW conservation management, and provided strong support for continuing the programme, while recognising that new funds were required to do so.

Two budget proposals were submitted on ASHW. The first directly addresses recommendations that arose from discussion of documents (SC/68B/CMP/16Rev1 and SC/68B/CMP/23Rev1), and proposes to map human activity in ASHW habitat, as well as expand drone work to assess body condition of ASHW in Oman. The second proposes to continue and expand the passive acoustic monitoring work off the west coast of India in order to confirm presence/absence of song and allow further comparison of song samples from India with song being collected simultaneously off the coast of Oman. These are discussed under Item 22.

The Committee **welcomes** the measures put in place by the Ministry of Environment, Forests and Climate Change, India and the coastal State Governments in India along with local research teams, to promote research, awareness-raising, capacity building and bycatch reduction, and offers technical and scientific support for these efforts where appropriate.

Attention: SC, CG, G, I, R, S

The Committee **reiterates** *that Arabian Sea humpback whales (ASHW) are a priority candidate for a CMP (IWC, 2019c, p.31) and* **recommends** *that the IWC Secretariat and SWG-CMP continue efforts with Oman and India towards development of a CMP in partnership with CMS, which already hosts a Concerted Action for the population. It* **commends** *the efforts of scientists within the region and especially the Arabian Sea Whale Network (ASWN) for developing a strong scientific basis to guide the development of a CMP and* **recommends** *continuation of research presented at this meeting and the network's regional collaboration.*

Furthermore, the Committee:

(1) **recommends** *that the work of the crew-based observer programme in Pakistan (SC/68B/CMP/08) continue, if possible, mapping fishing effort as well as sightings, and that it be replicated throughout the region where possible, especially in areas where systematic cetacean surveys are not feasible;*
(2) **encourages** *continued collaboration between the Pakistan observer programme and the IWC Bycatch Mitigation Initiative (BMI), and also encourages broader collaboration between relevant national governments, researchers and the BMI including through pilot projects on bycatch management, knowledge exchange or requests for capacity building initiatives;*
(3) **recommends** *that the use of passive acoustic monitoring to document whale presence and to analyse song be continued in Oman, on the west coast of India, and commences off the Sindh and Balochistan coasts of Pakistan; making every effort to ensure simultaneous recordings in all three countries, so that song comparisons can be made across the Arabian Sea;*
(4) **recommends** *the continued use of unmanned aerial systems (UAS) and other photographic methods (systematic assessment of images for evidence of disease, epizoites and anthropogenic scarring) to assess body condition and health of ASHW off the coast of Oman with the objective of adopting these metrics as proxy indicators of some of the key ecological attributes related to on-going population trend assessment and conservation planning for ASHWs;*
(5) **recommends** *that fishing effort and location of gear that may cause entanglements of ASHW are more accurately mapped throughout ASHW range, especially in the most dense and critical habitat, to assess co-occurrence and risk, in order to better inform mitigation measures; and*
(6) **recommends** *that a comparative study be conducted between the Oman ASHW catalogue and other Southern Hemisphere (SH) Indian Ocean catalogues to assess prevalence and coverage of barnacle scarring and colonisation, to determine whether this can be used as a proxy measure for distinguishing ASHW from SH whales.*

9.2.2 Central American humpback whales

The Committee received new information on the endangered Central American humpback whale population. SC/68B/CMP/26Rev1 presented evidence, based on photo-ID and mtDNA, on the similarities between the humpback whales from Central America and Southern México (Guerrero and Oaxaca states). The authors conclude that the humpback whales from southern Mexico belong to the endangered 'Central America' Distinct Population Segment (DPS).

SC/68B/CMP/25Rev1 presented the report of a Workshop on the Central America Humpback Whale Population that took place from 9-10 March 2020 in Panama City, Panama. The Workshop reviewed information that was available on population structure, abundance, distribution, and threats of the humpback whales of the Central America population and discussed the development of a CMP for this population. The Workshop was attended by 21 participants from eight countries (US, Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama), and was hosted by the Minister of Environment of Panama and supported by the Secretaría Nacional de Ciencia, Tecnología e Innovación (SENACYT) de Panamá and the Cetacean Society International (CSI). The participants propose to conduct a second workshop with the representation of the proponent countries to develop the CMP of the Central America Humpback Whale Population, in February 2021.

Attention: SC, CC, CG

The Committee reiterates the recommendation of last year (IWC, 2020a) that the Central American humpback whale population be treated as a 'priority population' for the purpose of the CMP development process.

Regarding the Workshop on the Central America Humpback Whales' population' at Panama City, Panama, the Committee **recommends** *the continuation and increased collaboration of the Range States. The Committee also* **recommends** *that the report of a second workshop to develop a draft CMP to be presented at the SC68C meeting.*

9.2.3 Mediterranean sperm whales

The Committee received information on the ACCOBAMS Scientific Committee meeting held in February 2020 that acknowledged the need to start work on an IWC-ACCOBAMS CMP for sperm whales.

Following the ACCOBAMS Survey Initiative, an update of the IUCN Red List assessment of the Mediterranean sperm whales is currently underway as part of a joint effort by ACCOBAMS, IUCN Mediterranean in Malaga, and a larger group of Mediterranean scientists. This new regional assessment should be ready by the end of 2020.

The Committee **welcomes** that ACCOBAMS is considering the development of a CMP for Mediterranean sperm whales which are threatened by various anthropogenic threats including ship strikes and bycatch, and since 2019 have been subject to an UME (SC/68B/E/10Rev1), which is discussed in detail under Item 14.3.3.

Attention: CG, CC, IGO

ACCOBAMS is considering drafting a CMP for sperm whales in the near future and the Committee **agrees** *that consideration should be given to this being a joint ACCOBAMS/IWC CMP; it* **reiterates** *the recommendations of last year (IWC, 2020a) that the Mediterranean sperm whale be treated as a 'priority population' for the purpose of the CMP development process.*

9.2.4 Mediterranean fin whales

The Committee received information that a CMP Workshop funded and organised by ACCOBAMS was held in Barcelona, Spain, to develop an initial draft CMP for Mediterranean fin whales and to stimulate discussion within the region. The CMP was an initiative of ACCOBAMS member countries, all of whom are also range states. The ACCOBAMS plan is: (1) the initial draft be examined by the ACCOBAMS SC; (2) the IWC SC review the CMP from a scientific perspective; (3) the revised CMP be sent to member states; and (4) a stakeholder Workshop be held to develop a final CMP (to which IWC as well as other IGOS, NGOs, local and national authorities will be invited).

Stock structure is the main scientific issue with respect to fin whales in the region. New published and unpublished evidence (i.e. genetics, stable isotope and telemetry data) suggest that the ACCOBAMS region contains a single 'Mediterranean' population of fin whales, with some whales moving out through the Strait of Gibraltar into the adjacent North Atlantic in summer and returning in the winter.

The first ever, basin-wide survey was completed in summer 2018 and the full set of analytical results (i.e. abundance and relative density throughout the region) is expected soon. These results will need to be taken into account in the draft CMP when they become available. A predictive model for local and seasonal occurrence/density of fin whales has been developed and is being tested (so far for the summer only). This may prove to be a valuable tool for identifying winter distribution and habitats (of which relatively little is known, especially in the east) and from a CMP perspective assisting with prioritising spatio-temporal mitigation actions. This will also link in with the IMMA (Important Marine Mammal Areas) work under IUCN.

Mediterranean fin whales face a number of both direct and indirect threats. Direct threats (i.e. those that may cause instantaneous or near instantaneous death of the animal) include vessel strikes, and, rarely, severe blasts of extremely loud noise. Fin whales appear less vulnerable to fishery entanglements. Indirect threats that may affect survival or reproduction but at a longer timescale, include: (1) anthropogenic noise from different sources (e.g. industrial, extractive, prospective or military activities, or even from approaching vessels, such as during whale watching or research); (2) chemical pollution including micro- and nano-plastic ingestion (both fin whales and/or their prey); and (3) physical disturbance (e.g. intrusive whale watching and research). Climate change may influence/exacerbate several of these, especially abundance and distribution of prey (and hence whales). The need to consider threats cumulatively as well as individually is important for conservation and management.

The work of the IWC Scientific and Conservation Committees on the threats faced by Mediterranean fin whales was highlighted, especially with respect to previous joint IWC/ACCOBAMS Workshops on ship strike mitigation and work on anthropogenic noise, marine debris and whale watching. In all cases, the need to co-operate with a wide range of stakeholders including IGOs, local and national authorities, NGOs and industry, was stressed. This included the need for public awareness and capacity building.

The need for a full-time co-ordinator under the guidance of a Steering Group representing key stakeholders was emphasised. Ongoing effort is aimed at integrating the draft CMP with actions targeting acoustic work, which was not included in the drafting effort in Barcelona.

Attention: CG, CC, IGO

The Committee **notes** *that ACCOBAMS has adopted the IWC guidelines for its CMPs. It* **welcomes** *progress made in developing a CMP for Mediterranean fin whales and* **reiterates** *the recommendations of last year (IWC, 2020a) that the Mediterranean fin whale be treated as a 'priority population' for the purpose of the CMP development process.*

The Committee **encourages** *the relevant IWC and ACCOBAMS Range States to work towards finalising a draft CMP for fin whales for presentation at SC68C.*

9.2.5 South American river dolphins

The Commissioner from Colombia, on behalf of the Governments of Brazil, Colombia, Ecuador and Peru presented the proposed CMP nomination for South American river dolphins (SC/68B/CMP/21). The main objective of the CMP is to promote the conservation of river dolphin species (*Inia geoffrensis, Inia boliviensis, Inia araguaiaensis* and *Sotalia fluviatilis*) in the Amazon, Orinoco, and Tocantins/Araguaia basins through a regional concerted strategy. The proposed CMP will facilitate prioritisation of research and conservation actions among the different South American countries where these species live, as well as guide national and regional actions. The CMP nomination was a very complete and well drafted document, with clear collaboration and support from range states, four governments, researchers and NGOs with many years of experience in the region. The Committee thanked the Commissioner for this new initiative.

The Committee welcomed this initiative and full consideration will be given to the scientific aspects of the CMP and any related intersessional work at SC68C.

In discussion, it was noted that the Chair of the SWG-CMP (Australia) usually works in a supporting role for CMP development. Australia noted that it was pleased to see this nomination considered by the Committee and offered assistance to the proponents to seek Conservation Committee consideration. It welcomed the opportunity to work with the drafting countries to refine and clarify some of the text of the nomination.

The Committee **congratulates** the four countries of Colombia, Brazil, Ecuador, and Peru for submitting an excellent nomination for a CMP for South American river dolphins; such international collaboration at governmental, environmental and scientific levels is exemplary. It notes that the proposal will be considered by the Conservation SWG on CMPs during the intersessional period.

Attention: SC, CC

The Committee:

(1) **strongly endorses** *the scientific components of the South American river dolphins CMP nomination in principle this year;*
(2) **encourages** *the proponents to prepare a draft CMP, pending consideration and endorsement of the nomination by the Conservation Committee;*
(3) **establishes** *an Intersessional Correspondence Group to examine the scientific components and interact with the proponents on scientific matters and priorities to be included in the draft CMP;*
(4) **agrees** *to fully consider the scientific aspects of a draft CMP and the intersessional work at its 2021 meeting (SC68C);*
(5) **encourages** *the range states to work with the IWC's Bycatch Mitigation Initiative since bycatch was identified in the presentation as a key threat for river dolphins; and*
(6) **encourages** *the proponents to appoint a full-time co-ordinator for the plan and ultimately the CMP, as soon as possible.*

Table 11

Summary of the work plan for the sub-committee on conservation management plans (CMPs) for intersessional 2020/21 and 2021 Annual Meeting.

Item	Intersessional 2020/21	2021 Annual Meeting (SC68C)
Southeast Pacific right whale	- Complete recording of PAM on Arauco Gulf; - start passive acoustic monitoring near Antogafasta for one full year; and - conduct the 3-day CMP coordination meeting	Review progress on scientific aspects of CMP
Southwest Atlantic right whale	Workshop to review priority actions	Review progress on scientific aspects of CMP
Gray whale	Scientific workshop (pending safe travel given the situation with COVID-19)	Review progress on scientific aspects of CMP
Franciscana	Workshop to finalise the review	Review the intersessional workshop report and new information
Arabian Sea humpback whale	Complete the revised abundance and trend estimates; complete genetic analyses to provide clarity on the taxonomic status of ASHW, continue PAM along the west coast of India	Review progress on identified priorities for research and conservation
Mediterranean fin whale	Coordinate with ACCOBAMS SC to prepare final draft CMP including updating research priorities and actions for initial email review by range states and others	Review the draft CMP and progress on scientific aspects
Mediterranean sperm whale	Coordinate work with ACCOBAMS to identify drafting working group and streamline development process	Review new information
South American river dolphin	Establish Intersessional Correspondence Group (see Annex K) to examine the scientific aspects of the proposed CMP for South American river dolphins	Review report of the ICG and the draft CMP
Central American humpback whale	Coordinate CMP strategic planning (via email) and workshop	Review of the draft CMP

9.2.6 South Asia river dolphins (not covered in CMP)

The role of a CMP to improve conservation of South Asia river dolphins (SC/68B/CMP/10) was discussed in Item 16.1.7, as was the report of the intersessional Workshop held in Malaysia in July 2019 (SC/68B/REP/04).

9.3 Budget requests

The Committee recommended the funding of four research proposals and three workshops and these are discussed under Item 22.

9.4 Work plan

The work plan is detailed in Table 11.

10. STOCK DEFINITION AND DNA TESTING

During the present meeting, the Committee via the Stock Definition and DNA Testing Working Group received voluntarily submitted information on the DNA registers maintained by Iceland, Norway, and Japan (Item 10.1); discussed recommendations to avoid the depletion of tissue samples in existing collections (Item 10.3); and provided advice on stock structure to other sub-committees (Item 10.4).

10.1 DNA testing

10.1.1 Reference databases and standards for DNA registries

This year, the Committee received voluntary updates of the DNA registers from Iceland, Norway, and Japan. Details are given in Annex E for each country, respectively. The Japanese and Norwegian registers cover the period up to and including 2019. The Icelandic register covers the period up to 2018; no whales were taken in 2019. Almost all samples in the Japanese and Icelandic registers have been analysed for mitochondrial DNA (mtDNA) and a standard set of microsatellites. Norway discontinued mtDNA analyses of samples in 2016. Almost all of the samples in the Norwegian register have been analysed for a standard set of microsatellites, and almost all of the samples collected in 2016 or later have also been genotyped for SNPs.

Representatives of the three countries submitting voluntary reports this year (Iceland, Norway and Japan) reiterated the statements made at previous meetings on DNA registers (e.g. IWC, 2019g).

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

10.1.2 New techniques for species, stock, and individual identification

Discussion on this topic was postponed until SC68C.

10.2 DNA data quality and genetic analysis guidelines

Two sets of guidelines have been developed for reference in the Committee's discussions of stock structure: (1) the DNA quality guidelines, which provide advice on best practices for ensuring the quality of data produced for genetic analyses; and (2) the genetic analyses guidelines, which provide advice on genetic analyses commonly used in the Committee's work.

10.2.1 Updates to DNA quality guidelines

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[18]. In recent years, it has become common for the Committee to review papers using data derived from Next Generation Sequencing approaches, including Single Nucleotide Polymorphisms (SNPs), to address stock structure questions. Further discussion of this topic was postponed until SC68C, although the Committee agreed to continue work on these guidelines intersessionally (see Table 12).

10.2.2 Consideration of need to update analysis guidelines

The Committee is pleased to note that the most recent version of the guidelines for genetic data analyses has been published in the *J. Cetacean Res. Manage.* (Waples *et al.*, 2018). No sections of these guidelines were identified as in need of updating this year.

Attention: SC, S

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

(1) **encourages** *that the guidelines be followed in papers reporting the results of DNA analyses to the Committee;*
(2) **emphasises** *the need to update these guidelines to incorporate the discussion of data quality measures used for Next Generation Sequencing;*
(3) **agrees** *to continue the Intersessional Correspondence Group review of revised sections of the DNA data quality guidelines that apply to data generated from next generation sequencing platforms, including SNPs and whole genome sequencing; and*
(4) **recommends** *that the guidelines be made available on the main Scientific Committee webpage to ensure that they can be easily found by researchers.*

10.3 Recommendations on the avoidance of sample depletion

Last year (IWC, 2020d), the Committee received a summary of intersessional work that had been compiled on the general advantages and disadvantages associated with three broad categories of high throughput sequencing approaches, including whole genome sequencing (WGS), reduced-representation sequencing, and high-throughput targeted capture. Following discussion, the Committee had agreed that WGS is the best approach to maximise the value and avoid depletion of tissue samples and agreed that requests for projects using this approach (WGS) will be prioritised. The resulting sequence data should be submitted to a public database (e.g. *GenBank*) and interested parties could then retrieve the data rather than request use of the tissue sample.

The Committee had also noted that while WGS could provide genome sequences that would be valuable in addressing a wide range of questions, it is also important to preserve some tissue for use with other emerging technologies. The need to consider preserving tissue for alternative approaches was highlighted in the discussion of Antarctic blue whale population structure (see Item 8.2.2), where it was noted that analyses of stable isotopes and skin microbiomes collected from blue whales on Antarctic feeding grounds could potentially provide insight into whether sampled individuals share a common wintering ground, a question that genetic analyses have thus far failed to answer. Epigenetic analyses constitute a further valuable approach, e.g. in the context of age estimation.

In discussion, it was agreed that while WGS data is the 'gold standard' given that complete genomic data is produced, other considerations may also be important when evaluating tissue and/or DNA requests. Some questions of interest to the Committee can be adequately answered with traditional methods (i.e. microsatellites and mitochondrial control region sequencing). In other cases, genome-wide survey methods like DNA capture, which can generate thousands of SNP genotypes while using markedly lower amounts of DNA, can provide sufficient power to address Committee-relevant questions. One possibility would be to ensure that sufficient DNA is retained from each sample that a WGS with reasonable read depth could be generated, but the remaining tissue and/or DNA would be made available for other approaches, perhaps with the requirement that sample requesters accompany their proposals with a power analysis demonstrating that the number of samples requested (and otherwise available from other sources) is sufficient to answer the question.

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

Attention: SC

In reviewing the results of stock structure analyses, the Committee **reiterates** *its concern regarding the depletion of tissue samples in existing collections (including those collected during the IWC SOWER and POWER surveys). Given recent advances in high throughput sequencing technology, the Committee* **agrees** *that:*

(1) *sample depletion should be avoided, such that sample requests will be fulfilled only with those samples for which substantial tissue remains;*
(2) *whole genome sequencing (WGS) is generally the best approach to maximise the value and avoid depletion of tissue samples, and requests for projects using this approach (WGS) should usually be prioritised;*
(3) *in some circumstances use of other genetic approaches may be justified (e.g. by demonstrating sufficient power can be provided to address the question of interest); and*
(4) *preserving some tissue for emerging genomic technologies (e.g. epigenetics, microbiome analysis) or alternative techniques (e.g. stable isotopes) should be considered when evaluating sample requests.*

The Committee **agrees** *that the intersessional working group should continue its work to provide recommendations on genomic approaches to maximise the utility of these samples for future studies. The Committee also* **encourages** *submission of reports detailing the current status of genome sequencing of cetaceans and implications for tissue collection and preservation.*

10.4 Advice on stock structure to other groups

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

10.4.1 Gray whale stock structure

Seven alternative hypotheses, some of which include multiple variants, were initially proposed to describe the stock structure of gray whales in the North Pacific (IWC, 2015d). In light of the results of a series of intersessional workshops on the status and population structure of gray whales in the North Pacific (IWC, 2015d; 2016d; 2017g; 2018c; 2019b), the Committee had agreed that two of the hypotheses (3a and 5a) should be considered high plausibility, while trials to evaluate stock status would also be conducted for four additional stock structure hypotheses or variants (3b, 3c, 3e and 6b). This year, the Committee reviewed five papers relevant to gray whale stock structure (SC/68B/SDDNA/01-03, Brykov *et al.*, 2019; SC/68B/ASI/01) that were submitted for consideration under the 2020 *Implementation Review* of gray whales (see Item 6.2).

SC/68B/ASI/01 extends the analyses of Calambokidis *et al.* (2017) to include photo-identification data collected from whales within the Pacific Coast Feeding Group (PCFG) study area between 1996-2017. The results are similar to those presented previously and thus are consistent with the stock structure hypotheses currently being considered.

SC/68B/SDDNA/01 incorporates previous advice from the Committee (IWC, 2019g) to combine photo-identification and genetic data to evaluate stock structure of gray whales. Mitochondrial and nuclear genetic differentiation was found between whales that feed off Sakhalin Island (SI), Russia, and those feeding in the Bering and Chukchi Seas (the North Feeding Group, NFG), indicating high internal recruitment of whales to the SI feeding area and a lack of random mating between SI and NFG whales. Clustering analysis identified two distinct genetic groups among the SI samples, one of which was genetically similar to the NFG whales, and both groups contained individuals known from photo-identification data to have travelled from SI to the Mexican wintering ground. Comparison of samples collected from whales off the southeastern coast of Kamchatka with SI and NFG whales revealed greater similarity between the SI and Kamchatka whales than between the Kamchatka and NFG whales.

Similar to results presented in Brüniche-Olsen *et al.* (2018), which was reviewed by the Committee in 2018 (IWC, 2019c), the paper identified two genetic clusters when SNP data generated for whales biopsied off SI were analysed, one which was more similar to the genotypes of whales sampled off Mexico (‘eastern genotype’) and one that was found primarily among Sakhalin whales (‘western genotype’). The analyses in Brykov *et al.* (2019) separated the SI samples into groups that corresponded with the two genetic clusters and then compared the sequences of four mitochondrial genes between groups. Statistically significant differences in mtDNA haplotype frequencies were identified between groups, and a haplotype network did not reveal clear evidence of structure between these groups.

The study reported in SC/68B/SDDNA/02 sequenced the full mitogenomes of samples collected from gray whales on the SI feeding ground and on the Mexican wintering ground. The two strata had a high degree of haplotype sharing but significantly differed in the distribution of haplotypes. Evidence for a recent population size change was not detected, suggesting that mtDNA diversity was already reduced prior to commercial whaling.

SC/68B/SDDNA/03 reviewed the results of studies using genetic and genomic data to evaluate the stock structure of gray whales, with a focus on evidence providing insight into the relationship of the SI whales that currently feed in the area to the population of whales that was historically hunted in the western North Pacific. The authors conclude that the whales using Sakhalin are comprised of two groups, both of which are likely to have been derived from eastern North Pacific gray whales.

In discussion, the Committee noted that deep divergence is present in the mtDNA network and phylogenetic tree presented in SC/68B/SDDNA/02, which could be concordant with the pattern expected if a remnant of the historically hunted WNP whales were present. While this highly divergent branch contains one mitogenome haplotype that is found in high frequency among whales sampled off SI, it has also been identified among whales sampled in Mexico. This divergent branch also includes two mitogenome haplotypes found only among Mexican whales and one mitogenome haplotype found only in SI whales. While the divergence is less prominent (due to a more limited amount of sequence data), the divergent branch can also be seen in the mtDNA network presented in Brykov *et al.* (2019), where the majority of Sakhalin whales containing the high frequency haplotype belong to the 'western genotype' cluster with a much lower proportion belonging to the 'eastern genotype' cluster. Thus, this pattern is likely driven by the stochastic maintenance of ancestral diversity. However, the Committee **agrees** that possible existence of separate western lineages should be re-evaluated in the future when more gray whale genetic and/or genomic data is expected to become available.

The Committee evaluated whether any of the new information presented in the reviewed papers suggested that changes to the plausibility rankings of the stock structure hypotheses were needed (see Annex F for details of the hypotheses). Hypothesis 3a describes a scenario where the Western Feeding Group (WFG) of whales show matrilineally-driven fidelity to the feeding ground off SI, Russia, but interbreed with whales from both the NFG and the PCFG, such that only one panmictic breeding stock exists. The results presented in SC/68B/SDDNA/01, as well as those in Brüniche-Olsen *et al.* (2018), reviewed in IWC (2019g), and Lang *et al.* (2010b) and Lang *et al.* (2010a), both reviewed in IWC (2011a) indicate that the whales that feed off Sakhalin do not interbreed at random with the whales considered part of the NFG or the PCFG, probably because some and perhaps most mating occurs before the migratory path used by SI whales converges with that of the whales migrating south from Arctic feeding grounds.

Hypothesis 4a is identical to Hypothesis 3a except that in 4a the whales feeding off SI primarily mate with one another while on migration to Mexico, implying the existence of two breeding stocks that use the same wintering ground. Hypothesis 4a was previously considered low priority in part because the underlying modelling structure and input parameters are identical to those of 3a, although under 3a the Eastern Breeding Stock (EBS) would include the WFG, NFG, and PCFG while under 4a the EBS contains only NFG and PCFG. While this implies that conservation metrics based on the projections of the two models could differ slightly for the EBS, the Committee's evaluation of conservation metrics has focused on the PCFG, WFG, and Western Breeding Stock (WBS, which does not exist in hypotheses 3a and 4a), all of which have markedly lower abundance (~ two orders of magnitude different) than the NFG.

Given that the underlying structure and model inputs are the same for Hypotheses 3a and 4a, simulations based on 3a would identify trials that would result in depletion of the WFG under 3a as well as those that would result in depletion of the breeding stock (demographically the same as the WFG in 3a) under 4a. Since Hypothesis 4a is functionally the same as 3a, elevating its plausibility to high would not entail including additional trials for testing under the gray whale *Implementation Review*. The Committee noted, however, that it was important to maintain clarity regarding the biological scenarios being evaluated for the purposes of the rangewide review of the status and population structure of North Pacific gray whales. An Intersessional Correspondence Group was formed to address this issue; their Terms of Reference are laid out in Annex K.

Details on the hypotheses considered to be of high or medium plausibility are included in Annex F.

Attention: SC

Upon reviewing new information relevant to evaluating the plausibility of the hypotheses that have been proposed to describe the stock structure of gray whales in the North Pacific (IWC, 2015d), the Committee **agrees** *that for the purposes of the Rangewide Review of the Status and Population Structure of Gray Whales:*

(1) *Hypothesis 4a should be given high plausibility while Hypothesis 4b should be given medium plausibility;*
(2) *additional medium plausibility variants (4c and 4e) should be added that are functionally the same as 3c and 3e but incorporate a lack of random mating between the Western Feeding Group whales and other whales considered part of the Eastern Breeding Stock under Hypothesis 3;*
(3) *the plausibility of Hypothesis 3a and its variants will remain unchanged; but*
(4) *an Intersessional Correspondence Group will be formed to clarify the terminology used to describe the hypotheses and to assess if further changes are needed to ensure that all plausible scenarios and their respective plausibilities are represented. A report summarising the group's discussions will be provided at SC68C as well as being presented to the proposed scientific Workshop.*

10.4.2 Franciscana population structure

The franciscana is a small dolphin endemic to the southwestern Atlantic that has been classified as vulnerable by the IUCN due to fishing-related mortality at levels believed to be unsustainable (Zerbini *et al.*, 2017). Four 'Franciscana Management Areas' (FMAs) were initially defined using a phylogeographic approach and incorporating multiple lines of evidence (Secchi *et al.*, 2003). When the Committee last reviewed franciscana population structure (IWC, 2015c), analyses of a more extensive sample set (Cunha *et al.*, 2014) suggested that strong quantitative mtDNA differentiation in AMOVA analysis separated the FMA I population in the North from FMAs II-IV in the South at a level of differentiation consistent with an Evolutionarily Significant Unit (ESU). In addition, the analyses suggested that the existing FMAs should be further subdivided into separate management units (designated as FMA Ia, Ib, IIa, IIb, IIIa, IIIb, IVa, IVb, and IVc) to reflect the genetic differentiation found within each ESU (Cunha *et al.*, 2014). Following the 2015 review, the Committee recommended that (1) additional analyses using nuclear markers be conducted to evaluate management unit boundaries for both males and females; (2) additional samples be included in future analyses if available, in order to improve resolution of FMAs; and (3) attempts be made to resolve the biologically critical dispersal rates in terms of management goals, and determine what levels of genetic differentiation such dispersal rates are expected to generate.

Several papers have been published subsequently that address the first two recommendations for analysis of nuclear markers and use of additional samples to evaluate franciscana management units (Gariboldi *et al.*, 2015; 2016; Negri *et al.*, 2016). This year, the Committee reviewed three additional papers.

SC/68B/SDDNA/04 investigated population structure within FMA IIb by comparing samples collected from a small group of franciscana that inhabits Babitonga Bay in southern Brazil with those collected from franciscana in nearby coastal areas. Significant nuclear and mitochondrial genetic differences were identified, suggesting that population structure occurs at small geographic scales (<20km) in this area. In discussion, the Committee noted that three of the seven microsatellite alleles used in the nuclear analyses showed evidence of departure from Hardy Weinberg equilibrium (HWE). This could indicate the presence of null alleles, which can lead to biased estimates of genetic differentiation (Waples *et al.*, 2018). The Committee suggested that the nuclear analyses of genetic differentiation be repeated after excluding the loci that deviated from HWE. While reducing the number of loci analysed will decrease the power to detect genetic differences, greater confidence can be placed on the findings if the nuclear genetic differences between the groups remained apparent.

SC/68B/SDDNA/05 analysed additional samples collected within FMA IIa. Comparison of this data with previously published data collected throughout FMA II provided additional support for the separation of FMA IIa from the other areas compared (FMA IIb, FMA III, FMA IV). Comparison of stable isotope signatures and contaminant profiles between FMA IIa and FMA IIb also supported the separation of these two areas.

Finally, SC/68B/SDDNA/07 provided an overview of the results of published and unpublished genetic analyses of population structure within the range of the franciscana. Eleven putative management units were proposed, and recommendations for future analyses were provided.

The Committee thanked the authors for their work, which followed the first two recommendations made at the last review. The Committee further noted the value of the summary provided in SC/68B/SDDNA/07, which pulled together the results from multiple different sources, not all of which are easily accessible.

How to relate dispersal rates and genetic differentiation to 'operational definitions of stock' and to 'evaluate stock structure, based on the management context in which they are to be used' was one of the needs recognised in the creation of the Committee's Stock Definition Working Group in 1998 (IWC, 1999b). Developing a single quantitative threshold for differentiation that indicates management as separate stocks is difficult in natural systems as that threshold can vary substantially depending on a variety of factors (e.g. relative population sizes, productivity, migration rates, Waples *et al.*, 2018). Thus, identifying biologically critical dispersal rates in terms of management goals, which was the third recommendation to come out of the 2015 review, has remained a challenge both for franciscana and for the work of the Committee more broadly. Within the range of the franciscana, there is evidence for deep divergence (e.g. the North and South ESUs) as well as more shallow structure, which in some cases is at very small geographic scales (e.g. within FMA IV; Gariboldi *et al.*, 2016). Given the high levels of bycatch that occur, however, defining management units at these small scales is the most risk-averse strategy.

The value of combining the genetic data with other lines of evidence (e.g. movement data, morphology, contaminants) when investigating population structure, as was done in SC/68B/SDDNA/05, has long been recognised by the Committee (Donovan, 1991). Several other data sources exist (Barbato *et al.*, 2012; do Amaral *et al.*, 2018; Henning *et al.*, 2018; Lázaro *et al.*, 2004; Ramos *et al.*, 2002; Wells *et al.*, 2013). Integrating these with the genetic data could build support for delineating management units in areas where genetic data are sparse and provide insight into what constitutes biologically meaningful units that have been identified at fine scales using the genetic data.

The Committee noted that efforts are ongoing to combine available genetic datasets and conduct an integrated range-wide analysis of structure. This work would provide a better understanding of patterns of structure across the range to be explored and would aid in determining where boundaries between management units should be placed. The combined dataset would also allow patterns of isolation by distance, as well as isolation by environmental distance, to be explored, both of which have proven useful in understanding franciscana population structure within parts of its range (Mendez *et al.*, 2010).

It was noted that some of the FMA delineations are well-supported. For example, recognition of the division of FMA Ia and FMA Ib was suggested in the Report of 8th Workshop for Research On and Conservation of the Franciscana (Fransicana Consortium, 2016) which was endorsed in 2016 (IWC, 2017f). Others, however, are less robust. Although SC/68B/SDDNA/07 provided a valuable summary of the available genetic data, evaluating the level of confidence in each subdivision will require examining the results presented in individual papers as well as the integration of non-genetic data sources. An Intersessional Correspondence Group was formed to conduct this task; their Terms of Reference are outlined in Annex K.

While recognising that additional information could be useful in better understanding the population structure of franciscana, the Committee noted that an extensive dataset is already available. Over 700 samples have been collected, sequenced for mtDNA control region, and genotyped at microsatellite loci, seven of which are common to samples from Brazil, Uruguay, and Argentina and four that are common across all datasets and could be combined after calibration between laboratories.

Attention: SC, R

Since the Committee last reviewed population structure in franciscana (IWC, 2015a), considerable new information has become available, leading to a proposal to recognise eleven management areas within the range of the species.

In reviewing the available evidence relating to population structure in franciscana, the Committee:

(1) **commends** *ongoing collaborative efforts to combine available genetic and other datasets to conduct an integrated rangewide analysis of population structure of franciscana and* **encourages** *the continuation of this project; and*
(2) **agrees** *to form an Intersessional Correspondence Group to further evaluate the strength of currently available evidence (genetic and other, e.g. stable isotopes, contaminants, etc.) supporting the proposed management units and report on its findings at SC68C.*

10.4.3 Sotalia guianensis population structure

Sotalia guianensis is a small coastal delphinid that ranges from Nicaragua to southern Brazil (Flores and Da Silva, 2009). This species faces anthropogenic threats throughout most of its distribution and is listed as Near Threatened by the IUCN (Secchi *et al.*, 2018). SC/68B/SDDNA/06 provided a review of population structure studies of *Sotalia guianensis* and a proposal for delineating management units. Due to limited time, the Committee was unable to review this paper this year and has established an Intersessional Correspondence Group (see Annex K) to make progress intersessionally.

Attention: SC

The Committee notes the importance of understanding the population structure of Sotalia guianensis in order to delineate management units within the species' range. It **agrees** *to establish an Intersessional Correspondence Group to review genetic and other evidence relating to population structure in this species and to provide advice on the proposed management unit delineations. A summary of this group's progress will be reported at SC68C.*

10.4.4 Overview of stock structure analyses based on POWER biopsy samples

The Committee reviewed SC/68B/ASI/16, which responds to a recommendation of the IWC-POWER's Technical Advisory Group (SC/68B/REP/01) to summarise the results of genetic studies that have included data from IWC-POWER and to develop proposals for additional analyses to infer stock structure using the POWER and other available samples. The genetic analyses of North Pacific sei (Pastene *et al.*, 2016a; 2016b), Bryde's (Pastene *et al.*, 2016a; 2016c; Taguchi *et al.*, 2017), and right whales (Pastene *et al.*, 2018) that are summarised in SC/68B/ASI/16 have been reviewed by the Committee in the past (IWC, 2017d; 2018d; 2019c), and thus no further discussion on these topics was needed.

Attention: SC

Upon reviewing a summary of genetic studies that have used samples collected as part of the IWC-POWER surveys, the Committee:

(1) **recognises** *the value of past work in which biopsies collected as part of the IWC-POWER surveys have been used to understand the stock structure of large whales in the North Pacific;*
(2) **expresses** *appreciation to the authors for providing the summary, which responds to a recommendation made by the IWC-POWER's Technical Advisory Group;*
(3) **encourages** *the inclusion of IWC-POWER samples, including those from blue and fin whales, in future studies to infer population structure; and*
(4) **encourages** *the continuation of IWC-POWER and the collection of samples on all future surveys.*

10.5 New genetic approaches of use to the Scientific Committee in addition to stock structure issues

Discussion on this topic was postponed until SC68C.

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, subspecies, stocks, and individual cetaceans. As in previous years, it* **encourages** *the submission of similar papers in the future and* **recognises** *the relevance of these techniques to the Committee's work.*

Table 12
Work plan for the working group on stock definition and DNA.

Topic	Intersessional 2020/21	2021 Annual Meeting (SC68C)
2.1. 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
3. 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
4.1 Gray whale population structure	Intersessional email group to clarify terminology associated with the gray whale stock structure hypotheses and, where needed, to further evaluate plausibility of hypothesis in preparation for the Range-wide Review of the Status and Population Structure of Gray Whales.	Report and provide advice
4.2. Franciscana population structure	Intersessional email group to evaluate stock structure in franciscana.	Report and provide advice
4.3. *Sotalia guianensis* population structure	Intersessional email group to evaluate stock structure in *Sotalia guianensis*.	Report and provide advice
6.2. Terminology	Intersessional email group to continue discussions of the use of stock structure-related terms within the SC.	Report

10.6 Other

10.6.1 Simulation tools for spatial structuring

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; IWC, 2017d, p.48), and in 2016 the Committee agreed to expand this item (formerly specific to the Testing of Spatial Structure Models, or TOSSM) to include a broader range of tools (IWC, 2016a, p.44). Discussion of this item was postponed until SC68C.

Attention: SC
The Committee ***notes*** *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 used within the Committee for this purpose. The Committee therefore* ***encourages*** *the submission of papers using simulation-based approaches to address questions of interest to the Committee and* ***reiterates*** *(IWC, 2019c, p.34) that consideration should be given to bring in invited expertise to present an overview of the applicability of such approaches in order to expedite progress on this agenda item.*

10.6.2 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). Discussion of this item was postponed until SC68C.

Attention: SC
The Committee ***agrees*** *that the intersessional email group to review terminology with specific reference to the implications of inferred stock structure in other sub-committees should continue, with a focus this year on terms used in large whale assessments, including those used to describe gene flow among stocks versus the movements of whales between areas.*

10.6.3 Epigenetic ageing and close-kin mark-recapture

In previous meetings, the Committee reviewed novel methods that use genetics to estimate age (IWC, 2019c, p.34) and to estimate abundance, life history parameters, gene flow and stock structure (IWC, 2018d, p.40). Discussion of this item was postponed until SC68C.

Attention: SC
The Committee ***agrees*** *that the utility of epigenetic age estimation (Polanowski et al., 2014) to the Committee should be further evaluated with regard to the degree of precision needed for the specific application of interest. The Committee* ***encourages*** *future submission of papers using epigenetic ageing and/or close-kin mark-recapture (Bravington et al., 2016) in light of the potential of both approaches to inform many aspects of the Committee's work.*

10.7 Annual work plan for SDDNA

The details of the work plan are given in Table 12. Terms of Reference are outlined in Annex K.

11. CETACEAN ABUNDANCE ESTIMATES AND STOCK STATUS (ASI)

Since 2017, to ensure consistency in the way the Committee reviews and categorises them, all abundance estimates have been reviewed by a Standing Working Group (SWG) on Abundance Estimates, Stock Status and International Cruises (ASI), and the advice passed on to the relevant sub-group early in the meeting or at a future meeting as necessary (IWC, 2017d, p.94; 2018j, p.394). The ASI is also tasked to: (a) compile an agreed set of abundance estimates for use by the Committee; (b) produce a broader biennial document of abundance estimates for the Commission and the public by species and usually by ocean basin, and by specific areas if appropriate; and (c) provide a biennial overview of the status of whale stocks, largely based upon completed Comprehensive Assessments, In-depth Assessments and/or RMP/AWMP *Implementations* or *Implementation Reviews*.

11.1 Review of abundance estimates and update of IWC consolidated table

11.1.1 Eastern North Pacific gray whale

SC/68B/ASI/01 updated information on the abundance and population structure of the Pacific Coast Feeding Group (PCFG) of gray whales in the eastern North Pacific using photographic identification. Gray whales using coastal waters from Northern California to Northern British Columbia in summer and autumn generally include two groups: (1) whales that return frequently and account for the majority of the sightings; and (2) transient individuals seen in only one year, generally for shorter periods of time and in more limited areas. A time series of abundance estimates of the non-transients for 1996-2017 was constructed based on a mark-recapture model for the region from 41° to 52°N, excluding sightings in the Puget Sound region and adjacent areas i.e. the region defined by the IWC to represent the range of the PCFG for the summer and autumn feeding season (June-November). The fitted model indicates that the abundance in this region was relatively stable in the early 2000s but increased from 2010 to 2015 before decreasing slightly in 2016.

This document was reviewed by three independent experts as part of the review process established by the Committee last year (IWC, 2020j) and the Committee thanked the reviewers for their work. The paper is an update (and a more comprehensive data analysis) of Calambokidis *et al.* (2017), which used similar methods and obtained similar results and was previously reviewed; the estimates provided there were accepted by the Committee (IWC, 2018i, p.380).

As part of the review, it was noted that since the analysis uses a model-based mark-recapture method, adding new data and increasing the length of the time series impacts the estimates of abundance for earlier years (in addition to producing estimates for the subsequent years). Documentation and an explanation of this would be helpful for understanding the model fit and the consequences of the new data better.

The review also raised an issue that warrants additional consideration by the Committee. The model used effectively defines the population to be estimated by reference to the dataset itself. A whale is considered to have joined the PCFG when it has been seen there at least once (the PCFG population definition is such that it includes all whales that are seen there two or more times plus some of those seen exactly once, but no unknown whales). Thus, the population is not an entity that exists independently of the data but is partly defined by the same data used to estimate abundance. This gives the abundance estimate a certain tautological character. If the sampling effort changes, this will impact the population so defined. The model assumption that if a whale returns to the PCFG region in more than one year then it is part of the PCFG population also means that temporary emigration is not considered. If some whales occasionally do not return to the area, but then come back in a later year, they would be a part of the abundance estimate, so the abundance estimate would represent the population of whales that have ever used the area (more than in just one year), but not necessarily an estimate of the number of whales actually there in any given year.

The Committee agreed with the reviewers' conclusion that the technical aspects of the analysis were implemented correctly, and that the resulting time series of estimates (Table 13) starting in 1998 and ending with an abundance of 232 whales (SE = 25) in 2017 can be used, at least provisionally, as an estimate of abundance of the PCFG population for the *Implementation Review* discussed under Item 6.2.

Table 13

Abundance estimates of PCFG gray whales (see SC/68B/ASI/01).
The estimates for 1996 and 1997 are not considered to represent total abundance; see the text.

Year	N	SE(N)	Year	N	SE(N)	Year	N	SE(N)
1996	38	2.7	2004	216	16.6	2012	220	12.3
1997	80	10.4	2005	216	26.1	2013	240	14.1
1998	125	10.9	2006	199	21.5	2014	243	18.7
1999	146	14.2	2007	195	26.0	2015	250	18.2
2000	147	14.2	2008	214	19.0	2016	246	24.3
2001	179	13.4	2009	211	21.4	2017	232	25.2
2002	197	13.9	2010	203	19.6			
2003	207	17.3	2011	208	16.2			

The Committee noted that the estimates for 1996 and 1997 are biased low because the survey coverage area was much smaller, but those data were included in the analysis to improve model estimates later in the time series (IWC, 2015d, p.504). As noted below the Committee agreed that the time series of abundance estimates in Table 13 should be accepted as Category 1 and Evaluation Extent 2. The Committee noted that where a time-series of abundance estimates is provided, it has adopted the practice of tabling the most recent estimate and one earlier estimate sufficiently long in the past that the two are not strongly correlated. However, in discussion it was recognised that in cases where a long time-series of abundance estimates is provided, choosing the earliest year for which there is an acceptable estimate may not always be the best choice and alternatives (e.g. selecting an estimate from 10 years prior to the most recent) should be considered next year.

Attention: SC, ASW
With respect to the abundance estimates of the Pacific Coast Feeding Group (PCFG) of gray whales provided in SC/68B/ASI/01, the Committee **agrees** *that:*

(1) *the issue of estimating abundance for a population whose definition is derived from the same data used to estimate abundance has more general implications than for just the PCFG analysis and should be addressed in the future;*
(2) *the time series of abundance estimates for PCFG gray whales from 1998 through 2017 given in table 1 of SC/68B/ASI/01 be accepted as Category 1 (acceptable for use in In-depth Assessments or for providing management advice), and Evaluation Extent 2 (partially examined by the Committee but method has been previously reviewed);*
(3) *in accordance with past practice the IWC Consolidated Table of Abundance Estimates should include years 1998 and 2017 of the time series; and*
(4) *the most appropriate years to include in the IWC Consolidated Table for long time series of estimates will be reconsidered at SC68C.*

11.1.2 Bering-Chukchi-Beaufort Bowhead whales
SC/68B/ASI/02 presented results of an ice-based visual survey of the Bering-Chukchi-Beaufort (B-C-B) Seas stock of bowhead whales conducted in spring 2019 near Utqiaġvik (formerly Barrow), Alaska. Field and analysis methods largely as used in 2011, but unlike 2011 (and some other past years), the correction for availability bias (proportion of whales passing within visual range, P_4) was based on past surveys instead of being estimated from acoustic data collected concurrently. The estimated abundance of 12,505 (CV=0.228; 95% CI=7,994, 19,560) was markedly lower than the 2011 estimate of 16,820 (Givens *et al.*, 2016), but the 2019 confidence interval wholly encompassed the 2011 interval. The authors provided several reasons as to why the 2019 estimate was biased downwards and thus did not provide strong evidence of a decline including: highly unusual ice conditions; an unusual migration route that was sometimes too distant from observers; failure to keep watch because of closed lead conditions during the early weeks of the migration when many whales probably passed; and hunters' unprecedented heavy use of powered skiffs which disturbed the whales during the survey.

The discussion emphasised the particular challenges of the 2019 survey. Questions were raised about the future of the ice-based survey, which has been considered to provide more precise results than any other approach but has become increasingly difficult to conduct due to changes in sea ice conditions and concerns about safety. Line-transect aerial surveys (see below) are among the alternative options being considered but a fully successful ice-based census is likely to provide a smaller CV than an aerial survey.

In response to a question on the reliability of using past P_4 estimates to correct the 2019 ice-based counts, the authors explained that there is a strong correlation between perch location and P_4 (ocean depth was not a significant factor). The approach used in SC/68B/ASI/02 for P_4 was an improvement over the past simple averaging that has previously been considered sufficiently precise by the Committee to provide abundance estimates for years without acoustic data. Moreover, the acoustic data collection and analysis required to estimate P_4 concurrently with the visual census represents a large undertaking and increases survey costs substantially. If the past relationship between perch location and P_4 did not hold in 2019 (e.g. because of the anomalous ice/lead conditions), then this could have a substantial impact on the abundance estimate. It was also noted that using the standard error of prediction rather than the error of estimation represents the inherent uncertainty about P_4 more correctly. Finally, the Committee noted that the level of biases used in testing the *SLA* make it robust to potential biases of the magnitude expected to apply in this abundance estimate.

Attention: SC, ASW
The Committee **endorses** *the abundance estimate of 12,505 (95% CI=7,994;19,560) provided in SC/68B/ASI/02 for B-C-B bowhead whales in 2019 and* **agrees** *that it meets the definitions of Evaluation Extent of 1 (examined in detail) and Category 1 (acceptable for use in In-depth Assessments or for providing management advice). A note should be added to indicate that several sources of negative bias contribute to this estimate.*

SC/68B/ASI/09 presented results from aerial line-transect surveys conducted over the Beaufort Sea shelf and Amundsen Gulf during August 2019. A preliminary estimate for B-C-B bowhead whales, based on a geographically stratified analysis with parametric and non-parametric bootstrap estimates of uncertainty, was around 14,500 with a CV of 0.54. The estimate incorporated correction factors for trackline detection probability, availability bias, and the effects of distance and other covariates on the probability of detecting available whales. Trackline detection probability was estimated using mark-recapture distance-sampling methods for trial configurations of observers, with independent data from imagery collected concurrently from a belly port camera during some line-transect aerial surveys. Availability bias was derived from estimates of observation time based on specialised field-of-view experimental flights and estimates of bowhead whale surface and dive duration from Robertson *et al.* (2015). A bootstrap sensitivity analysis suggested that the largest contributors to CV(N) were sampling variance in the line-transect encounter rates and the estimate of trackline detection probability.

The Committee commended the scope and complexity of the study and the efforts made to correct the results for multiple sources of bias. Clarification was sought on several sources of uncertainty such as variation in survey altitudes (which is used as a covariate) due to low cloud ceilings, different levels of left truncation for the two aircraft because of bubble window designs and differences across observers. It was noted that diving behaviour and detectability likely differ when whales are in groups, which suggests that the availability correction factor varies with group size. Telemetry studies also show that availability bias differs by activity state and region.

The author noted that the paper represented an initial effort and that future work will include explicit spatial modelling to reduce the uncertainty of the abundance estimate. When that analysis is complete, the author will present the updated result and seek Committee endorsement for it.

The Committee noted that, if the line-transect survey estimate is eventually endorsed, there will be two independent estimates for 2019 abundance of Bering-Chukchi-Beaufort (B-C-B) bowhead whales. SC/68B/ASI/10 summarises the differences between the two approaches using the new standards adopted in 2019 by the Committee for the presentation of abundance estimates (IWC, 2020j). Computing an average of these two estimates prior to *SLA* input, or inputting both estimates to the *SLA* are possible approaches that require formal consideration by the Committee.

Attention: SC

The Committee welcomed the preliminary estimates of B-C-B bowhead whale numbers using aerial survey techniques (SC/68B/ASI/09). The Committee:

(1) **recognises** *the value of the approach used, and the additional work proposed;*
(2) **encourages** *the author to submit a revised estimate to next year's meeting (SC68C); and*
(3) **agrees** *to consider the appropriate way to incorporate two independent abundance estimates for the same year in SLA calculations at SC68C.*

11.1.3 Eastern Canada/Western Greenland bowhead whales

The Committee received an abundance estimate for Eastern Canada-Western Greenland bowhead whales computed using genetic mark-recapture methods (Frasier *et al.*, 2020). There was insufficient time to consider this paper fully.

Attention: SC

The Committee **agrees** *that a review of the estimate of abundance computed using genetic mark-recapture methods provided by Frasier et al. (2020) be coordinated by the Abundance Steering Group (ASG).*

11.1.4 Franciscana

Several documents on abundance estimation of franciscana dolphins (SC/68B/ASI/03-08; Cremer and Simões-Lopes, 2008; Crespo *et al.*, 2010; Danilewicz *et al.*, 2010; Secchi *et al.*, 2001; Sucunza *et al.*, 2018; 2020; Weyn, 2016) were received by the Committee as part of the ongoing review of the status of this species. Time constraints precluded a review of these documents.

Attention: SC

The Committee **agrees** *that to complete the review of franciscana abundance estimates, an Intersessional Working Group should be established with the following Terms of Reference:*

(1) *review estimates of abundance of franciscanas following the process agreed by the Committee (IWC, 2020j), and;*
(2) *provide advice on future work (e.g. additional analyses) that could be conducted to improve these estimates.*

The Committee **recommends** *that the report of the Intersessional Working Group should be provided prior to completion of the review of the status of the franciscana in 2021.*

11.1.5 Update of the IWC Table of Consolidated Abundance Estimates

Abundance estimates recommended for inclusion in the IWC Consolidated Table of Accepted Abundance Estimates during the 2020 meeting include the time series of estimates for the PCFG gray whales (Item 11.1.1) and the shore-based 2019 estimate for B-C-B bowhead whales (Item 11.1.2).

Attention: SC, S, C-A

The Committee **recognises** *that the IWC Table of Abundance Estimates is an important tool for the work of the Committee including facilitating the provision of advice to the Commission on the status of whale stocks. It* **agrees** *that estimates endorsed during the 2020 meeting should be incorporated into that Table and uploaded to the IWC website and that Allison continues to update the Table intersessionally.*

11.2 Review and provide advice on surveys (past and future)

The Committee did not receive any requests for advice on abundance surveys.

11.3 Methodological issues

11.3.1 Amendments of the RMP Guidelines to consider model-based abundance estimates

The Committee agreed in 2018 (IWC, 2019k) that the 'Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme' (referred to there as the RMP Guidelines; IWC, 2012b) needed to be modified to incorporate spatial model approaches to estimate abundance. A Steering Group was established to: (1) develop a set of specific instructions for the amendment of the RMP guidelines to consider model-based abundance estimates; and (2) select a candidate to conduct this work. David Miller from CREEM (Centre for Research into Ecological and Environmental Modelling, University of St. Andrews) was selected to make proposals to modify the Guidelines.

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 computed using model-based methods. The Committee **agrees** *that the Steering Group established to oversee this process should continue its intersessional work to develop instructions to amend the Guidelines.*

11.4 Consideration of the status of stocks

The Scientific Committee has been asked to provide advice to the Commission on the status of whale stocks (IWC, 2017a). An approach to convey the relevant information was developed at last year's meeting (IWC, 2020j) and reviewed at a virtual pre-meeting this year.

11.4.1 Review of previously agreed-upon approach

The Committee had agreed on a two-step process to summarise the status of stocks. The first step included analyses for internal use by the Committee. The following three statistics (with 90% intervals as specified in IWC, 2020j, p.282) would be produced for a set of *Implementation Simulation Trials* (*IST*s) for stocks that have been the subject of RMP or AWMP *Implementations* and *Implementation Reviews*:

(1) current depletion (number of animals aged 1+ relative to 1+ carrying capacity, if available);
(2) current 1+ abundance; and
(3) a pointwise median trajectory plot of 1+ abundance from pre-exploitation or the first year used in the simulations to the present.

Results will be provided for $MSYR_{1+}$=1% and $MSYR_{mat}$=4% unless the base-case trials were based on a higher value for the lowest plausible value for MSY rate or if MSY rate had been estimated and there is an agreed value. Results will be summarised across simulations and trials (medians over simulations and averages across base-case trials) and reported by area normally for Ocean Basin and 'Medium Area' (some flexibility is allowed depending on circumstances).

The second step is to consolidate and simplify this information for reporting to the Commission by providing only average values (and 90% intervals) for current 1+ abundance and depletion (if available), for the appropriate stocks/areas. A qualitative statement on recovery in the past several decades will be provided based on the trajectory plot.

For stocks that have been the subject of a Comprehensive or In-depth Assessment, the same outputs as identified above (internal and final) will be produced. For stocks with an agreed abundance estimate but no assessment, some case-specific adjustments will be provided.

Punt and Allison had prepared examples of the stock status outputs in the format proposed above for most RMP/AWMP cases. Producing these outputs required changes to control programs, but no serious difficulties were encountered. The results had not yet been made available to and considered by the intersessional group established last year because of time constraints exacerbated by the coronavirus pandemic. The Committee thanked Punt and Allison for their work, noting that the results will be examined intersessionally (see below).

Table 14

Simple summary of assessment information for large whales at a broad regional level (key below).

Region	Assessment information	Type*	Removals**	Refer to ISG this year?
Blue whale ('true')				
North Pacific	Pre-assessment stage	2c	F	No
North Atlantic	No assessment plans	3b	F	No
Southern Hemisphere	Work ongoing towards new assessment	2c	E	Yes
Blue whale (other sub-species)				
North Indian Ocean	Central and Eastern: in progress	2b	D	No
	Northwest: no assessment plans	3a	D	No
Southern Hemisphere	Southeast Pacific, southwest Pacific: in progress	2b	F	No
	Southeast Indian, southwest Indian Ocean: in progress	2b	F	No
Sei whales				
North Pacific	Ongoing *In-Depth Assessment*	2b	B, E	No
North Atlantic	Request for RMP *Implementation* postponed	3d	E	No
Southern Hemisphere	No assessment plans	3d	E	No
Fin whales				
North Pacific	No assessment plans.	3b	E	No
North Atlantic	*Implementation Reviews* completed. *SLA* for Greenland	1a	A, B, E	Yes
Southern Hemisphere	No assessment plans	3d	F	No
Omura's whale				
Indian and Pacific Ocean	No assessment plans	3d	E	No
Gray whale				
North Pacific	Range-wide review and *Implementation Review* in progress	1b	A, C	No
	Western North Pacific (CMP)	3a	C	TBD[1]
Common minke whale				
North Pacific	Overall - no			No
Western	In-depth assessment underway	2b	B, C	No
North Atlantic	RMP/AWMP completed	1a	A, B, E	Yes
Southern Hemisphere	No assessment plans for dwarf minke whales	3d	F	No
Antarctic minke whale				
Southern Hemisphere	Overall – no assessment but abundance estimates available for 1st and 2nd circumpolar surveys	-	F	No
	Assessment completed for Indo-Pacific in 2014	2a	F	Yes
Bryde's whale				
North Pacific	Overall - no assessment plans	-	-	No
Western	*Implementation Review* completed	1a	B	Yes
North Atlantic	No assessment plans	3c	F	No
Gulf of Mexico	No assessment plans	3a	F	Yes
S. Hemisphere	No assessment plans	3c	F	No
Right whale species				
North Pacific	No assessment plans – critical especially in the east	3a	C, D	Yes
North Atlantic	Overall: no but critical (and see western below)	3a	C. D	Yes
Western	New assessment required - critical	2b	C, D	Yes
S. Hemisphere	Assessment completed in 2010.	2a	C, D	Yes
	Regional assessments considered (SE Pacific critical)	2c	C, D	No
Bowhead whale				
North Atlantic	Overall no – but critical apart from below.	3a	C, D	No
Eastern Arctic	*SLA* developed for Greenland hunt.	1a	A, B	Yes
North Pacific	Overall no - but see below	-	-	-
B-C-B	*Implementation Review* completed	1a	A	Yes
Eastern	No assessment plans	3a	C, D	Yes
Okhotsk Sea	Receive new information	3b	C, D	Yes
Humpback whale				
North Pacific	Subject to *In-Depth Assessment*	2b	C	No
North Atlantic	Due a new assessment (last one completed in 2002)	2c	A, C	No
Southern Hemisphere	Assessment completed in 2015	2a	C, D	Yes
Arabian Sea	Pre-assessment	3a	C, D	Yes
Sperm whale				
Global	Reviewing assessment plans	3d	F	No

[1]Decision on whether this stock will be referred to the ISG will depend on the results of the intersessional IST/CMP workshop and modelling.

***Key to Types:**

Type 1=RMP/AWMP 'stocks': Type 1a=*Implementation* or *Implementation Review* completed within the last 6 years. Type 1b=*Implementation Review* underway.

Type 2=IA 'stocks': Type 2a=Comprehensive Assessment or in-depth assessment completed within last 6 years. Type 2b=Assessment expected to be complete within 2 years. Type 2c=Assessment expected to be complete within 4 years.

Type 3='Other' stocks: Type 3a=No assessment but broadly recognised as 'critical'. Type 3b=No assessment but abundance estimate available and catch history suggests might be depleted. Type 3c=No assessment but abundance estimate available and catch history suggests might not be depleted. Type 3d=No assessment and little or no current information.

****Key to removals:**

A=IWC regulated catches; B=nationally regulated catches; C=bycatches are/might be important at regional level; D=ship strikes are/might be important at regional level; E=neither bycatches or ship strikes believed to be important at the regional level; F=unknown.

Although some concern was expressed over the use of averages if the trial set was unbalanced (i.e. primarily focussed on conservation concerns in an RMP or AWMP management context), it was noted that this issue is alleviated by using only two values for MSYR and by only integrating across stocks for a single base case (thus not including all sensitivity trials). Multiple base case trials would be used only when necessary (e.g. for multiple stock structure hypotheses).

The Committee concluded that the approach developed last year was appropriate and should be implemented intersessionally (see Item 11.4.3 below), recognising that adjustments may need to be made in the light of experience, and that suggested modifications be brought back to the Committee next year.

11.4.2 Listing of stocks for which the approach may be applied

Table 14 summarises, at a broad regional level, the assessment information available for large whales, and highlights those which will be examined intersessionally.

11.4.3 Priority for undertaking the work and establishment of an Intersessional Working Group

In order to progress this work the Committee established an Intersessional Working Group under Donovan.

Attention: SC

The Committee **agrees** *that to provide advice on stock status to the Commission, an Intersessional Working Group should follow the process described in IWC (2020j, item 3.3).*

The Committee also **recommends** *that the results of the Intersessional Working Group should be reviewed at a 3-day pre-meeting prior to SC68C where they will be used to develop draft text for the Commission for review by the Committee at SC68C.*

11.5 Progress on previous recommendations

The cancellation of the 2020 in-person meeting severely impacted the Committee's work on abundance estimates and status. Future cancellations are not sustainable given the technical nature of the review of abundance estimates, an in-person meeting is essential. Nevertheless, progress was made with respect to some recommendations from last year's meeting. An item that had been in the agenda for the past two years, the provision of advice to the Commission on status of stocks (Item 11.4), was addressed during the virtual pre-meeting and the Committee established an Intersessional Steering Group to further advance this work.

Last year, the Committee developed a process to review and validate abundance estimates (IWC, 2020j) and this was followed at this year's meeting to the extent possible; the process facilitated productive reviews by the Committee. The Committee **reiterates** that review of abundance estimates and the update of the IWC Consolidated Table of Abundance Estimates represent important recurring tasks for the work of the Committee.

Last year, the Committee also agreed that the work required to: (a) address issues related to estimation of *g*(0); and (b) develop robust estimates of abundance for North Pacific minke whales should be referred to an Intersessional Correspondence Group (IWC, 2020j). There was insufficient time to review the work of this group and the Committee **agrees** that a report by this ICG be reviewed in 2021 at SC68C.

The Committee also **agrees** that the amendment of the RMP Guidelines is a priority for completion within the next two years (Item 11.3.1 above). This work will continue intersessionally led by a Steering Group.

Simulated datasets are valuable to test new methods for abundance estimation and the Committee has recommended that existing computer code previously developed for simulating line transect data be updated (IWC, 2019k). The Committee **agrees** that this ongoing project should be continued, and that progress be reviewed at next year's meeting.

The Committee also **agrees** that intersessional work on priority tasks identified in the work plan should continue and progress be reviewed at SC68C.

11.6 Work plan

The Committee **agrees** to the work plan provided in Table 15. The proposed pre-meeting has financial implications for the Committee and this is discussed under Item 22. For details of Intersessional Correspondence Groups, see Annex K.

12. BYCATCH AND ENTANGLEMENTS (HIM)

12.1 IWC's Bycatch Mitigation Initiative

SC/68B/HIM/12 provided an update on the progress of the IWC's Bycatch Mitigation Initiative (BMI). The BMI efforts have focused on identifying priority countries for pilot project development and engaging with priority Regional Fisheries Management Organisations (RFMOs) and the Food and Agriculture Organization of the United Nations (FAO). Pilot projects are intended to allow the BMI to apply multi-disciplinary, experimental approaches to bycatch mitigation, monitoring and management. Seven countries (India, Kenya, Pakistan, Republic of Congo, Thailand, Peru, and Indonesian/Malaysian Borneo) were identified for pilot project development, and a longer list of countries has been identified for possible future project development. The BMI will continue to engage with national governments and local experts to discuss collaboration on pilot projects, develop the scope of projects and project concepts for fundraising efforts. The BMI has continued to engage with the FAO on the development of Technical Guidelines to reduce bycatch of marine mammals in capture fisheries and with priority RFMOs including the Indian Ocean Tuna Commission (IOTC) regarding bycatch in the Indian Ocean and the joint tuna-RFMO bycatch working group.

Table 15

Work plan for the review of abundance estimates and provision of advice to the Commission on status of stocks for the period 2020/21.

Topic	Intersessional 2020/21	2021 Annual Meeting (SC68C)
11.1 Review of abundance estimates	ASG to coordinate the review of the abundance estimates with priorities to include: (1) franciscana; (2) non-Antarctic blue whales in the Southern Hemisphere; (3) North Pacific humpback whales; (4) North Pacific sei whales; (5) Eastern Canada/Western Greenland bowhead whales; and (6) Southeast Australian southern right whales.	Review intersessional progress, estimate reviews or new estimates available at SC68C
11.1.4 Franciscana abundance review	ISG to coordinate a review of estimates of franciscana abundance to complete the review of the status of the species by the SC in 2021.	Provide report to an intersessional workshop or to SC68C
11.1.5 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 SC68B (Allison).	Review progress
11.1 Address issues (including *g*(0)) related to estimates of abundance of western North Pacific minke whale abundance estimates for use in the current in-depth assessment and the provision of regional estimates	ICG to coordinate intersessional work.	Review progress
11.3.1 Amend the RMP Guidelines to consider abundance estimates computed with model-based methods	Develop a set of specific instructions for the amendment of the RMP Guidelines to consider model-based abundance estimates (SG Amendment of RMP Guidelines and Miller).	Review an updated document of the RMP Guidelines
11.3 Develop simulation software to evaluate methods for abundance estimates	Continue development of software (Palka and Smith).	Review Progress
11.3 Consider diagnostic methods (e.g. model fit) for mark-recapture models to estimate abundance	ASG identify an expert group.	Review progress
11.4 Provide Commission with advice on status of stocks.	Develop a draft report for provision of advice to the Commission for review by the Committee at SC68C using the guidelines developed by the Committee for advising on status of stocks. The draft should include recommendations to improve the guidelines in light of the experience gained, and advice on how to extend this approach to small cetaceans.	Review Progress
11.4 Host a pre-meeting for the Abundance Steering Group (ASG) and the Intersessional Working Group on Status of Stocks	ISG and ASG to review necessary information in making preparations for the pre-meeting.	Host pre-meeting

Discussion of general collaboration with FAO and RFMOs is given under Item 12.5 and with IOTC under Item 12.2.

The BMI is developing a new four-year work plan for 2021-24, to be considered by the Conservation Committee at its next meeting. During this period, the BMI will continue to focus on bycatch in gillnets and other fixed fishing gears and prioritise information gathering in currently identified and future priority pilot project locations.

The Committee welcomed the report given in SC/68B/HIM/12 and thanked Tarzia and the Expert Panel for their work.

Attention: C, CG, CC, SC, S

The Committee strongly **endorses** *the work of the IWC's Bycatch Mitigation Initiative (BMI) as reported in SC/68B/HIM/12,* **recommends** *continuation of this work and* **encourages** *the creation of a separate BMI budget line to support priority bycatch research, including for pilot project implementation.*

To further support the work of the BMI, the Committee **agrees** *to:*

(1) *request new bycatch information in advance of annual Committee meetings from priority locations for the BMI (and for focal species within pilot project countries/region);*
(2) *review new information with a view to providing recommendations for fisheries or locations which should be prioritised for BMI work (e.g. pilot projects or capacity building);*
(3) *assist the BMI to identify bycatch hotspots and review existing data available on cetacean distribution, bycatch and fishing effort; and*
(4) *continue to review mitigation and monitoring strategies and provide appropriate technical advice including assisting the BMI intersessionally on reviews of mitigation measures.*

The Committee also **encourages** *the ongoing collaboration among the BMI, RMFOs, independent researchers and NGOs. It* **requests** *that relevant NGOs and researchers contact the BMI regarding their specific geographical interests and expertise.*

Campos provided a statement on behalf of the Government of Peru requesting to be considered as a location for a BMI pilot project to monitor and mitigate the incidental capture of dolphins. She noted that a constant concern for Peru's artisanal fisherman and Government entities has been the interactions between cetaceans and the artisanal fishery, given that cetaceans are protected species. This conflict is a complex and multi-faceted issue. The interaction is reciprocal, in that cetaceans have an effect on the fishery (e.g. damage to gear, loss of catches) and the fishery has an effect on cetaceans (e.g. bycatch mortality, directed catch and decrease in food availability). The IWC Bycatch Mitigation Initiative's pilot projects will be focusing on monitoring and mitigating the incidental capture of cetaceans in artisanal fisheries.

12.2 Review new methods and estimates of entanglement rates, risks and mortality

Anderson *et al.* (2020) used the limited data available to make rough estimates of cetacean bycatch in Indian Ocean tuna gillnet fisheries. Cumulative total bycatch, 1950-2018, was estimated to be about 4.1 million small cetaceans (±50%) with annual bycatch peaking at about 100,000 individuals per year (±40%) during 2004-06. These levels of removal appear to be unsustainable, with some populations currently estimated to be at 10-20% of pre-fishery levels. Iran, Indonesia, India, Sri Lanka and Pakistan have the largest gillnet fleets in this area and the highest estimated cetacean bycatch.

The convention area of the Indian Ocean Tuna Commission (IOTC) has the highest gillnet fishing effort of tuna-RFMOs, and the type of regional level analysis of bycatch conducted by Anderson *et al.* (2020) has generally not previously been carried out for other regions. The analysis did not include any information on deliberate, directed catch of dolphins by tuna fisheries (some directed catch for consumption has occurred in Sri Lanka and parts of the Indian coastline). Recent anecdotal evidence suggests that many Indian Ocean tuna gillnet fleets are moving towards sub-surface setting of nets, which has been found to lead to bycatch reductions of some cetaceans and other taxa. For future analyses, it was suggested the effects of sub-surface setting (particularly post 2016 and the impacts of climate change in relation to changes in tuna distribution, abundance and fishery yields over time should be considered.

The IWC held a Workshop entitled 'Bycatch Mitigation Opportunities in the Western Indian Ocean and Arabian Sea' in Nairobi in May 2019. The report of the Workshop will be presented to the next Conservation Committee later in the year for consideration at IWC68 in 2021[19]. The Workshop identified known and potential cetacean bycatch hotspots across the region and recognised that bycatch is one of the most significant conservation threats to species and populations.

Discussions highlighted the limited data available for assessing bycatch throughout the Indian Ocean, the opportunities for the BMI to contribute towards mitigation trials and the potential for further collaboration with IOTC.

Attention: CG, CC, SC, S

The Committee **endorses** *the recommendations in the Report of the Workshop on Bycatch Mitigation Opportunities in the Western Indian Ocean and Arabian Sea,* **agrees** *on the need for integration of social and economic information and factors into bycatch reduction efforts and* **welcomes** *a multi-disciplinary approach to bycatch reduction efforts. It particularly highlights recommendations that:*

(1) *national governments should strengthen bycatch assessment, monitoring and reduction programmes as a matter of urgency;*
(2) *that the BMI explore means of more consistent and sustainable approaches for funding bycatch mitigation efforts;*
(3) *multi-disciplinary efforts are needed; and*
(4) *the IWC and IOTC should collaborate more closely to address cetacean bycatch.*

SC/68B/HIM/01 described estimates of entanglements of humpback and common minke whales in the Scottish creel fishery based on face-to-face interviews with fishers and examination of strandings data and disentanglement efforts. Two independent data sources were used for a capture-recapture approach to estimate the number of entanglements. Estimates were also made by extrapolating results from the interviews to the entire active fleet. The results suggest that the Scottish creel fishery may be responsible for considerably more whale entanglements than previously thought, with estimates of around five humpback whales and 30 common minke whales becoming entangled each year. The two independent datasets (strandings and interviews) and analysis methods (capture-recapture and extrapolation) were subject to many potential biases. However, the similarity of the estimates provided some confidence in the results. Given that over 80% of the common minke whales and 60% of the humpback whales were reported entangled in the ground lines, fishers suggested using sinking line, and some have been participating in informal trials of rope-less technologies. It was noted that the scale of the problem may surprise fishers since most individuals only occasionally encounter entangled whales. Fishers' engagement on this issue may have been facilitated by the fact that aside from the issue of bycatch, creel fishing is perceived as less environmentally damaging than some other fishing gears. During the IWC disentanglement training, some of the fishers commented that fleet-wide changes in fishing operations would only occur if regulations were implemented.

[19]See copy available at *https://archive.iwc.int/pages/view.php?ref=9612&k=*.

However, there was willingness to trial mitigation measures if there was financial support. The Committee **commends** the Scottish Entanglement Alliance (SEA) for its successful engagement with the Scottish creel fishing community, who have shown a strong willingness to try to address the entanglement problem.

Attention: CG
The Committee **recommends** *continuation of the SEA project, including ongoing outreach with fishermen and creel entanglement mitigation trials.*

SC/68B/HIM/08 described a study initially funded by the IWC Small Cetacean Voluntary Fund which conducted fisher interviews in Kuching Bay, Sarawak (Malaysian Borneo) between 2011-14 and 2016-19. In total, 36% of respondents reported having experienced an entanglement of a cetacean in their own gear sometime in the past year. In the second interview period, of the 62 respondents who had experienced cetacean bycatch in their nets, 58% reported finding animals alive and releasing them. Irrawaddy dolphins were the most frequently reported species entangled.

The BMI has identified Malaysian (and Indonesian) Borneo as a priority location for pilot project development and the Committee **welcomes** this new information on bycatch in artisanal fisheries in Sarawak and **encourages** further collaboration between the authors and the BMI to determine whether the data can be used to extrapolate mortality rates for local cetacean populations, and to test bycatch mitigation methods in these fisheries. The newly developed 'Guidelines for the Safe and Humane Handling and Release of Bycaught Small Cetaceans from Fishing Gear' (Hamer and Minton, 2020) should prove useful in these situations, and in some locations there might be a way to combine training for large whale disentanglement with safe handling and release of small cetaceans. There might also be opportunities for joint efforts with CMS who have recently developed a Concerted Action Plan for Irrawaddy dolphin which considers bycatch.

SC/68B/HIM/07 provided new information on the Baltic Sea harbour porpoise, which is listed by IUCN and HELCOM as critically endangered. Its current geographical range is significantly smaller than its historic one and there are only a few hundred animals left. The most recent abundance estimate (Amundin *et al.*, 2016) is 497 (95% CI 80-1,091). While pollution and disturbance through underwater noise may be contributing to the population failing to recover, bycatch is the most acute threat causing direct mortalities. Given the small size of the population, the sex ratio, age distribution, and the proportion of females that are potentially infertile due to high contaminant load, there may be fewer than 100 fertile females remaining in the Baltic Proper. The authors note that losing even one female could have a serious effect on the ability of the population to recover or even remain stable but initiatives from EU Member States to minimise bycatch are limited with no area closures to gillnets to protect the porpoise. While Sweden designated the main part of the porpoise breeding area in the central Baltic Proper as a Natura 2000 site in December 2017, the lack of progress to protect the porpoises due to the extended process for EU Member States to agree on joint measures is threatening the survival of the population.

The Committee discussed a number of recommendations made by the authors of SC/68B/HIM/07 and also noted its previous recommendations calling for urgent conservation action for the Baltic porpoise. Last year (IWC, 2020a, p.46) the Committee reiterated its concern and agreed that listing the harbour porpoise population of the Baltic Proper in Appendix I of CMS would greatly assist in conservation efforts. However, this did not happen at the CMS Conference of the Parties (CoP) in February 2020, although an NGO-sponsored 'Concerted Action' was approved by the Parties.

Attention: CG, CC, SC, S
The Committee has repeatedly stated its serious concern for the critically endangered harbour porpoise population of the Baltic Proper (e.g. see IWC, 2020a, p.46). The Committee again **recommends**, *as a matter of urgency, that all countries adjoining the Baltic Proper immediately act to eliminate bycatch of the Baltic porpoise.*

In addition, the Committee:

(1) **encourages** *further research into stranded and/or bycaught porpoises to investigate all factors negatively impacting on the population, including pollution and prey depletion;*
(2) **notes** *that ICES, at the request of the European Commission, is in the process of providing advice on fishery emergency measures for the Baltic porpoise and looks forward to seeing its advice;*
(3) **notes** *the recent statement from the European Commission and urges it to act on the latest advice and information and ensure that appropriate measures are implemented and are in place for the longer term until population recovery is achieved;*
(4) *again* **encourages** *the Baltic range states to propose the Baltic porpoise for listing on CMS Appendix 1 at the earliest opportunity and calls on CMS Parties to support this process; and*
(5) **requests** *the IWC Executive Secretary to write to all the range states informing them of the Committee's concerns.*

12.3 Review mitigation measures for preventing bycatch and entanglement

Omeyer *et al.* (2020) described a study to assess the effects of a Banana Pinger (Fishtek Marine Limited) on harbour porpoises near Cornwall, UK between August 2012 and March 2013. Two passive acoustic loggers recorded cetacean activity during cycles of active and inactive pinger periods. Harbour porpoises were 37% less likely to be detected near the pinger when the pinger was active, while they were only 9% less likely to be detected 100m further away. The results suggested that harbour porpoises did not habituate to the pinger over an 8-month period, that the pinger effect was localised, and that pinger use did not lead to harbour porpoise displacement.

Clay *et al.* (2019) examined the effect of pingers on the behaviour of Burmeister's porpoise in the vicinity of the Peruvian small-scale driftnet fleet, investigated over a four-year period. The use of pingers led to an 86% reduction in porpoise activity around nets. The results suggested that pingers are likely to be effective at deterring Burmeister's porpoises from fishing nets. Given the large capacity of this and other fleets in the region, pingers may substantially reduce mortality.

Bielli *et al.* (2019) examined the use of light emitting diodes (LEDs) deployed on the floatlines of paired (control vs illuminated net) gillnets, to provide a visual cue, during 864 fishing sets on small-scale vessels departing from three Peruvian ports between 2015 and 2018. For the illuminated nets, bycatch probability per set was reduced by up to 74.4% for sea turtles and 70.8% for small cetaceans. Target species CPUE was not negatively affected by the presence of LEDs.

It was noted that Bielli *et al.* (2019) demonstrated the efficacy of net illumination to reduce bycatch for Peruvian small-scale gillnet fisheries and that there could be wider applications given the ubiquity of small-scale net fisheries, the relatively low cost of LEDs and the current lack of solutions to bycatch. However, the effectiveness of LEDs as a mitigation measure may depend on the area, habitat characteristics, fishery, time of day (the Peruvian trials were overnight), target species and bycaught species. Further trials are needed to assess the effects of LEDs, particularly during the day and in different natural light conditions.

SC/68B/HIM/02 described a comprehensive design guide to enable the construction of gillnets that are efficient for target catch but acoustically visible to specified frequencies of echolocation signals. Species-specific resonators that substantially increase the acoustic visibility of gillnets were systematically identified through simulation and experimental testing. For example, 8mm acrylic glass spheres appear as large as table tennis balls at 130kHz, the frequency used by harbour porpoises. The authors suggested experiments to examine the behaviour of odontocetes in the vicinity of modified gillnets, and commercial fishing trials to investigate whether bycatch is reduced with modified nets. If successful there would then be a need to develop an automated process to build gillnets with acrylic spheres attached.

In discussion, Kratzer noted that an initial small commercial trial resulted in fewer bycaught porpoises in the modified nets, but the results were not yet conclusive. The prototype nets as well as the nets for the commercial trials were built by hand, but automated production would be needed for longer nets. Although the spheres are cheap, the engineering challenge during manufacture is to either attach the spheres automatically to a standard net or to integrate them into the filament as it is made. Trials conducted with a different type of reflector had not been able to detect changes in harbour porpoise behaviour around nets.

SC/68B/HIM/11 reported the results of trial of a low-cost bycatch reduction method in a small-scale drift gillnet fishery in Peru ('glass bottle alarms' a glass drink bottle with a bolt inside thought to produce a sound similar to that of a commercial 'pinger'). This should allow dolphins to more effectively detect a gillnet and avoid capture but the authors found that it did not significantly reduce bycatch of dolphins or turtles in gillnets (or target fish catch captures aside from a reduction in shark catch). Another potential low-cost technology, plastic bottle acoustic reflectors, will be tested in the coming months in the same fishery.

The Committee noted that the mean sound pressure level (SPL) of the 'glass bottle alarm' (120dB re 1μPa/√Hz at 1m) is much lower than a commercial 10kHz pinger (132dB), and that commercial pingers have been found to reduce bycatch in the same fishery as the glass bottle alarm tests. Berggren noted that it was probably easier to have closer spacing of the bottles rather than trying to increase the SPL with different materials. In the trials, the spacing had ended up being greater than intended because the easiest place to attach the bottles was between the net panels. Some sensory ecology or fine scale behavioural studies around the bottle alarms may be useful and could be compared with pingers. Another approach would be to repeat the experiment with a closer spacing. Tarzia noted that there may be possibilities within a BMI pilot project to help test these low-cost mitigation options further. The Committee **welcomes** the presentation of results of trials of technical mitigation measures which attempt to reduce cetacean bycatch in gillnets.

Attention: CG, CC, SC

The Committee **draws attention** *to previous discussions that in many situations there may be no technical option that can be implemented effectively and the only solution is to stop using high risk fishing gears; this can include situations involving critically endangered cetacean populations or difficult socio-economic circumstances.*

The Committee **recommends** *the further development and testing of simple technology and low-cost devices that might reduce cetacean bycatch. This includes lights (LEDs), 'glass bottle alarms' and simple reflectors discussed this year. In all cases, trials need to determine the effectiveness for reducing bycatch for the species of most concern, while also assessing consequences for other species and taxa, as well as on catches of the target species. Such tests should be conducted in conditions as close as possible to those in the fishery where they are intended to be implemented. For example, LEDs should be tested in a variety of different natural light and turbidity conditions across a range of fisheries.*

12.4 Reporting of bycatch (including small cetaceans) and large whale entanglements

12.4.1 Review progress on the global entanglement database

Last year, the Committee had agreed to request that members of the Global Whale Entanglement Response Network (GWERN) collect data using the consensus data form (see Annex D of IWC, 2013c) in order to assess the feasibility of creating a global entanglement database based on reports from GWERN. Mattila provided an update on the use of the data form. Eleven countries or regions responded to a survey on the use of the form, representing more than 150 entanglement response incidents. Most found the data form was helpful and many of the networks had already incorporated most of the data fields in their national or regional databases. However, most of the responding countries/regions already have a national or regional database and did not feel that there was a need for the IWC to develop a global database. In view of this, the Committee **welcomes** the ongoing efforts on data collection but **agrees** to defer a decision on developing a global database.

12.4.2 National Progress Reports

There was some discussion of National Progress Reports in the context of BMI work to identify the main barriers to reporting, gaps in IWC bycatch data, and opportunities to collaborate with other inter-governmental organisations collecting bycatch information. The Committee noted previous discussions regarding National Progress Reports and the challenges faced by many countries due to lack of resources. The Progress Reports only include reported bycatch and thus not estimates of the total. The new US import restrictions under the MMPA may incentivise some countries to improve their estimates. The Committee **agrees** to continue to encourage improved reporting and estimation of bycatch and notes that estimates of all anthropogenic removals are required for assessments. Double noted that for Australia, the national reporting process results in the only annual national synthesis of cetacean bycatch and entanglement.

A summary of the entries into the Progress Reports database for the past year is available as Annex G.

12.5 Collaboration on bycatch mitigation with IGOs (including FAO, Regional Fisheries Management Organisations and others)

The Bycatch Coordinator, Tarzia, briefly outlined the ongoing engagement between the IWC Secretariat and FAO, and efforts to develop a collaborative work programme on cetacean bycatch (see SC/68B/HIM/12). This has included participation in FAO expert workshops and coordination of comments from the BMI on FAO's draft technical guidelines to reduce marine mammal bycatch in fisheries. Tarzia has also engaged with FAO on the Common Oceans Areas Beyond National Jurisdiction (ABNJ) project (Phase 2 development) and she also remotely participated in the 2019 IOTC Working Party on Ecosystems and Bycatch meeting, presenting the IWC Indian Ocean bycatch Workshop report (to be presented to the IWC Conservation Committee at its next meeting[20]). Tarzia and Lent also attended the 2019 joint-tuna RFMO bycatch working group meeting and held a side event on cetacean bycatch. The Committee welcomed the participation in the meeting of the FAO, IOTC and ICCAT Secretariats.

Einarrson presented an outline of the development of the FAO's Technical Guidelines to reduce bycatch of marine mammals in capture fisheries, including two expert workshops (2018 and 2019) and the incorporation of feedback from national governments and IGOs and experts. FAO appreciated the input from both the Committee and the BMI and looks forward to further cooperation. FAO had planned to publish the final version of the Technical Guidelines in advance of its Committee on Fisheries meeting (July 2020), however due to the meeting being postponed it is currently uncertain if the guidelines will be published in the timeframe planned or with a slight delay (February 2021). The Committee noted the importance of the Guidelines and welcomed their publication in the coming months.

The Secretariat commissioned an analysis of RFMO efforts and policies related to cetacean bycatch to help inform the IWC and the BMI on which of the RFMOs should be prioritised for collaboration on bycatch reduction. The report (SC/68B/HIM/05) focuses on the following RFMO components: legally-binding conservation and management measures, observer programmes, data analyses and other voluntary progress (e.g. workshops and special collaborative projects). This information was analysed to generate a semi-quantitative 'bycatch mitigation effort' score, coupled with a 'potential for bycatch risk', to calculate an overall 'average bycatch performance' score for tuna RFMOs. The analysis was limited in scope to efforts on paper rather than in practice. Based on the assessment, the author recommended that IWC prioritise engagement with ICCAT, IOTC, the South Pacific Regional Fisheries Management Organisation (SPRFMO), and the Southern Indian Ocean Fisheries Agreement (SIOFA).

The Committee welcomed SC/68B/HIM/05 and thanked Elliot for this work which will be valuable to the BMI for long-term monitoring of RFMO progress in cetacean bycatch management. There is not currently an activity within the BMI's

[20] *https://archive.iwc.int/pages/view.php?ref=9612&k=.*

work plan to refine or expand on the methodology, but members of the Committee are encouraged to collaborate directly with Elliot on this.

Although some RFMOs may have conservation management measures relevant to cetaceans, compliance with these measures is often low and this is an important factor to consider in any future work. It was also noted that to bring about change within RFMOs, recommendations generally need to be made at the RFMO Commission level, either through a 'science channel' or a 'political channel'. The Committee noted that the Kobe[21] Bycatch Working Group might be the ideal forum to discuss the review and that this could initiate further collaborations with tuna RFMOs. It was noted that the draft review had been discussed at the ICCAT Ecosystems meeting, but that there had not been time to formulate a recommendation. The Committee looks forward to further discussion at SC68C.

Although in many regions the RFMOs are less relevant to the small-scale fisheries that are the priority of the BMI, a component of the BMI work plan does include engagement with RFMOs. In discussion, it was suggested that tuna RFMOs were already struggling with their primary tasks of fisheries management, with little attention to cetacean bycatch, and that engaging directly with member states might be more effective. However, others pointed to collaborations with RFMOs which had led to productive advances to address bycatch of other taxa (e.g. sea turtles and IATTC, seabirds and a number of RFMOs). Management measures within RFMOs for cetacean bycatch had been limited by a lack of expertise within the RFMOs, but the situation is improving. There was agreement on the need for long-term engagement with RFMOs. In particular, following the Indian Ocean bycatch Workshop in 2019[22], Tarzia has been trying to progress a research-based work plan with IOTC.

SC/68B/HIM/05 also proposed a Workshop to improve knowledge of cetacean bycatch levels and population-level impacts within RFMOs. There is a need to gather data at a regional level which could be facilitated by regional workshops and/or making use of existing meetings. The Ocean Modelling Forum (Punt *et al.*, 2019) also has ongoing projects to address setting and applying bycatch standards including estimating abundance and assessing bycatch rates. Tarzia will continue to explore opportunities for the BMI to enhance data gathering and understanding of bycatch impacts in collaboration with these other initiatives. It was suggested that there might also be an opportunity for a meeting associated with the IOTC Working Party on Billfish (WPB) and Working Party on Ecosystems and Bycatch in September 2020 to scope out a future technical Workshop on cetacean bycatch.

The Western and Central Pacific Fisheries Commission (WCPFC) hosts an online Bycatch Management Information System (BMIS) for fisheries managers, scientists, fishers, educators and the public (SC/68B/HIM/04). The database consolidates information on the mitigation and management of incidental catches of species of special interest in pelagic tuna and billfish fisheries. The BMIS information on mitigation techniques and RFMO regulations is updated frequently and regular peer review helps to ensure its consistency with international best practice. The BMIS team is seeking advice from the Committee and the BMI on periodic peer review of cetacean related BMIS content. The BMIS team are also interested in collaborative efforts to improve the availability of standardised regional bycatch data through the tuna-RFMOs Bycatch Data Exchange Protocol (BDEP).

There are several opportunities for coordinating international efforts to provide publicly accessible information on cetacean bycatch and mitigation and the Committee **agrees** that the IWC should continue to build collaborations with existing platforms, efforts and existing or potential linkages among initiatives. The FAO's 2019 workshop to develop Technical Guidelines (SC/68B/HIM/11) recommended that the FAO maintain updates on mitigation measures potentially through the BMIS platform.

BMI collaboration with the BMIS to review existing information and provide new information on mitigation could help to fill the large knowledge gap regarding large whale entanglement on the high seas. The Bycatch Coordinator is also engaging with many other global initiatives working on bycatch mitigation (including CMS, ACCOBAMS, SPREP, see *https//:www.bycatch.org*) and many of these are included in the BMI draft work plan. The Committee will continue to review new mitigation studies and consider how best to provide advice on specific mitigation options. An Intersessional Correspondence Group has been established (see Annex K) to assist Tarzia and the Expert Panel in addressing the requested review by BMIS including: (i) review of each mitigation technique description relevant to cetaceans; (ii) advice on prioritising cetacean mitigation techniques according to gear type; and (iii) review of descriptions of cetacean interactions by fishing gear/method employed in pelagic tuna and billfish fisheries.

[21]The 'Kobe process' is a collaboration between tuna RFMOs which started with the first meeting in Kobe, Japan, in January 2007.

[22]*https://archive.iwc.int/pages/view.php?ref=9612&k=.*

Attention: C, CG, CC, SC, S

The Committee notes the broad scope of work which would be needed to understand and address cetacean bycatch in all the regions covered by RFMOs. In relation to engagement at RFMO level, the Committee **recommends** *that the BMI:*

(1) *prioritises collaboration with IOTC, ICCAT, SPRFMO, and SIOFA, with further scoping of work plan activities;*
(2) *works alongside other RFMOs, in collaboration with the FAO, to develop baseline cetacean bycatch-related requirements;*
(3) *further develops its collaboration with the BMIS to review existing information, provide new information on mitigation and provides the BMIS with access to safe handling and release guides/information/material and species identification guides.*

The Committee also **recommends**:

(1) *collaboration with the FAO and RFMOs to build awareness and capacity to implement the FAO Technical Guidelines to reduce bycatch of marine mammals in capture fisheries;*
(2) *collaboration with the FAO and Western and Central Pacific Fisheries Commission (WCPFC) and the South Pacific Community (SPC) to contribute technical information for BMIS and BDEP; and*
(3) *raising awareness within the IWC Community of these tools.*

The Committee **endorses** *the 'Guidelines for the Safe and Humane Handling and Release of Bycaught Small Cetaceans from Fishing Gear' (Hamer and Minton, 2020).*

SC/68B/HIM/14 described the Marine Stewardship Council (MSC) Fisheries Standard Review which is conducted every five years. The Fisheries Standard requirements for Endangered, Threatened, or Protected (ETP) species considers a fishery's impact, both direct and indirect, on species listed as ETP in certain national or international agreements. The current review includes the requirements fisheries must meet for 'ETP species' and 'preventing lost gear and ghost fishing'. MSC has determined that changes to the Fisheries Standard may include the scope of what is eligible for assessment, ETP scoring requirements and supporting guidance. The authors noted that there can be inconsistencies between the designation of ETP species among fisheries assessments and they were trying to ensure that ETP species are designated consistently.

To facilitate the review, MSC held a Workshop in 2019 on incentivising consistent data collection and transparent reporting of marine mammal bycatch in fisheries (Gummery and Currey, 2020). The Workshop had been a good example of collaboration and similar cross-disciplinary workshops at future marine mammal conferences were encouraged.

There was some discussion about the connection between MSC standards and requirements under the US Marine Mammal Protection Act (MMPA) with respect to cetacean bycatch for fish products imported into the US. Gummery noted that the intention was that any MSC certified fishery should comply with the MMPA regulations, but the details of how this would be achieved remain to be resolved. It was noted that the classification of fisheries by the US Government under the MMPA regulations may still be subject to legal challenges.

It was suggested that observer programmes, or electronic monitoring that had been established as effective for monitoring bycatch, should be required for any fishery with a risk of bycatch, to be certified by MSC. In addition, observer coverage should be high enough to achieve a coefficient of variation (CV) of 30% or better on the bycatch estimate. Gummery noted that the MSC currently has guidance but not requirements for bycatch related information and that MSC would welcome input on this aspect. It was also suggested that the IUCN Red List should be used where relevant to help ensure consistency in designation of ETP species.

12.6 Provide advice on observer schemes in South Africa

In 2019, the Committee received a request from South Africa for advice on development of a national programme to monitor and mitigate marine mammal bycatch in national fisheries and recommended the Bycatch Expert Panel provide advice on the development of the national programme. Discussions on the issue in South Africa are currently ongoing and this topic will receive more thorough discussion intersessionally and in 2021 (SC68C).

12.7 Progress on previous recommendations

Last year, the Committee noted limitations of cetacean bycatch estimates and mitigation programmes across the EU and recommended that improved monitoring programmes be established (IWC, 2020a, p.32). The Committee had also expressed concern that the bycatch of common dolphins in the Bay of Biscay may threaten the conservation status of the population. This year the Committee discussed the specific situation regarding the Iberian (see Item 16.1.2) and Baltic (see Item 12.2) populations of harbour porpoise. Taking account these previous discussions and recommendations and the specific new information, the Committee elaborated on these with respect to more general recommendations to address bycatch in European waters.

Attention: C, CG, CC, SC

In addition to the new information discussed this year on cetacean bycatch within a number of EU countries and the specific recommendations related to small populations of harbour porpoises and large whale entanglement mitigation, the Committee **recalls** *its previous recommendations related to bycatch of harbour porpoises and common dolphins in the North Atlantic and on the limitations of cetacean bycatch estimates and mitigation programmes across the EU. Improved monitoring programmes should be established.*

The Committee also **notes** *with appreciation the recent statement made by EU Commissioner Sinkivičius on 'EU action on bycatch of dolphins and other marine animals' and urges EU Member States and relevant IWC member states to act on the latest advice and information to ensure that appropriate bycatch measures are implemented effectively and are in place for the longer term throughout European waters.*

The Committee **recommends** *a focus on cross-border and cross-agency cooperation with fishers and among countries on bycatch monitoring and mitigation, building on the expert advice of ICES and other relevant regional organisations (e.g. FAO, GFCM, EU STEFC). To enable this and to allow a consistent approach across regions, bycatch risk assessments should be undertaken, within the appropriate regional management framework, for each European marine region, including the Mediterranean and Black Sea.*

The Committee **emphasises** *the need for increased and robust monitoring and attention to the reliable and consistent collection of fishing effort per fleet and bycatch per unit effort in all fleets. The European Commission, with the support of relevant advisory groups, should provide guidance to ensure improved collection of data for use in bycatch-estimation, including at-sea sampling, metrics of fishing effort and sampling design.*

In 2019, the Committee recognised the potential for the Ecuadorian artisanal drift gillnet fishery to be a BMI pilot project and also encouraged the IWC's large whale entanglement initiative to provide entanglement response training in Ecuador. The IWC entanglement initiative and BMI have been in discussions with Ecuador and potential funders to explore opportunities for training and projects.

Last year, the Committee reiterated its continued grave concerns regarding Māui dolphins (IWC, 2020a, p.34). The Committee proposed an intersessional process for reviewing the spatial risk assessment model for Māui and Hector's dolphins presented in Roberts *et al.* (2019). However, New Zealand is currently in the process of revising its management measures to protect Māui dolphins, and therefore elected to defer the proposed intersessional review of the Māui dolphin modelling work until after the revision is completed.

12.8 Work plan

In addition to the work related to the BMI (see Item 12.1) the Committee **agrees** to maintain current agenda items:

(1) review new methods and estimates of entanglement rates, risks and mortality;
(2) review mitigation measures for preventing bycatch and entanglement;
(3) reporting of bycatch (including small cetaceans) and large whale entanglements; and
(4) collaboration on bycatch mitigation.

The Committee **agrees** to include an agenda item on bycatch risk assessment and to encourage papers on rapid risk assessments and approaches to assess bycatch risk (e.g. Bycatch Rapid Risk Assessment Toolkit, ICES, work by Ocean Modelling Forum).

The Committee also noted a recent paper (Myers and Moore, 2020) that examined changes to the economics of a fishery in response to measures to reduce large whale entanglements through effort reduction. Although there was not time to discuss this paper, the Committee **agrees** to include an agenda item to review studies examining the implications of effort reductions on cetacean bycatch, fisheries economics and yields.

13. SHIP STRIKES (HIM)

13.1 Review new methods and estimates of rates of ship strikes, risk of ship strikes and mortality (including review progress on ship strike database)

SC/68B/HIM/10Rev1 summarises the work carried out by the IWC ship strike data coordinators between May 2019 and April 2020. The focus over the last two years has been on data validation and assessing new reports. The review process is now complete, and all records have been categorised and consolidated, resulting in 933 separate cases including 250 new reports in the last year. Facilities to enable bulk uploads of data to the database are being developed and the coordinators are currently waiting on several hundred records from other sources to be integrated into the IWC database. A summary of the complete data set held in the ship strike database is given in SC/68B/HIM/09. This was a result of a collaboration between the IWC and Christina Winkler at the Galway-Mayo Institute for Technology (GMIT). Winkler also entered a large number of new incidents into the database.

The Committee thanked Ritter and Panigada for their years of work on the IWC ship strike database and welcomes the summary analyses provided in SC/68B/HIM/09. The Committee noted the caveats highlighted by the authors, and in particular that any regional or temporal comparisons should be treated with caution due to differences in reporting rates.

In discussion, it was again noted that the IWC database, and any analyses using the data, such as those presented, would be greatly improved by the addition of two known large databases of ship strikes from Australia and the USA. Weller indicated that the USA fully recognised the importance of its potential contribution, and that there is an ongoing effort to organise the many regional databases in the USA into a format that can be submitted to the IWC database. Discussion of how to progress this work is given under Item 13.6.

National Progress reports provide a summary list of ship strike incidents and a contact person that should then facilitate more detailed reports being entered into the ship strikes database. However, this process had not always worked efficiently and sometimes the additional information needed was not easy to find. At the time of discussion, only 17 member countries had submitted National Progress Reports in 2020. The small proportion of IWC member countries submitting data limits their overall value. This issue will be considered by the Intersessional Correspondence Group discussing National Progress Reports.

13.2 Mitigation of ship strikes in high risk areas

SC/68B/HIM/03 presented the results of a collaborative study commissioned by WWF and implemented in collaboration with the IWC and the IUCN Marine Mammal Protected Area Task Force. The study assessed vessel traffic based on Automatic Identification System (AIS) signals in the 114 Important Marine Mammal Areas (IMMAs) that had been identified as of September 2019. Tables and graphs were based on unique vessel identities over the period of a year or by month within IMMAs, while 'heatmaps' were based on the total number of AIS signals transmitted in each IMMA. Two case studies, in the Mascarene Islands and the Savu Sea, examined vessel traffic in relation to what is known about cetacean distribution, identifying potential high-risk areas for humpback and sperm whales in the Mascarene Islands and blue whales in the Savu Sea.

The Committee thanked WWF and collaborators for advancing this work which was in response to previous recommendations made by the Committee and at the joint IWC-ACCOBAMS-IUCN Workshop in 2019 (IWC, 2019a). A primary objective was to investigate the feasibility and value of such a systematic approach to identifying possible areas of high risk for ship strikes. The Committee recognised its potential value and noted that a similar approach is underway using data of shipping route overlays with Ecologically or Biologically Significant Areas (EBSAs)[23]. In discussion it was noted that the metrics used in the tables would underestimate repeat traffic from the same vessel (e.g. ferries), while those in the heatmaps would be biased towards slower vessels (where density was represented by the number of AIS signals received). Other ship strike risk analyses considered by the Committee have generally expressed shipping density in km travelled per km^2 or the number of transits across a specified area (IWC, 2012a), often also stratified by speed and vessel type. The authors of SC/68B/HIM/03 indicated that further analyses might be possible to update the present study as well as for a similar study for newly identified IMMAs in the Southern Ocean and around Australia and New Zealand, but this work would require further funding.

The Committee also noted the need for data from other sources on vessel traffic in areas where a high proportion of smaller vessels were not equipped with AIS (Cope *et al.*, 2020; Greig *et al.*, 2020) also considered some of the data quality issues associated with AIS data received from satellites. In addition, the speed and type of vessel were re-iterated as useful variables to include in any analysis of shipping density with respect to ship strike risk.

SC/68B/HIM/15 described ongoing work by WWF to summarise information on the impacts on cetaceans of ship strikes and shipping-generated underwater noise, mitigation measures available and in use, and recommendations for best practice. The aim was to produce a report that is accessible for non-scientists including shipping regulators and policy makers. WWF is seeking engagement from the Committee to review the report which could then potentially be used by the IWC to support outreach and engagement related to mitigating shipping impacts on cetaceans. An Intersessional Correspondence Group was established to provide comments on the draft text.

Rodriguez-Fonseca informed the Committee of regulations enacted by Costa Rica that were intended to mitigate ship strikes, primarily with humpback whales, when ships transited to and from two major ports on their coastline. The Committee noted the table of ship strike mitigation measures on the IWC website and encourages information on any new measures to be sent to the Secretariat in order to keep this up to date.

It was also noted that reviewing existing, implemented mitigation measures is an activity under the IWC Ship Strikes Strategic Plan and that the Committee would **welcome** such reviews.

[23]*https://www.acops.org.uk/wp-content/uploads/2019/11/Report_EBSA-to-inform-application-for-IMO-Measures_24Nov2019_ForComments.pdf.*

13.3 Co-operation with IMO Secretariat and relevant IMO committees

The Secretariat and members of the Committee have continued to work with IMO on ship strike related issues. This is reported under Item 4.14. The Committee has an intersessional ship routeing group to consider any intersessional requests with regard to impacts on cetaceans of any changes in routeing measures proposed at IMO.

13.4 Approach for requesting/providing marine traffic data

The Committee has previously recommended that the Secretariat and the HIM Convenor explore possibilities for 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 MarineTraffic which has generously donated data for previous papers that have been discussed by the Committee and has continued to provide data for ship strike related analyses. The Secretariat and the HIM Convenor have recently met with MarineTraffic and a MoU is currently being developed.

13.5 Progress on previous recommendations

Last year (IWC, 2020e), the Committee drew attention to the high level of ship strikes in the Canary Islands and re-iterated previous Committee recommendations on the need to immediately implement mitigation measures that will reduce the risk of vessel-whale collisions in the Canary Islands archipelago. Garcia-Bellido reported that the Ministry for Ecological Transition commissioned the official body CEDEX to analyse maritime traffic from AIS data around the Canary Islands to identify inter-island routes and compared these to the available data on cetacean distribution and habitat use. This work will be used to identify areas of high collision risk. Meetings have also taken place with other Ministries in the Canary Islands and with one of the major ferry companies, Fred. Olsen Express. Work is planned to test the use of thermal cameras for collision avoidance on Fred Olsen vessels in collaboration with La Laguna University. Fernandez reported that there had been no reports or strandings showing evidence of ship strikes since May 2019.

In 2018, the Committee recommended 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. Last year (IWC, 2020e), the Committee also encouraged the ACCOBAMS Secretariat and ACCOBAMS Parties to further develop the process for the designation of a PSSA at a scale that includes the North West Mediterranean Sea, Slope and Canyon IMMA, plus potentially the Spanish corridor. Contacts with the ACCOBAMS and the Pelagos Sanctuary Executive Secretariats, as well as ASCOBANS, have been maintained to discuss possible synergies in assessing and mitigating ship strikes (see SC/68B/HIM/10). Panigada noted an ongoing project funded by the Pelagos Agreement on ship strikes in the Pelagos Sanctuary which will assess ship strikes and evaluate mitigation measures which could be applied there and in other areas of the Mediterranean. Garcia-Bellido also noted that similar work to that being undertaken in the Canary Islands on ship strike risk assessment is planned in the IMMA of the South East of the Balearic Islands, as well as in the southern sector of the 'Mediterranean Cetacean Migration Corridor' Marine Protected Area.

Noting previous concerns and recommendations regarding the situation for the northern Indian Ocean blue whales and ship strikes off Sri Lanka, the Committee recommended in 2019 (IWC, 2020a) that the Secretariat should maintain the ongoing dialogue regarding re-routing shipping off southern Sri Lanka with the IMO Secretariat and Sri Lankan officials. A meeting was held at the Sri Lankan High Commission in London (see Item 4.14). Sri Lanka had a presidential election in November 2019 and is due to have parliamentary elections in June 2020. Further engagement will be resumed when the new government is in place.

Recognising that ship strikes are a significant threat to the eastern sub-population of sperm whales in the Mediterranean and taking account of its previous recommendations, the Committee encouraged risk reduction measures in the Hellenic Trench through a formal proposal to the IMO by 2020 (IWC, 2020a). Leaper noted that a number of meetings had been held between the scientists involved and the relevant Greek ministries, and also with the European Commission, but a number of issues still need to be overcome.

In 2019 (IWC, 2020a), the Committee welcomed the decision of the International Association of Antarctic Tour Operators (IAATO) to adopt mandatory measures to mitigate ship strike risk from ship operations around the Antarctic Peninsula. These came into effect on 1 January 2020 until the end of the season (IWC, 2019h). IAATO informed the Committee that all operators complied, with approximately 80% choosing to travel at 10 knots in the designated areas. Vessel speeds were spot checked by the IAATO Secretariat using platforms such as MarineTraffic and RedPort. Operators reported challenges principally related to itinerary planning. IAATO will continue monitoring and collating information to promote best operational practice in the vicinity of whales. One whale strike in the Antarctic (a fin whale) was reported to the IWC database from the 2019-20 season. This happened outside the designated areas and involved a vessel travelling at 10 knots. The Committee welcomed the new information for IAATO and looked forward to further updates. The Committee also drew attention to its Ship Routeing Intersessional Correspondence Group which has been established to provide advice on any further proposed measures if requested (see Annex K).

Attention: CG, CC, S
With regard to ship strikes in identified high risk areas, the Committee:

(1) **encourages** *scientifically rigorous trials of thermal cameras to examine their efficacy in assisting in collision avoidance for ferries in the Canary Islands;*
(2) **welcomes** *further consideration by Spain, France, Monaco, Italy and ACCOBAMS of a proposal for an IMO Particularly Sensitive Sea Area (PSSA) including the Mediterranean coast of Spain, along with the Pelagos Sanctuary and identified migratory corridor;*
(3) **requests** *the Secretariat to contact the new Government of Sri Lanka following the 2020 elections to repeat the offer of help and advice made to the previous government; and*
(4) **requests** *the Secretariat to request an update from the relevant ministries in Greece regarding any progress with consideration of mitigation measures in the Hellenic Trench.*

13.6 Work plan

The Committee discussed proposals for the progression of work by the IWC on ship strikes (SC/68B/HIM/13). In a broader context, the IWC has identified the need to address the effects of ship strikes on cetacean populations, and especially large whale populations, as a conservation concern worldwide. Both the Conservation Committee and Scientific Committee are working to understand and reduce the threat posed by ship strikes. The Conservation Committee progresses its work through its Working Group on Ship Strikes. The Scientific Committee progresses its work through: (a) its sub-committee on Non-deliberate Human Induced Mortality (HIM); and (b) the ship strikes database coordinators contracted to the IWC. The Secretariat (including the Human Impact Reduction Technical Advisor) supports work across both Committees, particularly in support of the database and co-operation with other organisations.

The existing 2017-20 IWC Strategic Plan to Mitigate the Impacts of Ship Strikes expires in 2020 and the Committee **supports** the proposal that the existing Strategic Plan be retained with its timeline extended for two more years and that any revisions to the Strategic Plan be presented for endorsement of the Commission at IWC/69 (or a suitable future date). The current Ship Strikes work plan underpins the Strategic Plan and as such a new Ship Strikes work plan for 2020-22 is being developed by the Conservation Committee Ship Strikes Working Group. The proposed work plan sets out priority activities in support of the objectives of the strategic plan, establishes timelines, and proposes roles and responsibilities including a ship strikes co-ordinator.

In discussion, it was suggested that the work of the proposed co-ordinator might also take into consideration ship noise, its impacts and mitigation measures because many of the actions to address ship strikes also had implications for underwater noise. It was noted that the proposed ship strike coordinator would liaise between the IWC and IMO, and that both ship strikes and underwater noise have been considered by the IMO MEPC. Ritter noted that a dedicated ship strike coordinator might be able to overcome some of the obstacles that he and Panigada had encountered, including stimulating the ship strike data review group to greater efficiency and facilitating the entry of data from other databases.

Attention: CG, CC, S
The Committee **endorses** *the proposed structure for supporting IWC work on ship strikes outlined in SC/68B/HIM/13 including the following.*

(1) *The Ship Strikes Working Group, reporting to the Conservation Committee and Commission that is tasked with developing a work programme and overseeing the work conducted.*
(2) *The Scientific Committee, including its HIM sub-committee which would continue to implement the Committee work programme relevant to ship strikes.*
(3) *An Expert Panel, established by the Ship Strikes Working Group in consultation with the Scientific Committee to provide scientific and technical advice in support of implementation of the Ship Strikes work plan.*
(4) *A Ships Strikes Coordinator within the Secretariat of IWC who will implement the programme of work and represent the IWC.*

The Committee **agrees** to maintain current agenda items.

(1) Review new methods and estimates of rates of ship strikes, risk of ship strikes and mortality.
(2) Mitigation of ship strikes in high risk areas.

In addition, the Committee **agrees** to include an agenda item to review methods of estimating vessel traffic for vessel types that are not equipped with AIS. The HIM Convenor was tasked with identifying relevant papers on this issue for SC68C.

The Committee has previously considered papers providing advice on reducing ship strike risks for specific shipping sectors. It was noted that the draft Ship Strikes Work Plan includes developing specific advice for fast ferries and support vessels for the oil and gas or renewable energy industries. The Committee **agrees** to encourage papers on specific advice for these sectors at SC68C.

14. ENVIRONMENTAL CONCERNS

The Commission and the 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 1994-12 (IWC, 1994b) and it has subsequently passed additional Resolutions on environmental matters (IWC, 1997; 1998; 1999a; 2000; 2004; 2010; 2013a; 2017c), and 2018-4 (unpublished).

14.1 Chemical pollution

14.1.1 Final Report of Pollution 2020 Project

SC/68B/E/02 provided a summary of the major activities that occurred during the three phases of the Environmental Concerns Pollution Initiative (2000, 2000+, 2020). Among other important outcomes, an individual based model to assess risks to cetacean populations was developed and is now available as open source model through the IWC website, which also includes a contaminant mapping tool (*https://iwc.int/chemical-pollution*). The Committee **welcomes** the report on the history of the IWC's chemical pollution initiatives, and thanked the author, Hall, for compiling it.

14.1.2 Pollution 2025

In discussion, it was noted that pollutants are often one component of multiple stressors, and the importance of addressing these stressors through a 'One Health' approach was emphasised. The One Health approach recognises that the health of people is closely connected to the health of animals and our shared environment (*https://www.cdc.gov/onehealth/basics/index.html*). The Committee noted the relevance of two former workshops, on habitat degradation in 2004 (IWC, 2006) and on multiple stressors in 2018 (IWC, 2019l) which recommended the development of analytical tools and methods to assess the effects of multiple stressors and the need to further develop case studies. The Committee also recognised the value of understanding the different approaches used between research groups in measuring the effects of stressors, and noted the value of attempting to align methodologies, standardise protocols and improve interpretation of disease occurrence.

It was suggested that the treatment of multiple stressors be taken up within the framework of the Pollution 2025 initiative. The Committee recognised the necessity of a broad, cross-disciplinary approach and that an integrated view of health is needed. Different opinions on the best way forward included: (1) developing a multi-disciplinary review, which would include a summary of recent efforts to address multiple stressors, cumulative effects and new modelling techniques; (2) holding an intersessional workshop to discuss this issue in greater detail; and (3) reviewing a series of papers on long-term health effects of pollutants that are expected to be available over the next few months.

The Committee also noted recent efforts to develop models for specific case studies to understand multiple stressors on marine mammals but cautioned that some of these are in their infancy. Additional time is thus needed to evaluate and validate models. However, future collation by the Committee of those efforts and lessons learned would be beneficial as would a review of recent studies, such as Barratclough *et al.* (2019). The Committee agreed that furthering the issue of multiple stressors under the Pollution 2025 agenda is warranted.

Attention: SC, S

The Committee **endorses** *the value of the contaminant mapping tool in facilitating compilation of data to provide a view of contaminant distribution worldwide. The Committee also* **recognises** *the importance of the 'One Health' approach which recognises that the health of people is closely connected to the health of animals and our shared environment (https://www.cdc.gov/onehealth/basics/index.html). The Committee* **agrees** *that the treatment of multiple stressors should be addressed within the framework of the Pollution 2025 initiative.*

The Committee **recalls** *its previous recommendation on engagement with other organisations on mitigation and* **requests** *the Secretariat to liaise with the Pollution 2025 Intersessional Group as it engages with other organisations on this issue.*

14.2 Diseases of Concern: Focus session on infectious diseases (Part 1 this year, Part 2 in 2021)

The Committee held a virtual focus session on cetacean diseases of concern (a standing topic for the sub-committee on Environmental Concerns). New information on the infection and co-infection of *Morbillivirus*, *Brucella*, *Toxoplasma* and *Herpesvirus* in cetaceans was considered with a particular focus on the latter two. An additional focus session on *Morbillivirus* and *Brucella* will be held in 2021 at SC68C. Infectious diseases remain significant demographic and evolutionary drivers of human, domestic and wildlife populations. Such infections may play an important role in cetacean health and may have public health implications, especially in regions where cetaceans are used for food (i.e. aquatic wildmeat and aboriginal subsistence whaling).

Climate change, through its effects on animal movements and range shifts, is probably an important driver of the emergent geographic distribution of infections of priority pathogens (e.g. *morbillivirus*). Clinical outcome, reflecting the complex host-pathogen interaction (i.e. immune response, ability of pathogen to evade detection by the immune system or manipulate the latter) is also influenced by host nutritional status and contaminant burden. Given these interactions, the prevalence of infection and associated disease among cetacean populations are useful indicators of overall animal health and the health of the regional marine or riverine environments.

Detection of these pathogens relies on molecular determination techniques. Their prevalence in both healthy and diseased animals should be better assessed to understand the effects, especially since different strains of the same pathogen may lead to differing effects. To fill data gaps on pathogen prevalence and disease in under-reported areas, there is a need to enhance sampling and diagnostic capabilities in those regions. A broad surveillance programme and database should be developed. The Committee offers a framework to provide such enhancement through empowering national programmes and developing collaborations amongst biologists, bycatch observers and veterinary laboratories to improve understanding of these emergent public health issues and the concept of 'One Health.'

Attention: SC, CG, C, E
The Committee **draws attention** *to the number of serious outbreaks of cetacean diseases of concern (e.g. morbillivirus) detected since the 1980s, recognising that the prevalence of infectious agents (e.g. viruses, bacteria) and associated animal impacts (i.e. acute to chronic morbidity, mortality) are useful indicators of overall animal and ecosystem health. It therefore* **recommends** *that a pathogen surveillance programme focusing on priority pathogens (e.g. morbillivirus) be developed.*

Such a globally linked surveillance program would require: (i) permits for sample shipping (e.g. CITES, CBD Nagoya Protocol, MMPA); (ii) networks of field samplers and diagnostic laboratories; and (iii) standardised protocols for sample collection, storage and shipping.

14.3 Strandings and mortality events

14.3.1 Update on IWC Strandings Initiative and work plan 2020-22

14.3.1.1 Report on Progress

Mazzariol presented an update on progress with the IWC Strandings Initiative 2019-20 (SC/68B/E/08). A draft new four-year work plan is being developed that will be presented at SC68C. In addition, work is underway to explore the relationship between the IWC Strandings Initiative and the proposed 'Global Strandings Network' which was an outcome of a Workshop at the World Marine Mammal Conference in December 2019 and the 'Barcelona resolution'. Recommendations on the possible synergies and relationships between these two entities will be presented at SC68C. Mazzariol invited the Committee to: provide comments on the development of the new strandings work plan; provide advice on how the Committee can best engage with the development of the new strandings work plan as it proceeds intersessionally; and approve the proposal for expansion in membership of the Strandings Expert Panel to address geographic gaps and gaps in expertise. The Committee **welcomes** the work to develop a new four-year work plan for the Strandings Initiative.

Brownlow provided further information on the development of the four-year work programme for the IWC Strandings Initiative. The review has three main foci: (1) to recognise progress on the initiative so far and lessons learnt; (2) to identify those areas in global strandings response which could be best addressed by the capabilities of the IWC Strandings Initiative; and (3) to develop a costed work plan as to how the IWC Strandings Initiative could develop over the next four years.

The Committee thanked Mazzariol and Brownlow for the updates. It recognised that the Strandings Initiative encompasses a broad range of issues related to cetacean strandings, including responses to both live and dead stranded cetaceans, entrapped or 'out of habitat' animals, scientific investigations to determine causes of strandings, as well as associated welfare implications, and that science related to strandings can improve both cetacean conservation and welfare. Furthermore, it noted that cross-cutting issues spanning the work of different sub-committees needs to be interlinked. A request to carry over the existing strandings funding to 2021 is discussed under Item 22.

Attention: S, CC, C
The Committee **recalls** *previous recommendations stressing the importance of the IWC Strandings Initiative. The Committee:*

(1) **draws attention** *to the need for funding for the Strandings Coordinator position and the Strandings Initiative work programme;*
(2) **encourages** *Contracting Governments and relevant organisations to contribute funding to the initiative; and*
(3) **requests** *the Strandings Expert Panel and Secretariat to pursue wider fundraising opportunities.*

Attention: S, CC, C
Regarding the new four year work plan for the Strandings Initiative, the Committee:

(1) **agrees** *on expanding the scope of the Expert Panel to address geographic gaps and gaps in expertise,*
(2) **requests** *the Strandings Initiative Steering Group to identify appropriate additional members; and*
(3) **encourages** *the Committee members represented on this group to engage with development of the work plan as it proceeds intersessionally.*

14.3.2 Strandings - other issues

The Committee welcomed SC/68B/E/04, which provided an overview of the recent effort of the Indian Ocean Network for Cetacean Research (*IndoCet*) to compile regional strandings data. The effort seeks to coordinate stranding response within *IndoCet* and the Western Indian Ocean region and identify a stranding coordinator to provide assistance and support with stranding response, documenting injury and mortality stranding data, sample collection, and training. *IndoCet* has collect unpublished stranding data from South Africa, Mozambique, Tanzania, Kenya, Reunion, Seychelles, Mayotte, Mauritius, Comoros, and Madagascar. The authors conclude that a lack of baseline data on animal health in the region is of concern as such data are required to assess the potential impact from anthropogenic activities in the region, as well as concerns regarding possible impacts from consumption of stranded cetaceans on human health. The report highlights the fact that regional capacity building is needed, and that ongoing efforts be focused on establishing geographical areas of response and determining the level of capacity and/or training requirements.

SC/68B/E/06 provided information on an unusual level of cetacean strandings in northern Norway, during spring 2020. A total of 17 animals of at least 7 different species was found stranded in a relatively small area of the coast during a short period of time. Based on meteorological simulations of drift, the carcasses may have originated from the same area in the Norwegian Sea, southwest of the Lofoten Islands. There were also unusually high numbers of reported strandings in Iceland during spring 2020. However, an increase in the frequency or range of species stranding during this period was not noted in Scotland, though there was a cluster of beaked whale strandings in southeast Ireland and the Atlantic coast of the UK in December 2019/January 2020[24]. Anthropogenic causes were not suspected in the latter cases, based on necropsy data.

A high number of strandings was also noted in SC/68B/E/07, which presented information collected during beach monitoring along approximately 1,000km of Brazilian coastline from 2015-19. During this period, 215 baleen whales and 4,162 toothed whales were found. Of toothed whales, 87% were from only three species: franciscana, Guiana dolphin and bottlenose dolphin. The authors believed that the average number of franciscanas stranding each year may indicate a population decline considering the population size estimates for this area. Daily beach monitoring revealed much higher numbers of stranded small cetaceans than previously recorded in the same area when opportunistic or less frequent sampling occurred, suggesting that turnover of carcasses on beaches may be relatively high.

SC/68B/E/09 summarised events involving cetaceans reported to the Strandings Expert Panel of the IWC Stranding Initiative during the period 2018-20 that could be considered atypical or an 'emergency'. An emergency can be defined as 'any event, or combination of events, natural or man-made, which causes a temporary and unusual increase in wildlife casualties, and which threatens to overwhelm local resources'. For cetaceans, this definition includes, but is not limited to, unusual mortality events (UMEs), mass strandings (MSEs), epidemics, live strandings of large cetaceans found dead in countries with no functional stranding response or in unusual places. In total, 53 events were reported, and geospatial mapping of these events was conducted. This summary of recent unusual marine mammal emergencies helps focus the IWC Strandings Initiative efforts and resources for training for emergency response investigations. A retrospective analysis, a standardisation of event reporting and continuous data entry would help the IWC to have a broader understanding of stranding events worldwide. The aim of the paper was not to undertake an exhaustive review of events, but to provide examples from recent years to demonstrate the need for prioritising the training of responders.

The Committee noted the importance of the development and implementation of a database of unusual cetacean stranding events; such a database could be used to extract information on worldwide events in near-real-time. The Committee also discussed the potential value of development of a database that integrates entanglement, ship strikes and strandings data that are collected by the IWC. Integrating databases is a complex issue that needs to be considered in more detail at SC68C. There was a need for detailed discussions with the Secretariat and the Committee's *Ad hoc* Working Group on Databases and Related Issues, which already has the mandate to take an overview of existing IWC databases (including considering the potential for merging databases) and for evaluating proposals for new databases. Furthermore, it was noted that data standardisation and management are critical topics requiring further discussion. Finally, it was suggested that a better definition of the Strandings Initiative Terms of Reference, clarifying which events are classified as novel or emergencies based on long-term 'baseline' datasets versus those that are due to the lack of a stranding network, would facilitate better interpretation of the data and help to focus the efforts of the Stranding Expert Panel. This will be further considered by the Strandings Consultant in development of the new four-year work programme for the Strandings Initiative (see above).

The Committee thanked the authors for their contributions and the new information they provided on stranding events around the world.

Attention: SC, S, E

The Committee **reiterated** *the importance of the IWC Strandings Initiative. Recognising the outstanding needs regarding the data generated through the initiative, the Committee:*

(1) **requests** *that the Secretariat liaise intersessionally with this group to facilitate discussion of existing database development plans, and coordination with the work of the Ad Hoc Working Group on Databases; and*

(2) **agrees** *to further consider the topic of database development and data standardisation at SC68C and coordinate this with the on-going work on database development in the Ad Hoc Working Group on Databases.*

[24]See *https://batchgeo.com/map/9ac1b7d69d89938f6371758ec2127b4e.*

14.3.3 New information on unusual mortality events

SC/68B/E/10 provided information regarding an Unusual Mortality Event of sperm whales in the Mediterranean. Between December 2018 and July 2019, an increase of stranded sperm whales was recorded along the Tyrrhenian coastline of Italy, with 16 individuals found stranded or floating close to shore. Two additional whales were reported in France, and eight in Algeria. Epidemiological and molecular data suggest that cetacean morbillivirus (CeMV) had a role in the deaths. A CeMV related outbreak was reported in bottlenose dolphins living in a contiguous area between July and September, further supporting the circulation of the virus in the Mediterranean Sea. It is not clear if the virus represents a significant threat for the Mediterranean population. Marine debris and fishing gear were considered incidental findings, although it cannot be excluded that the ingestion of marine litter may have had a role in predisposing animals to infection (i.e. reducing food ingestion, transporting chemicals or pathogens). The number of entangled individuals found in a short period stresses the need for constant monitoring and a continuous transboundary dialogue regarding human-related threats to cetacean conservation. In discussion, it was noted that this paper highlights the timeliness of next year's focus session on CeMV, which has been documented over the last 30 years to have caused multiple cetacean mortality events among a variety of cetacean species, across different oceanic basins, and with multiple CeMV strains circulating among different cetacean stocks.

14.4 Noise

14.4.1 Review of Noise Workshop

A virtual meeting was held on 11 May 2020 and attended by 70 participants, including representatives from shipping interests, to discuss advancing efforts to address underwater noise from shipping. The original agenda for a full-day workshop was reduced to a three-hour virtual session. The presentations and discussion focused on ambient sound, noise budgets and indicators, in addition to collaboration with IMO and the Conservation Committee. A meeting of the IMO Marine Environment Protection Committee (MEPC 75) had been postponed due to the COVID-19 pandemic but, when it does meet, they will take up pending proposals on underwater noise. The Conservation Committee was planning a Workshop on noise which would further develop the Conservation Committee work programme. The full report of the virtual workshop can be found as SC/68B/REP/06.

Attention: C, CG, CC, SC

The Committee **reiterates** *the threats posed to cetaceans by underwater noise (SC/19/26) and that this can also have adverse effects on other trophic levels including fish and invertebrates. Recalling Resolution 2018-04, and the Commission's objective to facilitate mitigation of adverse effects of anthropogenic underwater noise, the Committee:*

(1) **agrees** *to revisit the topic of collaboration with the IMO after the Marine Environment Protection Committee (MEPC) takes up pending papers on underwater noise;*
(2) **encourages** *the development of databases of ship source levels; and*
(3) **encourages** *intersessional work to further the collaboration between the Scientific Committee and the Conservation Committee on underwater noise.*

14.5 Review Report of the Workshop on Marine Debris

Simmonds presented the report of the third IWC Workshop on Marine Debris, held in La Garriga in Catalonia, Spain, 3-5 December 2019, with experts from nine countries attending, and supported by the IWC and the government of Netherlands (SC/68B/REP/03)[25].

The Workshop aimed to progress the IWC's work on this threat by: (i) reviewing the latest evidence on interactions with cetaceans (both ingestion and entanglement) and considering evidence for associated toxicology; (ii) identifying best protocols for gross pathology, pathology for microdebris and the standardised classification of recovered plastics and other debris; and (iii) developing liaison with other relevant expert bodies.

The Workshop considered published and unpublished information, including reviews of the latest literature and a comprehensive overview of marine debris-related activities by other international organisations, as well as regional reports (Mediterranean, the Spanish Canary Islands, German and Dutch waters). It was agreed that the scale of the actual and projected increase in plastics is alarming. Cetaceans can die after marine debris ingestion, due to gastric impaction/occlusion, perforation, or the associated lesions. Besides causing direct lethal effects, plastic debris can affect marine mammals' health if they persist in the gastrointestinal tract (GIT), for example by reducing the space for food and, subsequently, reducing their fitness and the nutritional condition. Presence of foreign bodies could also cause inflammatory changes to the GIT and/or induce stress and pain. An additional concern on the health effects of marine debris on cetaceans was related to the potential role of plastic debris as a carrier or vector of toxins and pathogens. The Workshop also considered the relationship between marine debris and entanglement in fishing gear and received new information on Fisheries Aggregation Devices.

[25]The draft report can be found here: *https://archive.iwc.int/?r=17025&k=870ad1ead3.* The final report is published in this volume (pp.273-310).

Noting that approximately 640,000 tonnes of Abandoned, Lost and otherwise Discarded Fishing Gear (ALDFG) enters the oceans every year, the Workshop also called for actions to address this threat, including for bowhead whales in the Bering Sea which may be at particular risk.

The Workshop made a series of detailed recommendations, including emphasising the importance of long-term studies; the need for standardised approaches for post-mortem studies; the importance of strandings networks; the assessment of floating debris during aerial surveys and the integration of marine debris concerns into the IWC's Conservation Management Plans, where appropriate. The vulnerability of some species was highlighted and the potential of some to be used as indicator species. The Workshop also called on the IUCN to consider marine debris in its next assessment of the sperm whale.

Other recommendations covered engagement with international bodies (the Workshop encouraged the establishment of a roster of marine debris experts by the IWC who would help to represent it at key meetings) and the development of a marine debris database of information from post-mortem examinations. A joint ACCOBAMS/ASCOBANS document on 'Best Practice on Cetacean Post-mortem Investigation and Tissue Sampling' was strongly welcomed and commended to the Scientific Committee for its consideration[26].

Communicating this issue was also discussed at the Workshop and it was agreed that this should: (i) take into account the audience; (ii) be accurate about the underpinning scientific information and its limitations; (iii) emphasise upstream solutions in addition to end of life measures; (iv) consider consulting communication professionals or social scientists; and (v) wherever possible, focus on positive, actionable messaging. The report, presented to the Committee as SC/68B/REP/03 contains the full set of recommendations.

The Committee welcomed the report as an insightful, comprehensive and valuable document, and thanked Simmonds for organising and chairing the Workshop and Smith, Frisch-Nwakanma, Creek and Nunny for their support. It endorsed the recommendations from the Workshop, and strongly supported the need to remove netting, including lost netting, from the vaquita habitat in the upper Gulf of California as has been recommended by the Committee for many years (IWC, 2020a, pp.44-45). It was noted that the best practice approaches identified in the report are living documents and interested parties should also look for updates.

It was further noted that in the framework of MARCET Network (2014-20 Interreg V-A MAC - Spain-Portugal [Madeira-Açores-Canarias]), joint work has been carried out between Portugal (Madeira, Açores), Spain (Canary Islands), Cape Verde and Senegal, producing the MARCET-Atlantic Cetacean Necropsy and Sampling Protocol, aimed at harmonising technical procedures related to post-mortem investigations on cetaceans in the Macaronesia region. With respect to Annex 6 of SC/68B/REP/03 (containing a list of definitions from the ASCOBANS/ACCOBAMS Best Practice on Cetacean Post-mortem Investigation and Tissue Sampling document), it was further noted that the IUSA-ULPGC Protocol provides an improved glossary of terms based on the MARCET-Atlantic Protocol.

In discussion, the Committee recognised that the impacts of marine debris on cetaceans are more substantial than was previously thought and further noted the importance of continued work on this topic. It was stressed that marine debris acts synergistically with other stressors (e.g. chemical contaminants, noise pollution, impacts of bycatch). The Committee agreed that the Intersessional Working Group on marine debris should continue and should assess potential mitigation measures, both preventative and curative, taking account of the Workshop's other recommendations and should report back at SC68C.

An update was provided of recent reports of ingestion of debris by cetaceans from the last 16 years (2005-20, SC/68B/E/03). In addition to published sources, information on new cases was kindly provided by: A. Fernandez, R. Puig-Lozano and team at the Animal Health, University of Las Palmas Gran Canaria, Spain; Wayne McFee, National Centers for Coastal Ocean Science, NOAA National Ocean Service; Nick Davison, Scottish Marine Animal Stranding Scheme (SMASS); and others. 74 new cases were reported and, as previously recognised, deep diving cetaceans seem to be particularly vulnerable to marine debris ingestion.

As discussed under Item 14.3.3, an unusual mortality event of Mediterranean sperm whales occurred in 2019 with a total 26 dead animals stranded (IWC/68B/E/10). Epidemiological and molecular data suggest a relevant role of CeMV in the mortality. Marine debris was found in the stomachs of some animals and therefore the possibility of marine debris predisposing the animals to the infection cannot be excluded. The relatively high number of dead individuals within a relatively short period stresses the need to monitor and engage in transboundary cooperation to mitigate human-related threats to this species in the region through common approaches.

In discussion, it was noted that the IWC and ACCOBAMS have initiated a dialogue on producing a Conservation Management Plan for the Mediterranean sperm whale (see Item 9.2.3), highlighting the integration of the work between the E and CMP sub-committees.

[26]see *https://accobams.org/wp-content/uploads/2019/04/MOP7.Doc33_Best-practices-on-cetacean-post-mortem-investigation.pdf* and *https://www.ascobans.org/en/document/best-practice-cetacean-post-mortem-investigation-and-tissue-sampling.*

Attention: SC, CC, CG, C
The Committee **welcomes** *the report of the IWC Workshop on Marine Debris: The Way Forward (SC/68B/REP/03) and* **endorses** *its recommendations. It recognises the impacts of marine debris on cetaceans and encourages the communication and implementation of the Workshop recommendations by all relevant stakeholders.*

Attention: SC, E
The Committee recognises that data collection using appropriate, standardised protocols, including for post-mortem examinations, is of paramount importance and **agrees** *to take forward an intersessional effort, overseen by the existing Intersessional Correspondence Group on marine debris to address:*

(1) *what appropriate data should be collected;*
(2) *how the data might best be sourced and managed; and*
(3) *how this relates to ongoing work on the IWC's various databases.*

14.6 State of the Cetacean Environment Report (SOCER) (Atlantic Ocean)

The State of the Cetacean Environment Report (SOCER) focused this year on the Atlantic Ocean (see also the 5-year compendium: *https://iwc.int/socer-report*) and summarised papers on the full range of recognised threats to cetaceans: bycatch, ship strikes, marine debris, chemical pollution, disease events, harmful algal blooms, oil spills, noise and climate change. Regionally, bycatch exceeded 'maximum sustainable total anthropogenic removals' of harbour porpoises in Sweden. Strandings of common dolphins in France correlated with fishing efforts. The impact of marine debris on a wide range of cetaceans emphasised the need for standardised research methodologies. For North Atlantic right whales, ship strikes continued to pose a serious threat. Proactive conservation measures such as 'ropeless' fishing gear are recommended. Diseases reported in Atlantic cetaceans included pneumonia, brucellosis, toxoplasmosis and morbillivirus. 'Impulsive noise activity' has increased in the Northeast Atlantic, leading to a call for 'noise budgets' within regional seas. The *Deepwater Horizon* oil spill has had long-term impacts on cetaceans, and an ongoing oil spill in Brazil is the most extensive and severe environmental disaster ever recorded in the South Atlantic basin. The Caribbean was highlighted as a case study for pollution problems and other threats in ocean regions bordered by multiple jurisdictions. Globally, research continues to emphasise the impact of bycatch, microplastics and heavy metals on cetaceans. Climate change impacts on cetaceans are also becoming increasingly clear, with impacts on prey potentially leading to local extinction of some cetacean populations. The Committee thanked the editors of SOCER for their report and commended them for compiling this information. The co-editors of SOCER in turn thanked the Committee members for their active input during the remote discussion of this year's report. The full SOCER report can be found as Annex H.

Attention: SC
The Committee **agrees** *that the State of the Cetacean Environment Report for SC68C will focus on the Pacific Ocean (North and South).*

14.7 Progress on previous recommendations

Progress on previous recommendations is summarised in Table 16. This is an updated extract from the IWC database of recommendations.

14.8 Biennial work plan

The work plan for the sub-committee on Environmental Concerns is given in Table 17. The Committee **agreed** that the work plan summarised below 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. The Intersessional Groups (Steering and Correspondence) are given in Annex K.

15. ECOSYSTEM MODELLING

The Working Group on Ecosystem Modelling was first convened in 2007 (IWC, 2008) and was tasked with informing the Committee on relevant aspects of the nature and extent of the ecological relationships between whales and the ecosystems in which they live.

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

(1) ecosystem modelling 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.

Table 16

Progress on previous recommendations for Environmental Concerns.

Number	Actioned by	Text	Recommendation notes
SC1910	E	The Pollution 2020 initiative is complete and a consolidated final report will be developed by Hall and others for next year's meeting and for the Commission.	A paper was written and was discussed in SC/68B/E/02. Recommendations to be closed post SC68B.
SC1911	SC	A new multidisciplinary pollution/cumulative effects initiative named Pollution 2025 should be developed. A Steering Group under Holm has been established to develop options for such an initiative to be submitted to next year's meeting.	Postponed to 2021. Steering Group met April 2020 and work plan in development to be presented to next meeting.
SC1912	S	The Committee reiterates the importance of engaging with key initiatives and organisations on mitigation and in this regard and offers to assist the Secretariat in engaging with initiatives such as the Stockholm Convention, the Convention on Biological Diversity and the United Nations Environment Assembly to facilitate knowledge exchange about reducing exposure of cetaceans to pollutants.	As Pollution 2025 is further scoped, it would be helpful for the Secretariat to liaise with the intersessional steering group. Follow up recommendations are to be considered.
SC1913	CC	The Committee requests that the Conservation Committee considers how to take forward interactions with relevant fora to reduce cetacean exposure to pollutants.	In part this can now be taken forward by the Secretariat in association with SC1912. CC is also considering this in development of its own work programme but there is no progress on this as of yet. CCPG will discuss how to make progress when it meets on 25 May 2020.
SC1914	E, S	Hold a focus session on disease at next year's [2020] meeting. In addition to the issues identified for this session last year (IWC, 2019h): (1) that the focus session on Brucella and Morbillivirus in cetaceans that is organised for SC68B be expanded to include Toxoplasmosis. and Herpesviruses; and (2) that papers be submitted that address knowledge gaps on cetacean host-pathogen interactions identified by Di Guardo *et al.* (2018), i.e. characterisation of the cell receptors allowing infection; interaction and effects of chemical pollutants on the expression levels of the aforementioned cell receptors; pathogenetic evolution of the concerned infections in T helper 1-dominant *vs* T helper 2-dominant cetacean individuals; and effects of pregnancy-associated immune status on the infectious potential of specific pathogens.	Two virtual focus sessions were held on 15 and 17 May 2020. This recommendation is to be completed at the conclusion of SC68B.
SC1917	E, S	The Committee encourages the Strandings Coordinator and SEP to develop a package of training materials for use in IWC events and for outreach purposes.	Discussion ongoing as to whether IWC should develop its own training materials or act as a repository and disseminator for others. Will be considered in context of development of new SI work programme.
SC1918	Strandings Steering Group, S	Funding be sought for the continued support of the Strandings Coordinator beyond October 2020.	Currently there is no funding for re-appointment of the coordinator and there will need to be focused efforts on fundraising for the coordinator to be reappointed.
SC1920	CG, S	Secretariat to pursue wider fundraising efforts for Strandings Initiative activities.	Fundraising possibilities also being reviewed by the strandings consultant.
SC1922	CG	National coordinators should indicate mass stranding or unusual mortality events in the National Progress Reports.	Work also underway to encourage more countries to submit progress reports.
SC1925	CG	Wherever possible strandings and especially mass strandings events of beaked whales and baleen whales be thoroughly investigated - the Committee can assist in this through the Strandings Initiative and it encourages governments to request help if required.	Support being provided by Strandings Expert Panel. See SC/68B/E/08.
SC1929	E	Agrees that the Steering Group established last year should continue to develop the agenda for next year's pre-meeting including international approaches to noise targets and thresholds (ambient and impulsive) and monitoring and communicating such targets; the contribution of small vessels to coastal soundscapes; collaboration with other IWC bodies and with IMO.	Pre-meeting held 11 May 2020. Follow up in person meeting to be held next year.
SC1930	E	The Committee welcomes the provision of new information on marine debris and its impacts on aquatic ecosystems and cetaceans including papers that will allow estimation of baselines and trends, such as that provided from IWC-POWER cruises this year.	-
SC1933	E	Receive report from the IWC marine debris workshop to be held in December 2019.	See SC/68B/REP/03. This recommendation will be completed at the conclusion of SC68B.
SC1934	E	SOCER 2020 should be compiled as planned for the North and South Atlantic and that any relevant contaminant data identified would be appended to the Contaminant Mapping Tool database.	SOCER report submitted but more discussion needed on input of data for the Contaminant Mapping Tool.

Table 17

Work plan for Environmental Concerns.

Topic	Intersessional 2020/21	2021 Annual Meeting (SC68C)
Pollution 2025	Planning activities and work priorities for Pollution 2025	Review progress of intersessional work and agree on priorities
Cetacean diseases of concern (Morbilliviruses and Brucella)	Planning of focus session	Hold focus session
Strandings	Develop a four-year work plan	Review progress of intersessional work
Climate change	Workshop on climate change	Review workshop results
Noise	Advance underwater noise topics of interest	Review progress of intersessional work
Marine debris	Follow up on the recommendations from the workshop	Review progress of intersessional work.
SOCER	Report compilation on the Pacific Ocean	Review SOCER Pacific

15.1 Cooperation with CCAMLR on multi-species modelling and progress with related workshop(s)

15.1.1 Plan for postponed Workshop on the Role of Cetaceans in Ecosystem Functioning; Gap Analysis

In response to Resolution 2016-3 (IWC, 2017b) that tasked the Committee with investigating the contribution of cetaceans to ecosystem functioning, the Committee recognised that this was a complex long-term task and agreed to start the process by holding 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 functioning (IWC, 2019c, p.46).

Last year, the Committee reiterated the need to hold a Workshop to begin the process of responding to Resolution 2016-3 and agreed a plan for the Workshop including potential hypotheses and questions for consideration, and the need to ultimately compare the ecosystem function of cetaceans amongst different ecosystems (IWC, 2020f; 2020g). To advance the funding and other logistical matters intersessionally, an Intersessional Steering Group (ISG) was re-established under Ritter. Three sub-tasks were accomplished.

(1) A close link was developed between the IWC Secretariat and CMS representatives so as to constantly review budgetary issues.

(2) Cavanagh (British Antarctic Survey, who later joined the ISG) and Kitakado (EM Convenor) were nominated as Chairs for the Workshop.

(3) Two preparatory review papers were commissioned. The first one will deal with the literature that is currently available on the ecosystem function of cetaceans, authored by Roman (University of Vermont). The second one, authored by Wassmann (University of Tromsø), Haug (Institute of Marine Research, IMR) and Biuw (IMR), will evaluate the potential role of whales as ecosystem engineers through estimating the magnitude of their contribution as compared with other species in the ecosystem (the working title is 'A critical evaluation of whales as ecosystem engineers'). This work will largely be based on in-depth knowledge on ecosystem structure and function (including extensive long-term cetacean visual survey datasets) in Arctic regions, particularly the Barents Sea, thus also providing a comparative case study to the Southern Ocean.

(4) It was originally decided that the Workshop would be held in Cambridge (UK) as a pre-meeting to SC68B. The preparation of the Workshop proceeded smoothly, but for reasons related to COVID-19 pandemic, it had to be postponed to the next intersessional period when it is planned to be held as an in-person meeting.

The Committee was pleased to be advised of the progress made by the ISG intersessionally, and thanked Ritter for his leadership. To further progress the Workshop planning and work toward drafting the Committee's response to the Commission's Resolution, the Committee **agrees** to re-establish the Workshop Steering Group (see Annex K).

Attention: SC, C

The Committee **reiterates** *(IWC, 2019c, p.46) the need to hold a Workshop to assist in responding to Commission Resolution 2016-3 asking for advice on the role of cetaceans in ecosystem functioning. Considerable progress was made towards organising the Workshop, but it had to be postponed due to COVID-19. The Committee* **recommends** *that the Workshop be held during the next intersessional period and the report submitted to the 2021 meeting of the Committee (SC68C). The Committee* **re-establishes** *the Workshop Steering Group under Ritter.*

15.1.2 Finalise response to Commission's request on review of cetaceans to ecosystem functioning (Resolution 2016-3)

The Committee will develop a response to Resolution 2016-3 (IWC, 2017b) on scientific aspects of the role of cetaceans in ecosystem functioning at SC68C.

15.1.3 Planning of the future joint IWC-CCAMLR Workshop(s) and possible MoU

Ecosystem modelling in the Antarctic Ocean is an active area of research of interest to the Committee especially with regard to ecological functions of whales. The Committee noted that the proposed joint IWC-CCAMLR Workshop (IWC, 2018g) is now expected to take place after the results of the Ecosystem Functioning Workshop discussed under Item 15.1.1. A full discussion of this is expected at SC68C that will take into account any progress (since the original plans were developed) made by both the Committee and the CCAMLR Scientific Committee in identifying information gaps and necessary research. The Committee will invite a member of CCAMLR's Scientific Committee to future Committee meetings to strengthen engagement between CCAMLR and the Committee.

As one of the target study areas of the Workshop on ecosystem functioning discussed under Item 15.1.2 is the Southern Ocean, it was agreed that inviting CCAMLR scientist(s) and ecosystem expert(s) to that Workshop will be beneficial. To this end, the Committee will invite a member of the CCAMLR Scientific Committee and Tulloch (University of British Columbia) to the SC68C meeting (and the Ecosystem Functioning Workshop if it is held as a pre-meeting workshop).

Recognising the need for enhanced scientific collaboration between the IWC and CCAMLR, the Committee was informed that the development of a Memorandum of Understanding (MOU) will be discussed by the IWC Bureau. A similar process is underway within CCAMLR and if the development of an MOU is approved by both bodies, it will be presented to the two Commissions next year.

15.2 Progress on species distribution models (SDMs) and ensemble averaging, including preparation of guidelines

The Committee has recognised that species distribution models (SDMs) can help predict species density spatially by quantifying the relationship between the observed species distributions and the factors which influence these. In general, although both statistical models and machine learning methods can be applied as SDMs, there is still an open question regarding the estimation performance of these SDMs. To this end, an Intersessional Correspondence Group led by Murase made good progress to develop guidelines for best practice for the application of SDMs including machine learning methods.

To date, the Committee has focused on single species modelling for 'whale species'. Last year, to evaluate estimation performance amongst the SDMs, new 'simulation' analyses on SDMs were presented with an example for the Antarctic krill, a key prey species of many Southern Ocean baleen whales. Given that spatial and temporal interactions between predators and prey and/or those among predators are of great interest in the Committee, it would be beneficial to extend the scope of the original SDM work to include guidelines for best practices for advance ecosystem modelling. In this regard, the Committee **agrees** to establish a new Intersessional Correspondence Group, with membership of Kitakado (Convenor), Biuw, Burkhardt, Friedlaender, Genov, Herr, McKinlay, Miller, Kelly, Murase, New, Palacios and Palka, for future development of guidelines for analyses, with Terms of Reference as follows:

(1) to finalise the guidelines for single species distribution models (SDMs);
(2) to conduct a literature review of multi-species distribution models (MSDMs); and
(3) to develop possible simulation platforms to evaluate these models.

Attention: SC
The Committee **recognises** *the importance of multi-species distribution models (MSDMs) to its work on ecosystem modelling and* **agrees** *to establish an Intersessional Correspondence Group to work towards the future development of guidelines for such models.*

15.3 Modelling of competition among whales including progress with IBEMs

The Committee did not receive any new information this year, but this is an important research area within the Committee, with close links to ecosystem modelling and future contributions to RMP trial specifications (and see Item 5.1). In this regard, the Committee **agrees** to establish an Intersessional Correspondence Group (see Annex K) with membership of Friedlaender (Convenor), Biuw, Cooke, de la Mare, Donovan, Kitakado, Palacios and Palka to facilitate work on modelling of competition among whales with the following Terms of Reference:

(1) to further develop individual-based energetics models (IBEMs), *inter alia* for progressing the emulator model to use in RMP trial specifications;
(2) to discuss new strategies for model development that utilise new data; and
(3) to infer functional responses using an IBEM for rorqual foraging dives.

The Committee **looks forward** to receiving the progress on this topic at next year's meeting.

Attention: SC
The Committee **recognises** *the importance of further development of IBEMs to account for competitions among whales and* **agrees** *to establish an Intersessional Correspondence Group to facilitate work on modelling competition among whales.*

15.4 Standing topics

15.4.1 Progress on considering effects of long-term environmental variability on whale populations

The issue of variability in baleen whale demographics was last examined at a Workshop held in 2010 (IWC, 2011b).

Given time constraints and that no new papers were available this year, the Committee decided to postpone the discussion on this issue, and re-establishes the Intersessional Correspondence Group (see Annex K).

Attention: SC
The Committee **reiterates** *the importance of understanding baleen whale demographics and long-term environmental variability and re-establishes an Intersessional Correspondence Group.*

15.4.2 Review progress on evaluation of krill distribution and abundance

The Committee has received information on a krill and oceanographic survey conducted in the Southern Ocean for four years between 2015/16 and 2018/19 under the New Scientific Whale Research Program in the Antarctic Ocean (NEWREP-A). The Committee was also informed that Japan conducted an international ecological survey independently from NEWREP-A in the Indian sector in 2019, which includes research on krill distribution and biomass based on the CCAMLR standard method (CCAMLR, 2019). However, no final results have been produced as yet. It was noted that biomass estimates from the international '2019 Area 48 Survey' covering CCAMLR management area 48 (the Scotia Sea) have been provided to, and approved by, the CCAMLR Scientific Committee (Macaulay *et al.*, 2019). Since the relationship between krill biomass estimates from surveys in the Southern Ocean and consumption rates of baleen whales are of great interest, and further that krill biomass, distribution and aggregation (swarm) characteristics are important variables informing ecosystem models, the Committee **looks forward** to receiving the data related to these from krill surveys in the near future.

15.4.3 Modelling of relationship between whales and prey

Friedlaender advised about his ongoing work to better understand the foraging ecology of baleen whales in relation to their prey, with a focus on quantification of foraging rates and predictions about resource partitioning between Antarctic minke and humpback whales. This work can facilitate more accurate estimates of consumption and feeding rates for individual whale species, and this information can be used to develop better predictive individual-based energetic models (IBEMs). It is also useful when considering krill abundance estimates by determining better what patches or threshold densities are necessary for a patch to be of value to different krill predators in the Antarctic. The Committee welcomed this information and **looks forward** to receiving any updates on this work.

15.5 Progress on previous recommendations

Previously, the Committee recommended that collaboration be enhanced between the SC and CCAMLR (IWC, 2018f). To this end, the Committee **agrees** to invite a member of the CCAMLR Scientific Committee to future SC meetings (and see Item 15.1.3 above).

Regarding the work on the ecosystem functioning, considerable progress has been made and the postponed Workshop will be held intersessionally or as a pre-meeting, with its report to be submitted to the 2021 meeting of the Committee (and see Item 15.1.1 above).

15.6 Work plan

For details of the Intersessional Correspondence Groups for Ecosystem Modelling, see Annex K.

16. SMALL CETACEANS

Summary tables of data on small cetacean bycatch and ship strikes are available as Annex I.

16.1 Previous recommendations

16.1.1 Review and consolidation of previous recommendations

Jimenez and Porter worked intersessionally to compile all recommendations made by the SM sub-committee since 1979 with the purpose of assessing them for inclusion into the new IWC Database of Recommendations. This exercise consolidated all recommendations in one place and identified gaps within previous recommendations with regards to the new format of IWC recommendations. It was suggested that one way forward with the proposed review of past recommendations was to circulate the compiled information to members of the SM for classification of each recommendation as 'high priority', 'needs review', 'completed', 'no longer relevant' and 'do not know'. It was anticipated that this first cut would reveal which of the recommendations required immediate attention, so that high priority species could be explored as candidates for the forthcoming two (and four and six) year work plan. The general opinion of this Committee was that such an exercise may not be adequate as some recommendations, especially the earlier ones, would require review of the relevant committee report to allow correct allocation to the proposed categories. It was suggested that a small Intersessional Correspondence Group, to include past SM Chairs and rapporteurs, be established to better develop a detailed review process (see Annex K). Some members expressed willingness to try the database exercise and provide the resulting summary to the ICG. In later

Table 18
Summary of work plan for ecosystem modelling.

Topic	Intersessional 2020/21	2021 Annual Meeting (SC68C)
Ecosystem modelling in the Antarctic Ocean	Continue further analyses	Review results of further analyses
Multi-species distribution models (MSDM)	Intersessional Correspondence Group activity	Review progress of Working Group
Effect of long-term environmental variability on whale populations	Intersessional Correspondence Group activity	Review results of further analyses and progress of Working Group on literature review
Further development of individual-based energetic models (IBEMs)	Intersessional Correspondence Group activity	Review results of further analyses
Modelling of competition among whales and relationship between whales and prey	Continue further analyses	Review results of further analyses
Update of any exercises on krill distribution and abundance	Conduct any data analysis	Review results of analyses
Cetacean and ecosystem functioning: a gap analysis workshop	Continue analyses and hold workshop	Review result of analyses and outcomes of workshop

email discussion, there was also support for the proposed review of previous recommendations, however, some concern was raised that there might be a risk of refocusing recommendations rather than bringing them up to date and in the format of current recommendations.

Attention: SC, CC
The Committee **establishes** *an Intersessional Correspondence Group to map a process to ensure previous recommendations reach their intended target and are not 'lost'. This may require finessing the wording to meet the current standards for Scientific Committee recommendations whilst ensuring that the recommendations are neither re-written nor re-focused.*

16.1.2 Harbour porpoise (Phocoena phocoena)

SC/68B/SM/04 and SC/68B/SM/06 discuss the Iberian harbour porpoise (*Phocoena phocoena*) population with a focus on fishery bycatch.

SC/68B/SM/04 reports that this population is genetically and morphologically distinct. It is recognised by ICES as a separate Management Unit that possibly deserves subspecies status. The most recent (2016) systematic abundance estimate is approximately 2,900 animals (CV=0.32; Hammond *et al.*, 2017). This estimate has not yet been reviewed by ASI to meet consistent standards across the Committee but has been forwarded for their consideration. The authors of SC/68B/SM/04 note that recent unpublished genetic evidence suggests a sharp decline in abundance over the last 30 years. The ability of such a small population to sustain high bycatch mortality is limited. A preliminary PBR exercise undertaken at the NAMMCO/IMO Harbour Porpoise Workshop in 2018[27] concluded that a 'safe' limit on removals would be about 25 animals per year.

SC/68B/SM/06 provided an analysis of 313 stranded or bycaught animals from the region between 1990 and 2010. An annual mortality rate of 18% was estimated from age data. Depending on assumptions on how to treat animals for which cause of death was 'undiagnosed', between 4.3% and 11% of the population died annually due to bycatch (129 to 329 animals). The proportion of diagnosed bycatches among strandings increased during 2006-10 and was higher in Portugal than Galicia. Gillnets and beach seines contributed almost equally to make up about half of diagnosed bycatch deaths but the gear responsible for the remaining half could not be determined. A minimum estimate of the annual bycatch (i.e. the sum of catches with a diagnosed cause in Galicia and Portugal) varied between five and 10 in the last 5 years of the series.

SC/68B/SM/04 provided an estimate of annual bycatch mortality for Galicia and concluded that, overall, it represented between 3.1% and 6.8% (90 to 197 porpoises) of the estimated harbour porpoise population. Bycatch data from fishery monitoring were available only for Portugal and were based on observation of a very small proportion of total fishing activity. Extrapolation of official data (communicated to ICES WGBYC) suggested that approximately 380 porpoises were killed annually by a combination of purse seiners and the polyvalent fleet, with project-based observations on beach-seining adding a further 152 animals. Two interview surveys in Galicia generated annual bycatch estimates of 40 and 126 (the latter includes small numbers from other northern Spanish regions), while an interview survey in Portugal estimated 19 bycatches. The average minimum estimate of annual bycatch based on the (patchy) observer data in Portugal (2008-16) was approximately three porpoises while that from strandings in Galicia (1990-2019) was approximately two animals.

The Committee **agreed** that the best estimates suggest that bycatch mortality is unsustainably high. Introduction of Fishery Emergency Measures under the EU is justified, coupled with work on long-term solutions. These might include obligatory use of pingers on fixed nets and trials of modified fishing practices in polyvalent and beach seine nets. Effective monitoring of fishery bycatch in Iberian Peninsula waters by both Spain and Portugal is essential, including monitoring of small-scale fisheries, with a particular emphasis on gillnet and beach seines gears.

[27]*https://nammco.no/wp-content/uploads/2020/03/final-report_hpws_2018_rev2020.pdf.*

During discussion, an update of recent progress in the protection of habitat that Iberian porpoise frequent was presented by Portugal. In January 2019, a Natura 2000 site was established which affords some protection to the population. Between 2011-17, mitigation trials using pingers were conducted and showed a decline in mortality in some net types. Pingers have been provided to beach seine fisheries, however, there is no funding to monitor the impact of this mitigation on bycatch, nor indeed to document how frequently fishermen deploy pingers (see also Item 12.7).

Attention: SC

Given that the level of bycatch of Iberian harbour porpoise is considered unsustainable and will consequently cause a population-level decline, the Committee requests ICES to provide advice on fishery emergency measures for the Iberian porpoise population and looks forward to such advice being implemented.

The Committee **recommends** *the following actions and requests the Secretariat to bring them to the attention of the range states and the European Commission:*

(1) *reduce bycatch throughout Iberian Peninsula waters, using a range of approaches including protected areas, pingers and other mitigation measures;*
(2) *prioritise the transition from gillnet fisheries in the area to the use of gears with no or low levels of cetacean bycatch;*
(3) *ensure existing legal obligations are met (e.g. EU Technical Measures Regulation 2019/1241*), as a minimum;*
(4) *increase surveillance by the relevant authorities to detect illegal fishing activities which contribute to porpoise bycatch;*
(5) *coordinate mitigation actions across relevant national and regional bodies in Spain and Portugal; and*
(6) *initiate a long-term monitoring programme focused on porpoise that is designed and implemented in the Iberian Peninsula, including:*
    (a) *on-board monitoring (e.g. dedicated observers or cameras as appropriate) regardless of vessel size;*
    (b) *monitoring using fisheries inspectors on fisheries patrol vessels and on beaches;*
    (c) *ensuring that fisheries observers are also trained and mandated to recognise and record porpoise, and other marine mammal, bycatch;*
    (d) *monitoring the effectiveness of mitigation measures to reduce porpoise bycatch;*
    (e) *obtaining seasonal estimates of abundance through dedicated survey work; and*
    (f) *implementing nationally funded/coordinated programmes to monitor strandings along the Iberian Atlantic coastline;*
(7) *The Iberian porpoise is added to Appendix 1 of CMS.*

**Regulation 2019/1241 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019R1241.*

16.1.3 Vaquita

SC/68B/SM/08 reports on effort in 2019 to locate and photo-identify vaquitas in the intended 'Zero Tolerance Area' (the area where vaquitas have been consistently detected acoustically since 1996, and where the goal has been to remove any illegal net within hours of its deployment). Two surveys took place (2-6 September and 15-27 October 2019) with experienced observers aboard one of two vessels, one from the Museo de la Ballena y Ciencias del Mar and one from the Sea Shepherd Conservation Society. Methods developed to find and track vaquitas in 2017 were used, however, only four days had optimal survey conditions. Photo-ID images were obtained for two individuals, one of which was matched to an individual identified in September 2018. Seven independent sightings were made in 2019. All but one sighting included a relatively small animal that could have been a calf, and all individuals appeared healthy.

Insufficient photo-identification data were obtained to support a mark-recapture estimation of population size and thus an 'expert elicitation' was conducted of the observers. The mean number of vaquitas estimated in 2018 was 9 individuals (range: 6-19), whilst expert elicitation in 2019 estimated a mean of 9.7 individuals (range: 4-17), with at least 3 calves. This is welcome, given the continued rampant illegal gillnet fishing in the vaquita range, including within the Zero Tolerance Area.

SC/68B/SM/08 further reported that planning is under way for future opportunistic and pre-scheduled photo-identification surveys and a refined expert elicitation process. The annual systematic summer deployment of the acoustic monitoring array has been put on hold because of the extent of vandalism of the C-pods and their anchoring systems over the past year. However, acoustic monitoring will be conducted opportunistically at neap tides when fishing effort is much reduced, and as needed to support visual sighting efforts.

The Committee **welcomed** this new information that vaquitas were sighted in 2019, and especially the observation of three calves showing that the few remaining vaquitas are continuing to produce young. This alleviates concerns that reproduction may have been compromised by genetic issues due to small population size, along with the recent genomic analysis that shows low genetic diversity evenly spread through the genome, which is not characteristic of inbreeding, but rather is consistent with a population that has been small for at least a two hundred thousand years and thus could have purged deleterious alleles (P. Morin, pers. comm.). This underscores the conclusion that mortality in gillnets is still and always has been the primary factor driving this species toward extinction. Overall, the results indicate that recovery should still be possible if there is a rigorous, concerted enforcement effort to prevent illegal fishing and the use of gillnets throughout the vaquita's range

The Committee also **expresses its admiration of and gratitude to** Rojas Bracho, Jaramillo Legorreta, their teams of scientific and conservation collaborators, including co-operating fishermen, and those involved in net-removal operations, for their dedication, determination and persistence as they continue efforts to prevent the vaquita's extinction.

Attention: SC, CC, CG

The Committee yet again **expresses its disappointment and frustration** *that, despite almost three decades of repeated warnings, the vaquita population hovers at the edge of extinction caused by gillnet entanglement and ineffective fisheries management and enforcement measures in the Upper Gulf of California. Accordingly, it* **re-emphasises the grave concerns** *it has raised about the status of the vaquita over many years,* **laments** *the deteriorating social fabric of the communities with rampant illegal fisheries and lack of support for legal alternatives, and* **reiterates** *the urgent recommendations of the past four Committee meetings, especially regarding the need to remove gillnets from the species' range immediately.*

The Committee **notes***, with caution, the encouraging information that the few remaining vaquitas observed appeared healthy and are continuing to produce apparently healthy calves. This indicates that with 100 percent enforcement of the ban on gillnets within at least the Zero Tolerance Area (240 km^2) there is a realistic chance for population recovery. This guarded optimism on the Committee's part is dependent on zero bycatches and it does not change its continuing* **grave concern** *over the vaquita's plight. Therefore, the Committee* **reiterates its previous recommendation** *that the Government of Mexico fully mobilise its enforcement assets to eliminate illegal fishing in at least the Zero Tolerance Area, and* **strongly urges** *that the goal now must be to completely prevent deployment of gillnets in the vaquita habitat of the upper Gulf.*

The Committee also **urges** *the Government of Mexico to fully permit and fund the implementation of alternative fishing gears for shrimp and legal finfish to help communities address the vicious cycle of illegal fishing and provide viable, legal livelihoods that do not endanger vaquitas.*

Furthermore, the Committee **strongly recommends** *that: (i) efforts to photo-ID individuals be continued and that these efforts be supplemented to the extent feasible by the deployment of acoustic devices; and (ii) ideally, the decade-long acoustic monitoring programme be continued to the extent it is safe to do so.*

In addition, the Committee **encourages** *the vaquita science team in Mexico to continue exploring further means to collect acoustic data despite the current conditions of vandalism and personal danger. Acoustics assistance in locating vaquitas is invaluable, for documenting their continued survival and current distribution patterns, and to help visual observers aboard vessels collect photo-identification images and data.*

16.1.4 Lahille's bottlenose dolphin (Tursiops truncatus gephyreus)

SC/68B/SM/11 updated the current conservation status of the Lahille's bottlenose dolphin and summarised progress on previous Committee recommendations. Two populations are recognised, one in Argentina and the other ranging between southern Brazil and Uruguay (SB-U), that comprise five management units (MUs) (Fruet *et al.*, 2014). Previous Committee recommendations included:

(1) an update assessment of the status of the Argentine population;
(2) immediate action to reduce the level of bycatch in the southern Brazil MUs;
(3) continued monitoring and photo-identification work throughout the subspecies' range to refine survival estimates and to assess trends in abundance and the prevalence and etiology of chronic skin disease; and
(4) priority be given to future assessment of the conservation status of the subspecies.

Due to the low number of individuals for the entire subspecies and evidence of decline in parts of its range as a result of bycatch in fisheries and possibly other factors, Lahille's bottlenose dolphin was categorised as 'Vulnerable' on the IUCN Red List (Vermeulen *et al.*, 2019). Brazil and Argentina have classified the subspecies as Endangered on their respective National Red Lists. In Brazil, it is included in the National Action Plan for the Conservation of Marine Cetaceans and special regulations and a local Action Plan aimed at reducing bycatch and other threats to the Laguna MU are in place. However, there has been a lack of compliance and the enforcement actions taken against illegal fishing have been insufficient to reduce bycatch to a sustainable level. An ongoing multi-institutional study in SB-U should provide robust data on population dynamics by 2022 to support future assessments.

SC/68B/SM/10 requests the establishment of an IWC Lahille's bottlenose dolphin Task Team to initiate, guide and coordinate the implementation of conservation strategies for subpopulations in southern Brazil and Uruguay and the further investigation of causes of population declines in Argentina and Uruguay. This would include, but not be limited to, consideration, support and harmonisation with existing agreements, strategies and activities developed in other fora, and ongoing initiatives at local levels. The Task Team would bring together experts from range states and beyond to instigate targeted field investigations or conservation efforts, provide advice and assist in seeking financial support for priority activities. The Task Team would deliver regular updates on progress to the Scientific Committee.

The Committee **commended** the authors of both papers for the quality of the work presented. It was noted that the distributions of Lahille's dolphin and the franciscana overlap to some extent in some areas and that coordination of effort to strengthen fishery regulations to limit bycatch in gillnets in those areas may benefit both species. It was also noted that a better understanding is needed of the fisheries and the underlying socioeconomic factors responsible for increased fishing effort. It was emphasised that any Committee recommendations must be clearly communicated to fishing communities and enforcement authorities.

Finally, the Committee's attention was drawn to the high concentrations of contaminants such as PCBs, acknowledging that more in-depth studies are needed to support assessment of the health implications for Lahille's dolphins. Planned studies to fill some of the information gaps in regard to conservation status in Argentina have been delayed because of the ongoing pandemic.

Attention: SC, CG
Noting the continuing conservation concerns surrounding the Lahille's bottlenose dolphin, the Committee:

(1) **reiterates** *its previous recommendations for: (a) an assessment of the conservation status of the Argentina population; (b) governments to take immediate action to reduce level of bycatch particularly in the southern Brazil MUs; and (c) continued monitoring throughout its range to increase knowledge of life history parameters, assess trends in abundance and document the prevalence and aetiology of chronic skin disease;*
(2) **recommends** *that a Lahille's Dolphin Task Team is formed and* **encourages** *it to: (i) coordinate regional efforts among Argentina, Uruguay and Brazil; (ii) seek ways to work cooperatively with fishing communities and fisheries authorities to reduce bycatch; and (iii) explore potential synergies with the Franciscana CMP; and*
(3) **recommends** *that a Lahille's dolphin health assessment programme is implemented, including use of the Committee's contaminants mapping tools.*

16.1.5 Indian Ocean humpback dolphin (Sousa plumbea)

This Committee last reviewed the genus *Sousa* in 2016. The IUCN Red List categorises all of the four currently recognised species of *Sousa* as threatened (Jefferson *et al.*, 2017). SC/68B/SM/05 discusses a new initiative focused on the Indian Ocean humpback dolphin (*Sousa plumbea*). The genus is not included in any of the currently available automated photo-ID matching software platforms and it is likely that new algorithms will be required if this genus is to be included in the future. In 2020, a collaboration between more than 35 researchers from seven countries (South Africa, Madagascar, Tanzania, Kenya, UAE, Iran and India) in the Western Indian Ocean was initiated to address this issue for *Sousa plumbea.* At the time of writing, more than 1,200 photos, comprising some 273 individuals, have been contributed to a training dataset. Flukebook (this report, see Item 20.2.2) and finFindR are developing matching algorithms and plans are underway to test these as well as develop a comprehensive plan for matching catalogues throughout the species range. It is hoped that any resulting algorithms will also work on the three other species of *Sousa*, and that ultimately these will help to answer questions regarding movement patterns, home range, etc., for these threatened species. The Committee **welcomes** efforts to develop an automated photo-ID matching package.

The Committee **recognises** that all four species of humpback dolphins (*Sousa* spp.) are threatened due to their extreme coastal distribution, and acknowledges the critical role of individual recognition for better understanding cetacean movement, distribution and abundance, and notes these data are also useful for developing, implementing, and monitoring effective conservation measures. The Committee therefore welcomes this initiative and congratulates the collaborators on progress to date.

Attention: SC
The Committee **recommends:**

(1) *continued collaboration between regional cetacean research consortia and individual researchers in the western Indian Ocean and Arabian Seas to facilitate the development of matching algorithms for Sousa plumbea in Flukebook;*
(2) *continuing collaborative efforts to match catalogues of Sousa plumbea from throughout the range of the species to answer important conservation questions about movements, home range and distribution, and*
(3) *testing of the newly developed Sousa plumbea algorithms on photographs of additional Sousa species for possible inclusion in the Flukebook platform.*

Furthermore, the Committee **encourages** *funding agencies and individuals to provide support for development of the image catalogue and matching software as well as for testing of final algorithms.*

16.1.6 Atlantic humpback dolphin (Sousa teuszii)

Although the conservation status of the critically endangered Atlantic humpback dolphin (*Sousa teuszii*) has been of increasing concern for two decades (SC/68B/SM/07), little progress has been made towards improving this status. A Concerted Action (CA) for the species was adopted by the Convention on Migratory Species (CMS) in 2017 and renewed in 2020, but implementation has stalled thus far due to a lack of funding. A Workshop on *Ex Situ* Options for Cetacean Conservation was held in late 2018 that also included discussion of the Atlantic humpback dolphin with recommended actions to improve conservation status (Taylor *et al.*, 2020). An IWC Africa-Focused *Sousa* Task Team was established in early 2020, with the purpose of reviewing previous IWC recommendations for *S. teuszii* and *S. plumbea* and providing a framework for the Committee to move recommendations forward. The various initiatives overlap in scope, and the authors of SC/68B/SM/07 suggest that wherever possible, co-ordination should be sought to maximise efficiency. The paper further highlights two priority targets that would benefit from immediate funding and could be achieved within a short period, namely: (1) supporting implementation of the CMS CA; and (2) beginning to address knowledge gaps with a *S. teuszii* field survey in Senegal/Gambia, considered a *S. teuszii* stronghold. The latter could be used to establish a standardised and comprehensive framework for assessments elsewhere in the species' range.

For many reasons, representatives from range states have had few opportunities in the past to participate meaningfully, and in a sustained manner, in the Committee's work; however, the Africa-Focused *Sousa* Task Team (see Item 16.3.2) includes members from 14 African countries so it is hoped that future engagement will be better facilitated. Nonetheless it is difficult to see how the Committee can contribute to efforts to save Atlantic humpback dolphins without more direct and regular engagement with institutions and individuals in the range states (Angola to Mauritania). During the brief on-line discussion of SC/68B/SM/07, the importance of local ecological knowledge in helping to identify areas for focussed research and threat mitigation was emphasised.

Attention: SC, G, S

Recognising that the Atlantic humpback dolphin (Sousa teuszii) is listed as Critically Endangered on the IUCN Red List, the Committee ***commends*** *efforts by a consortium of S. teuszii researchers and others for attempting to 'reinvigorate' conservation efforts and provide a set of prioritised targets, many of which echo previous recommendations by this Committee and other bodies.*

The Committee therefore ***welcomes*** *and* ***supports****, in principle, the approach proposed in SC/68B/SM/07 and* ***recommends*** *that the two highest-priority short-term actions: (1) assistance/collaboration in implementing the CMS Concerted Action for Atlantic Humpback Dolphins (with a sense of urgency); and (2) carrying out a field survey in Senegal/Gambia led by an experienced local team of conservation scientists, are pursued without delay.*

16.1.7 Asian freshwater cetaceans (Platanista gangetica, Neophocaena asiaeorientalis asiaeorientalis, Orcaella brevirostris)

In 2017, the Committee reviewed the small cetaceans that inhabit rivers, estuaries and restricted coastal habitats of Asia (IWC, 2018h). As a result, the South Asian River Dolphin Task Team (focusing on both subspecies of *Platanista gangetica*) was formed, the first report of which was presented to this meeting (SC/68B/REP/04; see Item 16.3.1). Previously, the Committee expressed its grave concern over all three species that occur within Asian freshwater habitats (*Platanista gangetica*, *Orcaella brevirostris* and *Neophocaena asiaeorientalis asiaorientalis*) and requested that updates on the status of these genera be provided when available. SC/68B/CMP/10 provides an update on several Asian freshwater cetacean populations and it is clear that all three genera are still subject to multiple threats and that further, more coordinated action is required throughout their range as a matter of priority. The idea of an Asian Freshwater Cetacean CMP was presented, and the Committee concluded that more detailed discussions should be initiated intersessionally and presented to the appropriate sub-committee(s) at SC68C.

Attention: SC, C, CG

The Committee ***reiterates*** *its previous grave concerns for Platanista gangetica, Orcaella brevirostris (freshwater populations) and Neophocaena asiaeorientalis asiaeorientalis. The Committee* ***agrees*** *that:*

(1) *these species remain on its agenda as priority species;*
(2) *potential mechanisms to coordinate research and management actions should be explored intersessionally and discussed in detail at SC68C;*
(3) *range states should strive to coordinate research and management actions across the species' ranges, whenever appropriate; and*
(4) *these species should be discussed as possible candidates for a CMP at SC68C.*

16.1.8 Amazon River dolphin

16.1.8.1 An Update on the Piracatinga (*Calophysus Macropterus*) Fishery and its Impact on River Dolphin Conservation

SC/68B/SM/01 provides an update on the use of river dolphins as bait in the piracatinga fishery in the Amazon and Orinoco regions. The fishery for this small (maximum length 40cm) catfish species followed declines in larger species from overfishing. The fishery first developed in Brazil, where caiman and Amazon river dolphin (*Inia geoffrensis*) meat was used to bait traps for the fish, which were primarily exported to Colombia (Brum *et al.*, 2015). The practice has since expanded into Bolivia, Colombia, Ecuador, Peru and Venezuela. The five-year moratorium established in Brazil for the fishery and the piracatinga trade ended in January 2020 and has not yet been reinstated, although actions are being considered to ensure its renewal[28]. Commercial sale of piracatinga was banned in Colombia in 2017 on the basis of high mercury levels in the fish, however, since the moratorium ended, the increased import of this species from Brazil has been noted. At this time, there is no other legislation banning this fishery or the trade of this fish. Monitoring of such a large region is challenging and limited border controls allow both legal and illegal trade to occur, essentially, unregulated. The authors state that integrated fisheries management plans are required to regulate fisheries for different species and that both national and regional regulations are required if effective control of any fishery is to be achieved.

The Committee **commends** the diverse and multinational authorship of SC/68B/SM/01 and the significant cross border collaboration it represents. There was strong support for a collaborative research effort to assess *Inia* (as well as *Sotalia fluviatilis*) abundance and trends, connectivity, movements, habitat use and taxonomy, and to evaluate the impacts of threats (bycatch, deliberate killing for bait, pollution, loss of connectivity). Results of such research can inform public awareness campaigns and decision-making.

Given the myriad of issues that continue to threaten South American river dolphins, the Committee **expresses serious concern** that if decisive action is not taken promptly, these species may follow the same fate as the baiji and vaquita. In addition to national policies, the Committee **draws attention to** the need for regional approaches for coordinated common actions and fisheries management plans.

Attention: SC, CC, CG, S

The Committee **reiterates its previous recommendation** *that a regionally co-ordinated fisheries management plan for the Amazon River basin and a regional strategy for the conservation of river dolphins are established urgently. Further, the Committee* **recommends** *that;*

(1) *alternative sources of income for local communities are developed in areas where the use of dolphins as bait in the piracatinga fishery is prevalent;*
(2) *research efforts are enhanced in areas where threats have been highlighted;*
(3) *enforcement regulations and actions throughout the piracatinga fishing areas are enacted and promoted;*
(4) *cross-border controls are promoted among Peru, Colombia and Brazil to prevent illegal trade in piracatinga; and*
(5) *use of alternative baits (e.g. slaughterhouse or pirarucu fishery waste products) is promoted and encouraged for the piracatinga fishery.*

Given continued concern over the use of dolphins as bait in the piracatinga fishery, the Committee **recommends** *that:*

(1) *the Government of Brazil* **reinstate for another five years** *the moratorium on piracatinga fishing to allow sufficient time to evaluate the effectiveness of protective measures, maintain and enhance the necessary protection of river dolphins and provides a report to the Committee on this matter at the next Committee meeting; and*
(2) *the Commission instructs the IWC Executive Secretary to send a letter drafted by the Chair of the Scientific Committee to the South American members of the IWC 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.*

16.1.8.2 Amazon River Dolphin in the Mamirauá Sustainable Development Reserve 2017-19

SC/68B/SM/09 presented preliminary results of a monitoring programme for Amazon river dolphins using strip-transect methods from a small boat in three small segments of the Mamirauá Reserve in the western Brazilian Amazon, from 2017 to 2019. Fishing gear along the transects was recorded and the high number of monofilament nets noted suggested that the risk of dolphin bycatch is high. No significant trend in densities of *Inia* or *Sotalia fluviatilis* was found over this period, during which the ban on piracatinga fishing was in force, although the power to detect a trend was low. The authors highlighted the additional analytical steps that will be undertaken as the research progresses.

[28]Editorial note: On 15 June 2020, it was decreed that a new, one-year moratorium on the piracatinga fisheries and trade would come into effect on 1 July 2020 (*http://www.in.gov.br/web/dou/-/instrucao-normativa-n-17-de-10-de-junho-de-2020-261498117*). This falls short of the five-year moratorium recommended by this Committee.

Attention: SC; CG
The Committee **notes** *concern over the high number of monofilament nets recorded in the dolphins' habitat. The Committee* **requests** *that updates on the Amazon River dolphin populations of the Mamirauá Sustainable Development Reserve be provided when available.*

16.2 Poorly documented hunts of small cetaceans for food, bait or cash and changing patterns of use including summary of workshops and databases

The Committee has prioritised the need to better document the take of small cetaceans for consumptive and non-consumptive purposes. The products from small cetaceans are referred to as 'aquatic wildmeat' and 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.'* (CMS, 2017; IWC, 2019m).

16.2.1 Aquatic Wildmeat Workshop Review

In 2015 (IWC, 2016c), the Committee established an Intersessional Correspondence Group tasked with developing a toolbox of techniques to guide and co-ordinate research into this topic, at both regional and global levels. A series of Workshops were funded by the Government of the Netherlands, which aimed to gather existing information on this issue from three continents: Asia, South America and Africa. Various methods used to gather existing data were discussed within the group and potential new tools identified, e.g. standardised questionnaire surveys, smartphone applications, forensic testing kits. The potential for analysing data at regional and global scales was discussed.

The first Workshop took place in Thailand in 2016, covering South East Asia (and combined with the first IWC Large Whale Entanglement Training Programme in Asia). A second Workshop focussed on South America and included analysis of the use of Amazon dolphins as bait in the piracatinga fishery, was held in Brazil in 2018. The final Workshop in this series focussed on western Africa and was held in Nairobi, Kenya in 2019. The Workshop series aimed to:

(1) identify threats, past and present, with respect to wildmeat, and discuss which techniques can be used to better understand wildmeat issues,
(2) gain a better understanding of the magnitude of small cetacean use as aquatic wildmeat, both nationally and regionally in the three continents, and determine how aquatic wildmeat is usually acquired; and
(3) increase co-ordination and co-operation among countries as well as unify efforts with the Aquatic Wild Meat Working Group of the Convention on Migratory Species (CMS) which also works on wildmeat issues.

The first Workshop in 2017 in Thailand had participants from Thailand, Malaysia, Vietnam, Taiwan China, Myanmar, Sri Lanka, Bangladesh, Cambodia, China and India, as well as experts on tools that may be useful to better document or collate data on aquatic wildmeat. The topic was not an active research topic in Asia at the time and thus an explanation was provided to regional research groups and government agencies with a focus on the potential negative implications for small coastal populations of small cetaceans. Terminology was defined and translated into the common working languages of each country. Information was collated from ecological research, strandings programmes, social studies and, in particular, online media applications. Various 'tools were discussed including the use of community interviews, e.g. how to build a regional framework for data collection that incorporates both fisheries and bycatch elements; forensic methods, e.g. use of instant DNA testing to identify marine mammal meat in markets; extraction of information from existing databases to assess regional patterns, hotspots or trends; and mobile applications to facilitate data collection. Zoonotics was also discussed, especially with regards to disease transmission through the handling and consumption of wild animals. Since the Workshop, the IWC Small Cetacean Voluntary Fund provided a grant to investigate the usefulness of tabulating social media information and to test a regional data collection framework. The Workshop participants populated a database from which regional patterns were mapped. Areas identified as being of particular conservation concern were in Bangladesh, China, India, Indonesia, Japan, Malaysia, South Korea, Sri Lanka and Taiwan.

The Workshop in Brazil (IWC, 2019m) elicited summaries of information from all South American countries except Guyana and Suriname. Products from small cetaceans are used as aquatic wildmeat throughout the region. Tools and techniques for data gathering, including forensic investigation, were discussed. A database of more than 3000 references was used to map existing knowledge and identify data gaps and a framework was established to standardise future data collection. Workshop participants populated a database from which regional patterns were mapped. Areas of concern were highlighted for Bolivia, Brazil, Colombia, Costa Rica, Ecuador, Peru and Venezuela. The use of river dolphins as bait in the piracatinga fishery (see Item 16.1.8.1 above) was reviewed. All range countries of *Inia* and *Sotalia fluviatilis* have laws in place to protect dolphins and prohibit intentional killing. Fishing for piracatinga in Brazil was banned at the time of the Workshop, and trade in piracatinga products was prohibited in Colombia. The practice of using dolphins as bait had recently expanded into Peru, Bolivia and Venezuela, following the restrictions in Brazil. No other range state had taken specific legislative or regulatory action in response to the emergence of this practice beyond the general protection of river dolphins. The Workshop concluded that some species and populations required urgent attention due to both the extent of their use as wildmeat and other threats.

The final Workshop (IWC, 2020h, p.231) focused on western Africa, with information from Benin, Cameroon, Ghana, Republic of Guinea, Mauritania, Nigeria, Senegal and Togo. The focus was on: (i) species of cetaceans perceived to be most at risk; (ii) other threats faced by these species; and (iii) the availability of relevant data. The challenges of gathering data in remote and often challenging environments were highlighted. In general, information was scarce and, in many countries, collected decades ago. Consumption of cetaceans (either bycatch, stranding or deliberate killing) was reported in all countries. It was unusual for coastal communities to consume aquatic wildmeat themselves, but meat obtained from marine mammals was not wasted and was smoked or cured and distributed via the same marketing channels as terrestrial wildmeat to the interior of the continent. In Africa, all wildmeat is referred to as 'bushmeat' when its primary purpose is for human consumption. Areas identified as being of particular conservation concern were Cameroon, Gambia, Ghana, Guinea Bissau, Republic of Guinea, Mauritania, Nigeria and Senegal. The Workshop expressed extreme concern over the conservation status of the Atlantic humpback dolphin (*S. teuszii*).

Attention: SC, ICG
The Committee **draws attention** *to the new information gathered by the Aquatic Wildmeat Workshop series and that several small cetacean species and/or populations are being negatively impacted in Asia, South America, and West Africa. The Workshop series highlighted that in some areas where wildmeat was once supplied from incidental takes, it is now being obtained from targeted hunting and a commercial trade has developed.*

The Committee therefore **recommends** *that the work of the ICG continue intersessionally to synthesise the findings and recommendations of the three workshops and recent research and provide a report to SC68C.*

16.3 Small Cetacean Task Teams

16.3.1 Progress on South Asian River Dolphin (Platanista gangetica) Task Team

The threats to South Asian river dolphins (*Platanista gangetica*, both subspecies) are myriad. Alteration, degradation and loss of habitat affects the entire range of the species across all four range states. The South Asian River Dolphin Task Team (SAR-TT) was formed in 2017 (IWC, 2018h) to assess emerging issues from across the range of *Platanista gangetica*. The IWC creates task teams to provide timely advice on situations where populations of cetaceans are known or suspected to be in danger of significant decline. In July 2019, a Workshop was convened in Kuala Lumpur, Malaysia, that included Committee members and South Asian river dolphin experts and managers from each range state; Bangladesh, India, Nepal and Pakistan (SC/68B/REP/04). The Workshop aimed to:

(1) detail information gaps and list research priorities for *Platanista* populations;
(2) identify research projects that require coordinated effort and sharing of expertise;
(3) initiate the development of a trans-national plan for coordinated research efforts; and
(4) identify key threats across the entire range of the species and any region- or country-specific threats.

The Workshop recognised the importance of communicating the results of the Workshop to government agencies and other bodies concerned with wildlife conservation in freshwater systems (rivers and lakes).

The taxonomy of the species was reviewed. Two independent lines of evidence, morphological and mtDNA, strongly suggest that the two subspecies should be elevated to species status.

The Workshop also found that a substantial part of these dolphins' habitat (>80%) had been altered by river flow regulation or construction. Across all countries, mortality as a result of bycatch was the second major threat, following habitat fragmentation and degradation.

Five themes were discussed in detail: dams, hydro-climatic change and water availability; population surveys and ecological modelling; dolphin bycatch; other types of interactions with fisheries; and human use of the animals (aquatic wildmeat), all with the goal of identifying practical conservation solutions and emerging issues.

16.3.1.1 Recommendations

Following the deliberations of this Workshop, the South Asian River Dolphin Task Team recommended that:

(1) by 2022, all range states identify key sections of national habitat that should be surveyed every five years, so that population trends can be monitored (methodology should be replicated in each identified habitat but need not be standardised throughout the range, as different habitats require different methodological adaptations)[29];

[29]This recommendation was targeted at:
Pakistan: WWF Pakistan (co-ordinator), Punjab Wildlife Department, Sindh Wildlife Department and KPK Wildlife Department.
Nepal: Department of National Parks and Wildlife Conservation, Department of Forest and Soil Conservation, WWF Nepal, Institute of Forestry Pokhara and Hetauda Campus, University of Tribhuvan (co-ordinated by Shambhu Paudel and Usha Thakuri).
Bangladesh: Forestry Department and WCS India: India's Conservation Action Plan for Ganges dolphins, State Forest Departments.
India: already a recommendation in India's Conservation Action Plan for Ganges dolphins and should be co-ordinated through State Forest Departments.

(2) all existing survey methods in use for population estimation are reviewed, and a decision system prepared to guide monitoring agencies and conservationists to identify and implement statistically robust and optimal survey methods based on river conditions and available survey resources;
(3) starting from 2020, surveys to establish population size are initiated as early as possible in the Padma, Jamuna and Meghna mainstems and tributary networks (excluding the Bangladesh Sundarbans), Bangladesh and the Budhi Gandak, Baghmati, Rapti and Mahananda, India;
(4) the review of *Platanista* taxonomy is completed and published;
(5) as a priority, studies are conducted to better understand movements of dolphins across barrages in all countries and the extent of population connectivity and impacts on dolphin populations in fragmented riverine habitats are quantified;
(6) pingers are assessed as an effective tool, both to minimise bycatch and to reduce the risk of dolphins becoming stranded in canals;
(7) a feasibility study is conducted to assess areas and methods to translocate Indus River dolphins (WWF-Pakistan) and to adapt existing marine mammal translocation initiatives specifically for river dolphins (co-ordinated by the Society for Marine Mammalogy and IUCN);
(8) as a priority and with data currently available, the level of dolphin bycatch throughout the species' range is assessed and its impact on local populations evaluated, so that from the outcomes of this assessment, recommendations are provided for future monitoring and actions to mitigate impacts, ranging from technical changes to the revision of fisheries policies; and
(9) assessment is undertaken of the extent of targeted take and the use of dolphins for oil or fishbait (aquatic wildmeat), particularly in India and Bangladesh, by involving social and ecological scientists, as part of co-ordinated survey actions listed above.

16.3.1.2 Work Plan

Task Team members agreed to start working towards fulfilling these recommendations through compiling data sets, taking forward ideas for joint and collaborative work, and planning additional workshops to fill the identified information gaps and research needs for each country.

In discussion, it was noted that the report recommendations mainly identified further research needs. The management of protected areas and the strengthening of fisheries legislation should also be reviewed and considered for future recommendations. In terms of how best to move forward with the SAR-TT itself, the inclusion of interdisciplinary experts and the merits of top-down, bottom-up management were noted.

It was clear from discussion that the Workshop, as the first action of the SAR-TT, was well received and that the team should continue its work intersessionally and consider the suggestions brought up in discussion, including developing a detailed work plan.

The Committee **congratulates** the South Asian River Dolphin Task Team on this excellent start to its work and **endorses** the Workshop report recommendations as provided in SC/68B/REP/04.

Attention: SC, S
The Committee **requests** *that:*

(1) *the Secretariat make the South Asian River Dolphin Task Team report available to the CMS Concerted Action on Asian River Dolphins;*
(2) *the Task Team considers the suggestions made in discussion and expands the group's membership and scope, as necessary, to continue and make its work more effective, including developing a detailed work plan; and*
(3) *the Task Team report on progress to the Task Team Steering Committee intersessionally and to this Committee at SC68C.*

16.3.2 Progress on Africa-focused Sousa Task Team

Given that high-priority areas and populations of *Sousa* in Africa have been identified previously by this Committee, an Africa-focused Sousa Task Team (AFS-TT) was established to develop a comprehensive framework of conservation actions to facilitate and co-ordinate Committee recommendations. In 2019, an email discussion group comprising researchers from Africa, the Task Team Steering Committee and the IWC Head of Science was established and a list of potential AFS-TT participants was compiled. The Secretariat formally invited all identified participants and the AFS-TT now comprises 35 members from 14 African countries. The first online meeting of the AFS-TT was held immediately prior to SC68B. Due to the large number of participants, and the size of the region that the team is tasked to cover, the AFS-TT is currently developing a process for carrying out its work efficiently. The AFS-TT will be divided into three working groups focusing on: (1) *Sousa teuszii*; (2) *Sousa plumbea*; and (3) bycatch. AFS-TT members are invited to participate in any of these working groups.

The Committee **recognises** that the work of the AFS-TT is particularly challenging, given the gravity of the threats that the two *Sousa* species face in Africa. The Committee **thanks** the AFS-TT for its progress to date.

Attention: SC
The Committee **encourages** *members of the Africa-focused Sousa Task Team to:*

(1) *identify a convener or conveners (these could be rotating positions); and*
(2) *consult with the Task Team Steering Committee on a regular basis intersessionally and to report on progress at SC68C.*

16.4 Review of intersessional workshops on *Sotalia guianensis*

The effects of bycatch, directed hunts, and habitat destruction on the river and estuarine dolphins of South America has been of great concern to the Committee for many years and the Committee identified the Guiana dolphin (*Sotalia guianensis*) as a priority species for evaluation of its conservation status in 2018 (IWC, 2019j). To facilitate this, an intersessional process to review current knowledge on the Guiana dolphin was proposed that included two Workshops.

The first Workshop was held in October 2018 in Lima, Peru where an inventory of known research activities/scientists involved in studies on Guiana dolphins was compiled and a participative strategy to compile existing knowledge on the Guiana dolphin developed. Following the Workshop, 35 experts responded to an online questionnaire which included a request to prioritise the locations and the scientific research needs most urgent to inform conservation actions.

The second Workshop was held in Brazil in 2019 with two objectives: (1) gather and analyse information on distribution and population structure, abundance and trends collected by the online questionnaire survey; and (2) compile available information under various population, biological and ecological parameters, as well as threats, for the entire species' distribution, and as delineated by the twelve proposed *Sotalia guianensis* management units (MUs; see SC/68B/SDDNA/06). The 15 participants broadly outlined the conservation and research needs on a region-by-region basis. The Workshop report (SC/68B/REP/05) presents preliminary information on research priorities and recommendations, management and conservation issues.

The Committee **notes** the planned intersessional work on the Action Plan proposed in the Workshop report which includes: (1) prioritisation of the recommendations, with implementation timelines, outlined in the report; and (2) consolidation of information on distribution, abundance, threats and population distinctiveness from Costa Rica, Nicaragua, Panama, Guiana, Suriname, Trinidad and Tobago and areas of Venezuela and Brazil.

The Committee **commends** those involved in the 2018 and 2019 *Sotalia guianensis* Workshops for their work and **endorses** the recommendations within the report (SC/68B/REP/05).

Attention: SC, G, CG-R
The Committee:

(1) **encourages** *the Workshop Steering Group to consult with the IWC's Bycatch Mitigation Initiative intersessionally for advice on implementing the report work plan;*
(2) **agrees** *that the highest priority for the Steering Group should be identification of actions that Governments can implement quickly, particularly with regards to fisheries regulations and bycatch reduction measures, noting the extreme vulnerability of this species to entanglement;*
(3) **notes** *the joint SDDNA/SM Intersessional Correspondence Group (ICG) established to review genetic and other evidence pertaining to population structure in this species and to provide advice on the management unit delineations proposed at the Sotalia guianensis Workshops (SC/68B/SDDNA/06) and* **encourages** *the ICG to provide a summary of that evidence and advice at SC68C; and*
(4) **encourages** *the provision of funding to support genomic analyses to adequately define management units (MU) throughout the species range; and*
(5) **requests** *that a progress report be submitted to SC68C.*

Further, the Committee **notes** *that Sotalia guianensis occurs in several countries with significant knowledge gaps in some regions and the uncertainties over population division will take some time to resolve. Given that the known populations are restricted in range, fragmented, and subject to multiple threats, even without additional scientific work the Committee is* **concerned** *that some populations are in immediate danger.*

The Committee therefore:

(1) **recommends** *that actions are urgently and immediately implemented to reduce bycatch of Sotalia guianensis throughout its range and in particular highlights the need for actions/initiatives to reduce the cumulative impacts and threats/pressures on:*
    (a) *the population from Guanabara Bay, as this population is declining and facing severe threats (as detailed in SC/68B/REP/05); and*
    (b) *similar vulnerable populations found in estuaries and bays along the south and southeast of Brazil; and*
(2) **reiterates** *its previous concerns for the species in Lake Maracaibo, Venezuela, where both directed takes and oil pollution are thought to be having serious population level impacts and* **stresses** *the need for all (including NGOs researchers and authorities) to focus on documenting the threats and working with local communities to mitigate the impacts.*

Table 19

One-year work plan for Small Cetacean (SM) sub-committee.

Topic	Intersessional 2020/21	2021 Annual Meeting (SC68C)
Franciscana Review (ICG)	ICG to co-ordinate outcomes of CMP across sub-committees.	Report progress
Poorly Documented Takes of Small Cetaceans (ICG)	ICG to synthesis results of past IWC workshops and recommendations and develop a framework for future work.	Report progress
Recommendation Review (ICG)	ICG to review SM recommendations (1979-2017).	Report progress
Sotalia guianensis (ICG)	ICG to continue review of genus *Sotalia guianensis* (continuation of SG-25).	Report progress
Small Cetacean Task Team Steering Committee (AG)	Provide ongoing advice and support to the South Asian River Dolphin Task Team, the Africa Focused Sousa Task Team and the Lahille's Dolphin Task Team; conduct a review of Task Team procedures.	Report progress
South Asian River Dolphin Task Team	Implement the work plan identified in 2019 workshop: work towards fulfilling workshop recommendations through compiling data sets, taking forward ideas for joint and collaborative work, and planning workshops aimed at identifying information gaps and research needs for each country and report progress to the Task Team Steering Committee at regular intervals.	Report progress
Africa Focused *Sousa* Task Team	Develop a framework of conservation actions to inform the SC and report progress to the Task Team Steering Committee at regular intervals.	Report progress
Lahille's Dolphin Task Team	TBC	Report progress
Sotalia guianensis Stock Structure Joint SDDNA (ICG)	Review genetic and other evidence pertaining to population structure in *Sotalia guianensis*; and provide advice on the management unit delineations proposed at SC68B.	Report progress

16.5 Review of direct takes and live captures of small cetaceans

16.5.1 New information on directed catches

SC/68B/O/02 noted that a scientific progress report on small cetaceans from Japan is available online[30]. The online tables summarise data on small cetacean fisheries in the calendar year 2018, as well as research conducted from April 2018 to March 2019 by the National Research Institute of Far Seas Fisheries and the fisheries agencies of the Ministry of Agriculture, Forestry and Fisheries of the Government of Japan. Direct catches of small cetaceans are reported by prefecture and type of fisheries. Catch statistics for Japan cover catches in the calendar year (as for IWC National Progress reports), while catch quotas for small cetacean fisheries are set seasonally in Japan. 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 online report presented a correction for the Dall's porpoise (*dalli* type) takes for the calendar year 2017.

A review of information provided in previous reports of this Committee was conducted with the assistance of the Statistical Department of the IWC Secretariat and researchers from the National Research Institute of Far Seas Fisheries, Japan Fisheries Research and Education Agency. Explanatory text is added to the tables in Annex J in order to facilitate its interpretation and future updating. The tables herein should be used as the correct version in future updates.

The Committee **notes** its great appreciation for all who compiled and reviewed data to update this and previous years information on directed takes.

Attention: SC

As there was little time to discuss the revised direct catches tables or to develop a framework for moving forward with these data, the Committee ***agrees*** *that the issue will be allocated sufficient discussion time at SC68C.*

16.6 Status of the voluntary fund for small cetacean conservation research

16.6.1 Expenditures and status of the Small Cetaceans Fund

The Voluntary Fund for Small Cetacean Conservation Research currently totals £71,413.00 (SC/68B/O/06: Annex B). There has been no net expenditure in 2020.

All previously funded projects have now been completed and will be reviewed by the Small Cetacean Fund Committee intersessionally. All final reports will be presented at SC68C and posted on the IWC website in due course (*https://iwc.int/sm_fund*).

16.6.2 Progress on a new approach for targeted allocation of the Small Cetaceans Fund

An update on the small cetacean fund was presented at SC68A where the Committee **agreed** to develop a process that is more strategic and targeted to utilise available funds more immediately. The Secretariat's Head of Finance and HR and the Convenors of SM have drafted a strategy to direct the funding in a transparent and consistent manner. This strategy will be presented to the Finance and Administration Committee for review at IWC68. Any new or changed procedures will be reported at SC68C.

[30]*http://www.jfa.maff.go.jp/j/whale/attach/pdf/research-4.pdf.*

16.7 Possible cetacean extinctions
The issue was raised about potential extinctions of cetacean species/populations and the Committee's/Commission's response to such events. As preventing extinctions is a core mission of the IWC, a proposal was forwarded to prepare a short document that provides a template enabling a timely announcement of an extinction. Based on the positive response of SC members, the proposal was expanded to include an IWC website-tailored text that focuses more generally on the topic of extinctions and cetaceans. An Intersessional Correspondence Group was formed under Stachowitsch, and a Secretariat-hosted Zoom meeting for interested participants to advance this initiative was scheduled to take place after the SC68B meeting.

16.8 Work plan
See Table 19 for the work plan for small cetaceans.

17. WHALE WATCHING

17.1 Assess the impacts of whale watching and swim-with-whale operations on cetaceans
17.1.1 Studies on assessing impacts, (i) short-term, (ii) mid- to long-term, (iii) swim-with operations, (iv) emerging areas of concern.

The Committee has considered the issue of assessing the impacts of whale watching, particularly for baleen whales, for some time, and has encouraged submissions on this topic. It was pleased to receive a paper concerning the potential impact of whale watching operations on the survival and reproductive output of Eastern North Pacific blue whales (SC/68B/WW/01). Results from the model used in this study suggested that disturbance from whale watching vessels is likely to primarily affect female reproduction, while individual survival appears to be more robust to disturbances. The Committee noted the importance of clearly distinguishing between model assumptions that are specific to the species, population and spatio-temporal scale under consideration, and those that are general statements about cetaceans more broadly. There is a particular need for precautionary language in such papers and reports when they contain general statements about cetaceans, in order to better facilitate the appropriate use of modelling exercises in management and minimise potential misunderstandings by managers and others regarding a model's assumptions.

The Committee **welcomes** the development of a model for assessing impacts of whale watching operations on baleen whales.

Attention: SC
The Committee **encourages** *the continuation of work on modelling the impact of whale watching operations, given its ability to provide guidance and input to management under the precautionary approach, but recognises that in order to inform management directly, exposure rates and responses would need to be measured in the field.*

The Committee has regularly received updates on the development of a Welfare Assessment Tool for Wild Cetaceans (WATWC), which has now been published (Nicol *et al.*, 2020). The WATWC makes use of the 'Five Domains' model of animal welfare to ensure that all areas of potential welfare impact are considered and Nicol *et al.* (2020) used it to assess real-world impacts of human activity, particularly whale watching, on Southern Resident killer whales. The Committee **welcomed** the publication of Nicol *et al.* (2020), **commended** the authors and was pleased to see that the collaboration initiated within its membership had been fruitful in this regard.

Attention: SC
The Committee **encourages** *further development and testing of the Welfare Assessment Tool for Wild Cetaceans (Nicol et al., 2020), noting that whale watching might provide further examples to be considered.*

The Committee welcomed the information that Parsons continues to work on the annual review of whale watching literature, which will be made available for the IWC's Whale Watching Handbook; more detailed discussion of the review was deferred to SC68C.

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

The Modelling and Assessment of Whale Watching Impacts (MAWI) has been on the Committee's agenda for several years, and a third and final MAWI Workshop was intended to be held intersessionally just before the International Statistical Ecology Conference in June 2020 in Sydney, Australia. Due to the global pandemic, the Workshop could not be held, so a questionnaire is being developed that can be distributed to a wide number of relevant experts, with a Workshop to follow if deemed necessary (see SC/68B/WW/02). Several Committee members offered input on the questionnaire during SC68B. The planning for the questionnaire and potential workshop is ongoing under the guidance of New.

17.2 Finalise IWC's General Principles for Whale Watching
Last year, the Committee recommended the approval and adoption of the revised General Principles for Whale Watching (IWC, 2020i, pp.258-59). The Committee recognises that there may be a formal delay in adoption by the Commission due

to the postponement of the 2020 Commission meeting to 2021 due to the global COVID-19 pandemic. It notes that once the revised principles are approved by the Commission, they will be uploaded to the IWC website.

Attention: C, CC, S, SC
As last year, the Committee **draws the attention** *of the Commission, the Conservation Committee and the Secretariat to the need to update the IWC General Principles for Whale Watching, as they have not been updated since 1996. It* **reiterates** *its recommendation for the approval and adoption of the revised general principles (IWC, 2020i, pp.258-59) at IWC68 in 2021 or earlier by intersessional correspondence if possible.*

17.3 Progress with regional reviews of whale watching

In January 2020, the Government of Timor-Leste invited the IWC (via the Convenors of the SM and WW sub-committees) to visit the country to provide guidance on draft whale watching guidelines that have been developed by the Assosiasaun Turizmu Maritima Timor-Leste (the Marine Tourism Association of Timor-Leste). The two Convenors were invited to attend a meeting with the relevant government departments in March 2020; however, this meeting was postponed due to COVID-19 travel restrictions. It is anticipated that this meeting will go ahead in 2021 and that the outcome of this meeting and draft guidelines for Timor-Leste will be presented at SC68C. Concern was raised regarding the growing number of foreign whale watch operators in Timor-Leste's territorial waters, particularly given reports from ATM-TL of unsafe practices, such as tandem vessels 'leap-frogging' mother and calf pairs for extended periods, and the conduct of swim-with-whale activities.

Attention: CG, SC
The Committee **supports** *the Government of Timor-Leste in their pursuit of sustainable marine tourism and* **encourages** *continued communication with them regarding whale watching guidelines. It* **draws attention to** *reports of rapidly increasing numbers of foreign operators who are violating best principles for whale watching as developed by the IWC and anticipates further updates on this issue at SC68C. The Committee* **agrees** *to establish an Intersessional Correspondence Group to address the outcomes of the scheduled meeting in 2021 between the Government of Timor-Leste and Committee members and to draft comments on the Timor-Leste draft guidelines for whale watching.*

17.3.1 Sri Lanka

Parsons reported that data on Sri Lanka's whale watching situation are available and analysed, ready to present to the Committee, but final approvals for the data's release are pending. He noted that compliance with regulations and regulatory enforcement efforts are both low. It is hoped that a paper will be presented at SC68C.

17.3.2 Latin America

Whale watching has the potential to have substantial positive economic impacts on the regions in which it is occurring, as demonstrated in Peru (Guidino *et al.*, 2020), but requires guidelines and regulations to ensure its sustainability. The Committee welcomed Peru's response to their growing whale watching industry and thanked the Government of Peru for providing Ministerial Resolution N° 451-2019-PRODUCE, which defines the country's whale watching regulations. The Resolution is strong, providing guidance on group- and behaviour-specific approaches and appropriately conservative approach distances. Furthermore, the Resolution has the potential to be useful as a tool to help raise awareness amongst operators and individuals interested in experiencing whale watching. A question was raised regarding effective enforcement, given the difficulties many locations face with regards to monitoring for violations and applying penalties. Suggestions were also provided of ways in which the Peruvian Government might strengthen the Resolution even further. These included providing comprehensive references to cetacean behaviour, placing the regulations within an adaptive management framework, requiring Captains and Guides to receive training as a condition of a license to operate, setting minimum approach distances to help account for taxonomic differences in behaviour that are irrespective of body size, and specifying the types of vessels and nautical activities to which the regulations are directed.

Attention: C, S, SC, CG
The Committee **commends** *the Government of Peru for its Ministerial Resolution N° 451-2019-PRODUCE, which defines the country's whale watching guidelines, for its alignment with many other nations' whale watching regulations and recommendations of the IWC, as well as for its mitigation efforts to protect the most vulnerable individuals in the population (i.e. mothers with calves).*

Iñíguez, Urbán and Trujillo have begun work on an update on the state of development of whale watching in Latin America. Representatives from multiple countries are involved, and efforts are being made to standardise the information so as to make comparison across the region possible. The Committee looks forward to the presentation of this effort at SC68C.

The Committee welcomed an update on the whale watching activities in Puerto López, Ecuador (SC/68B/WW/04), which over the last five years has experienced the highest growth in tourism in the region. However, in 2019 non-regulated commercial whale watching activities were reported for the first time since 2012. The increase in illegal activity is likely to be a result of current economic conditions and lack of enforcement and is of particular concern given practices that place passengers at risk (e.g. exceeding vessel capacity) and violate Ecuador's whale-watching regulations (e.g. approach distances, speed).

Attention: C, CC, CG
The Committee supports the whale watching regulations implemented by the Government of Ecuador but **expresses concern** *regarding the increase in illegal whale watching and current lack of enforcement for said recommendations.*

Given difficulties arising from the COVID-19 pandemic, the Committee was unable to discuss the current status of whale watching in Costa Rica, which remains an important location of interest. The Committee looks forward to papers on newly available data, information on the effects of whale watching and new elements of the industry in Costa Rica, to be presented at SC68C.

17.4 Collaborative work within the IWC

17.4.1 IWC's Whale Watching Handbook

The Whale Watching Handbook was endorsed by the Commission at IWC67 (IWC, 2018d, pp.36-37) and launched in October 2018[31]. The Committee thanked Minton and S. Smith for their hard work on this IWC product and congratulated them on their achievements. Given the importance of the Handbook, the Committee reiterates its support for its continued promotion.

Attention: S, SC, CG
The Committee **recommends** *that the promotion of the IWC's Whale Watching Handbook continue and that Contracting Governments and Scientific Committee members continue to provide relevant and up-to-date information.*

The Committee welcomed the response to their previous recommendation on the establishment of protocols for managing Handbook content, and provided feedback to Minton and S. Smith on the draft Editorial Protocol for Managing Handbook Content (SC/68B/WW/03), for new Country Profiles and Case Studies, factsheets for whale watching guides and the searchable table of literature. Detailed editorial and content suggestions were made on the documents provided, and Minton agreed to work with all relevant individuals, including the Committee and Secretariat where appropriate, to make the proposed changes. The Handbook is a living document that requires input from Contracting Governments, Scientific Committee members and regional experts to ensure that it remains relevant and up to date. Of particular importance is ensuring that the information presented in the Handbook, especially Country Profiles and Case Studies, remain an unbiased and accurate reflection of the current whale watching situation in each area. Last year (IWC, 2020i), concerns were raised with regards to the Canary Islands Case Study, for which Handbook text was overwhelmingly positive in tone, whilst the Committee had previously raised concerns regarding the safety and sustainability of the whale watching operations there. With this example in mind, discussion related to the proposed Editorial Protocol for the Handbook emphasised the need to maintain a balanced perspective in the Handbook Case Studies. Therefore, the Committee requests that, in cases where governments or other stakeholders might wish to emphasise the positive, the Secretariat works toward balanced presentation, consulting with relevant parties, including field scientists, to develop text for Case Studies that highlights adaptive management, acknowledging documented problems, but emphasising measures that are being taken to address those problems.

Attention: C, CC, S, SC
The Committee **endorses** *the Editorial Protocol for Manging Whale Watching Handbook Content presented in SC/68B/WW/03. It highlights the need for discussion and compromise between the Commissioners, Scientific Committee, and regional experts when drafting and approving content for the Handbook, in order for the Handbook to remain neutral and unbiased and* **recommends** *that this continue to be taken into account in the application of the Protocol.*

17.4.2 Work of Conservation Committee Standing Working Group on Whale Watching

The update on the IWC's Whale Watching Handbook served as the report on the work of the Conservation Committee Standing Working Group on Whale Watching for SC68B. Any further discussion on this item will occur when the Scientific Committee is next able to meet in person.

17.4.3 Collaboration with other SC sub-committees on platforms of opportunity and citizen science

Collaboration amongst sub-committees on platforms of opportunity and citizen science remains a priority for the Committee. However, given the complexity of scheduling and greater difficulties in communication resulting from the need to hold SC68B virtually, it was determined that this collaboration could be achieved more effectively if delayed until the Committee could once more meet in person. In order to facilitate this process, the Convenor of whale watching, New, will reach out intersessionally to Convenors and co-Convenors of relevant sub-committees.

[31]*https://iwc.int/whale-watching-handbook.*

Table 20

Summary of the work plan for matters related to whale watching. Several of these items have intersessional correspondence groups (ICG) or intersessional advisory groups (IAG). Those groups will work intersessionally and provide updates at SC68C. For details see Annex K.

Topic	Intersessional 2020/21	2021 Annual Meeting (SC68C)
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, e.g. drones and other emerging technology in the context of whale watching.	Prepare papers	Papers to be presented
MAWI questionnaire	Email correspondence and work	Paper to be presented
Finalise IWC's General Principles for Whale Watching (*https://iwc.int/wwguidelines*).	Convenor to liaise with Conservation Committee and Secretariat	Receive update
Review whale watching in Sri Lanka.	-	Papers to be presented
Review whale watching in Timor-Leste.	Intersessional correspondence and work	Papers to be presented
Review whale watching in Latin America.	Work to prepare review	Papers to be presented
Intersessional correspondence groups.	Email correspondence and work	Receive reports
Conservation Committee Standing Working Group on Whale Watching.	Email correspondence	Receive update
Increased collaboration with other sub-committees, particularly regarding platforms of opportunity and citizen science data.	Email correspondence and work	Receive updates

17.5 Progress on previous recommendations

Since progress on previous recommendations was reviewed last year (IWC, 2020i), the Committee's recommendation that the Secretariat establish protocols for management of the content of the Handbook has been completed admirably by Minton and S. Smith, as detailed under Item 17.4.1. In addition, the Carole Carlson Memorial Fund for Whale Watching has been established and is advertised on the IWC's Voluntary Fund for Conservation webpage[32]. Furthermore, the Intersessional Correspondence Group on swim-with-whale operations has met its Terms of Reference, establishing the prevalence of swim-with-whale operations and their potential effects, and thus the Committee will now include consideration of swim-with-whale impacts in its regular discussions. The majority of the recommendations are on-going, with work in progress toward their completion. Whilst there was the expectation that additional recommendations would be resolved by the present meeting, the COVID-19 pandemic prevented their conclusion. As a result, the Committee looks forward to a report from the Intersessional Correspondence Group on human induced behavioural changes of concern, particularly given on-going issues regarding solitary sociable dolphins and habituation. In addition, S. Smith will take over as Convenor for the Advisory Group on communication with the Indian Ocean Rim Association (IORA) and will report back to the Committee at SC68C, pending communication with Australia, Oman and other relevant parties.

17.6 Work plan

The work plan is given in Table 20. Regarding the General Principles for Whale Watching, the Secretariat acknowledged the urgency to post the updated version to the IWC website and noted the potential to approve and adopt them by correspondence before SC68C, although this is still to be discussed by the Conservation Committee Planning Group and the Bureau (see Item 17.2). With respect to 'increased collaboration with other sub-committees', it was noted that impacts of underwater noise, including that from whale watching vessels, is of particular relevance to the Sub-Committee on Whale Watching, so collaboration with the Sub-Committee on Environmental Concerns is highly relevant. The discussion regarding the Whale Watching Handbook noted, in particular, the need for a new mechanism for offering input to the Handbook, as the contract for the dedicated person responsible for drafting, updating and revising it expires in July 2020. New will liaise with the Secretariat and the Chair of the Conservation Committee's Standing Working Group on Whale Watching to determine the most appropriate way forward and will present the results of these discussions at SC68C.

Attention: S, SC

There is an ongoing need to effectively interact with the Conservation Committee and its Standing Working Group on Whale Watching generally, but with particular regard to the Whale Watching Handbook. The Committee therefore **agrees:**

(1) *to add a standing item on their agenda regarding updates on intersessional communications with the Conservation Committee and its Standing Working Group on Whale Watching; and*
(2) *that updates on the Whale Watching Handbook be included under this agenda item at future meetings.*

[32]*https://iwc.int/voluntary-fund-for-conservation.*

Table 21

Work plan for Sanctuaries, 2021-22.

	2021	2022
Receive relevant information relevant to the SOS management plan	x	x
Receive relevant information relevant to other Sanctuaries	x	x
Discuss progress on previous recommendations related to Sanctuaries	x	x
Discuss two-year work plan		x

Garrido highlighted the importance of a proposed Workshop between Chile and Peru on experience exchange on whale watching regulation and research permit systems, especially the need to standardise methods and monitoring in the region. Chile and Peru would appreciate the participation of multi-lingual experts from the IWC, particularly those who understand the cultural and political context in which whale watching is conducted in Latin America. Peru, in particular, where whale watching is still in its earlier stages, can learn much from Chile's experience. Galletti thanked the Committee for its support and for recommendations for speakers.

Attention: S, SC
The Committee **endorses** *the proposal and funding request for the participation for regional and international whale watching experts in a joint Workshop between Chile and Peru on experience exchange on whale watching regulation and research permit systems, to be held under the umbrella of the Conservation Management Plan for the Eastern South Pacific southern right whale in the region.*

18. WHALE SANCTUARIES (SAN)

Due to the logistical constraints on this year's Committee meeting, in particular the difficulties for many of those working in Sanctuary regions in being unable to attend virtual meetings during the UK working day, the *Ad hoc* Working Group on Sanctuaries made the decision (via e-mail) to postpone the working group's work until the SC68C meeting next year (2021).

18.1 Updates from relevant sub-committees on new information relevant to the SOS management plan

No new information was received, and the Working Group will welcome new information on the Southern Ocean Sanctuary Management Plan at SC68C.

18.2 New information for other sanctuaries

No new information was received. The Working Group will welcome the submission of relevant information on other sanctuaries at SC68C. In particular, the Working Group looks forward to receiving information related to the Indian Ocean Sanctuary, such as the work being undertaken by the IUCN Important Marine Mammal Areas network as well as a report from the IndoCet (Indian Ocean Network for Cetacean Research) meeting next year.

18.3 Work plan

The work plan for Sanctuaries is available in Table 21.

19. IWC LIST OF RECOGNISED SPECIES

At SC68A, the Committee noted that the list of recognised species needed to be updated for consistency with the list of marine mammal species and subspecies of the Society for Marine Mammalogy, which is adopted by the Committee. No time was available to discuss this Item in 2020, thus, the Committee **encourages** Brownell and Malette to prepare a document with proposed updates to the IWC List of Recognised Species for the 2021 Annual Meeting.

Attention: SC
The Committee **encourages** *Brownell and Malette to prepare a document with proposed updates to the IWC List of Recognised Species for the 2021 Annual Meeting (SC68C).*

20. IWC DATABASES AND CATALOGUES

20.1 Guidelines for IWC catalogues and photo-ID databases

The Committee agreed to postpone this item until SC68C in 2021.

20.2 Progress with existing or proposed new catalogues (PH)

20.2.1 Southern Hemisphere right whale photo catalogues

A successful AI algorithm for matching right whale photographs has been developed by the team at WildMe, using the platform Flukebook (SC/68B/PH/03). The algorithm uses vertical perspective photographs, but an algorithm for the lateral perspective is under development. As of late 2019, after training on the photographs of North Atlantic right whales, the algorithm performed at 88.9% top-1 accuracy and 97.8% top-5 accuracy (meaning that the correct whale was almost always found within the first 5 suggested matches). When tested on catalogues of southern right whales (from South Africa, Argentina, Brazil and New Zealand), initial tests showed a top-1 accuracy of 25.9% and top-5 of 40.0%. These datasets differ from the North Atlantic catalogue in the average re-sight rate of individuals: the northwest Atlantic data have a mean of 88 training photos per individual while the southern right whale datasets have only 4. Despite this, curators of the southern right whale catalogues expressed optimism about the usefulness of the Flukebook algorithm. Further funding and research is anticipated to make the algorithm more generalisable so that the southern right whale model can more closely approach the North Atlantic model in accuracy. The Committee **looks forward** to updates.

20.2.2 Happywhale and Flukebook

SC/68B/PH/01 cross-references the features of two automated photo-ID recognition software platforms: Happywhale[33] and Flukebook[34]. The Happywhale matching algorithm is almost 100% accurate on good quality humpback fluke images. Happywhale maintains a database of images solicited from citizen scientists and research collaborators worldwide. In addition to humpback whales, Happywhale has provided images of southern right whales, Antarctic blue whales and Antarctic killer whales to catalogues relevant to the IWC and IWC-SORP; its application for the *In-Depth Assessment* of North Pacific humpback whales is discussed under Item 8.1.1. Flukebook has developed or integrated algorithms for eight cetacean species to date (humpback whale, sperm whale, North Atlantic right whale, southern right whale, common bottlenose dolphin, Indo-Pacific bottlenose dolphin, common dolphin, spotted dolphin), rapidly improving the time it takes to compare identification photographs. When fully functional, it is expected that these algorithms will transform the matching process for photo-identification catalogues and facilitate the comparison of large regional catalogues for population assessments (and see the discussion under Item 16.1.5 for Indian Ocean humpback dolphins and Item 20.2.1 for right whales). An overview of recent developments of the Flukebook platform, as well as background information on matching algorithms is provided in SC/68B/PH/06.

Attention: SC, R

The Committee **welcomes** *information on the performance of the Flukebook and Happywhale platforms when comparing large photo-identification catalogues (SC/68B/PH/03 and SC/68B/PH/06). It* **draws attention** *to:*

(1) *the swiftness of the matches between regions for population assessments and the value already being shown in some of the Committee's work; and*
(2) *looks forward to receiving updates on developments.*

20.2.3 Arabian Sea Whale Network's Flukebook

SC/68B/PH/06 and SC/68B/CMP/11 reported that the Arabian Sea Whale Network's regional data platform, hosted by Flukebook, is being further refined and developed in collaboration with the Indian Ocean Network for Cetacean Research (Indocet). Current work focuses on the user interface required to facilitate bulk data uploads and exports, as well as systematic comparisons between catalogues held by Flukebook users. Such comparisons have not yet been possible in the Arabian Sea, where the only catalogue with more than 10 photographs is the catalogue held in Oman.

20.2.4 Southern Hemisphere blue whale catalogue (SHBWC)

SC/68B/PH/02 presented the results of comparing photographs of 858 individual blue whales within the southeast Pacific between areas off Chile and the eastern tropical Pacific (ETP; Peru, Ecuador and the Galápagos). About half of the photographs have been compared, yielding 10 matches within southern Chile but no matches between Chile and the ETP, although there is already one known match between Chile and the ETP (Torres-Florez *et al.*, 2015). Information from the completed comparison will facilitate a capture-recapture estimate of abundance integral for population assessment (see also Items 8.2.1.1 and 8.2.1.6). The Universidad Austral de Chile/Centro Ballena Azul also hold photographs, but funding issues have precluded the photographs being completely processed prior to uploading to the SHBWC. Cascadia Research Collective will upload photographs of 68 blue whales from the Costa Rica Dome, in the ETP, to the SHBWC. Whales from the Southern Hemisphere may be found there (e.g. LeDuc *et al.*, 2017; Reilly and Thayer, 1990) and last year the Committee advised the inclusion of photos from this area (IWC, 2020a).

20.2.5 Antarctic blue whale catalogue (ABWC)

The results of the comparison of 62 new individual Antarctic blue whale identification photographs to the ABWC is summarised in SC/68B/PH/04. The five sources of photographs (2015-19) include the Australian Antarctic Division, the

[33]*http://www.happywhale.com.*

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

Institute of Cetacean Research, Tokyo and opportunistic photographs collected by scientists in the Antarctic. Two inter-annual recaptures were found (time intervals of 6 years and 12 years, sighting locations separated by 384km and 3,307km, respectively). The total number of photo-identified Antarctic blue whales is now 517 whales (389 left and 383 right sides). This collection will provide data for capture-recapture estimates of abundance as well as information on the movement of individuals. An updated estimate of abundance is integral to an upcoming population assessment (Item 8.2.2.3).

Attention: SC, SH
The Committee **welcomes** *the work being undertaken with photo-identification catalogues of blue whales, including work funded by the IWC.*
The Committee:

(1) **encourages** *the completion of the matching of southeast Pacific blue whales by the Southern Hemisphere Blue Whale Catalogue so the dataset will be available for a capture-recapture analysis; and*
(2) **agrees** *that data should continue to be added to the Antarctic Blue Whale Catalogue to facilitate the development of abundance estimates of Antarctic blue whales.*

20.2.6 Fin whale catalogues
The results of a long-term photo-ID study conducted in the Pelagos Sanctuary (Western Mediterranean Sea) between 1990 and 2007 were presented in SC/68B/PH/05. The study examined site fidelity, seasonal residence and a number of biological parameters including sex ratio, survival rate, abundance and trends. Images from four research institutes were merged into a single catalogue checked for data consistency. A total of 435 individuals were identified over the 18-year study period, 47 (10.8%) of which were recaptured interannually. Annual within-season recaptures ranged from 1-4 over periods of 1-90 days, indicating that at least some whales use the Pelagos Sanctuary over the entire summer. The analysis implies a stable population although the apparent survival rate was unexpectedly low. The latter may be linked to temporary or permanent emigration, or mortality due to ship strikes. The results confirm site-fidelity to this feeding area and provide sound information to support the conservation of this unique population. As discussed under Item 9.2.4, work is underway to draft a joint ACCOBAMS/IWC CMP for Mediterranean fin whales. That recognises the need to create and maintain a single, centralised photo-ID catalogue (in conjunction with a genetic-ID catalogue) to improve information on population structure and movements, abundance and trends, population parameters, scarring and threats.

Attention: SC, CMP, R
The Committee **encourages** *the creation of a centralised photo-identification catalogue for fin whales in the Mediterranean Sea to be used, inter alia, for future capture-recapture analyses.*

20.2.7 Western gray whale catalogue
This item was presented this year in Item 9.1.3 (SC/68B/CMP/24).

20.2.8 Work plan
The work plan on work related to catalogues is provided in Table 22.

20.3 Progress with existing IWC databases
The IWC's database hosting architecture was reviewed in 2019 by an independent IT consultancy and it was concluded that the IWC has a large and overly complex IT infrastructure on mixed platforms that requires centralisation and simplification in order to mitigate ever-increasing development and data hosting costs and reduce the large server management burden faced by the Secretariat.

At present, the Secretariat is unable to develop any significant database projects in-house due to the challenge of administering the complex hosting servers of existing databases, so recent new projects have been developed externally (adding to the complexity) where funding was available. Otherwise new projects have been delayed. Actioning the review's recommendations would allow the development of such projects in-house and allow for external development with a standardised technical specification template that fits the architecture model if required. Steps have been taken to begin sub-contracting the server administration tasks, which will allow the Secretariat IT department to focus on IWC core development tasks.

The IWC portal, which is heavily utilised by the Committee, has been in service for 8 years and incorporates both the Ship Strikes Database and the National Progress Reporting Database. The underlying architecture is now reaching the end of its shelf life, so this will be redesigned and rebuilt over the course of the next 12 months to fit the needs of the IWC going forward. This presents an opportunity to begin centralising data held by the IWC and integrating workflows. Consequently, the Secretariat will fully engage with the *Ad hoc* Working Group on Databases and Related Issues on any related discussions.

In several sub-committee sessions at SC68B, there was detailed discussion on a wide range of issues surrounding data collection and reporting, and importantly, on the need for databases to store and allow access to this information. The

Table 22
Work plan for Photo-ID, 2020/21.

Topic	Intersessional 2020/21	2021 Annual Meeting (SC68C)
Completion of southeast Pacific blue whale photo comparisons	Continue comparisons within SHBWC	Included in SHBWC report
Addition of blue whale photos from the Costa Rica Dome to the SHBWC	Facilitate the collaboration with Cascadia Research and upload photos to SHBWC	Included in SHBWC report
Prepare dataset from ABWC for capture-recapture analysis	Complete the addition of recent photos and quality code photos	Report

discussions included proposals for new databases as well as the possibility of combining current and future databases. Sub-committees also discussed National Progress Reports (NPR), raising issues such as the low response rate (on average less than 20% of member countries submit reports) and the NPR's relationship to other data submissions (bycatch, ship strikes, strandings, etc.). Given the need to consider the actual needs of the potential users of these databases, there was recognition that these proposals will need further development intersessionally.

The *Ad Hoc* Working Group on Databases and Related Issues (convened by Mike Double) is requested to review the status of existing IWC databases, and to liaise closely with those sub-committee members who are developing ideas for databases as a follow up to their discussions at SC68B. This review will be critical in order to consider new database specifications in light of ongoing work in the Secretariat and the potential for interoperability with existing databases (see Item 20.4.1 below). Background to the history of this database and National Progress Report submissions since the last SC meeting are given under Item 3.2.

The Secretariat arranged two training sessions during SC68B to demonstrate the use of the National Progress Reports database and facilitate discussion on future improvements. The sessions were well attended and provided useful feedback. Over the next year, the Secretariat will continue to work to make the data entry system easier to use, including listing the data fields in advance of entry and investigating the possibility of bulk upload for csv files. Any further feedback is welcomed.

The Committee also noted the role of the *Ad Hoc* Group on Databases and Related Issues in working with the Secretariat to improve the accessibility of data from NPRs and to improve engagement in the reporting process.

Attention: SC, S
The Committee **notes** *the update on databases and National Progress Reports from the Secretariat and the extensive discussion in sub-committees relating to data reporting, collection and management, including proposals for new databases. It therefore* **requests** *that the Ad Hoc Working Group on Databases and Related Issues (convened by Double) develop an intersessional work plan to engage with the Secretariat on IWC databases and related issues, including improvements to National Progress Reports and the review of specifications for new databases in light of ongoing work.*

20.4 Potential future IWC databases (GDR)

20.4.1 Global database for disentanglement activities

The proposal for an entanglement database is discussed under Item 12.4.1.

21. IWC MULTINATIONAL RESEARCH PROGRAMMES AND NATIONAL RESEARCH CRUISES THAT REQUIRE IWC ENDORSEMENT

Multinational research programmes (e.g. IWC-POWER and IWC-SORP) and national research cruises are an integral part of the work of the Committee and provide valuable information to the assessment of whale stocks. These programmes occur in many regions around the world, most notably in the Antarctic and in the North Pacific, including the Bering and the Okhotsk Seas.

21.1 IWC-POWER and co-operation with Japan

21.1.1 Results of the 2019 cruise

The Committee welcomed the results of the 10th annual IWC-POWER cruise conducted between 3 July and 25 September 2019 in the Gulf of Alaska within the US Economic Exclusive Zone (SC/68B/ASI/20). The cruise was carried out on board the R/V *Yushin-Maru No. 2* by researchers from Japan, the USA and the IWC following plans endorsed by the Committee at last year's meeting. The main objective of the survey included obtaining information on distribution, abundance and stock structure of North Pacific sei, humpback, fin, blue, gray and the critically endangered right whales to inform ongoing and future assessments performed by the Committee. The vessel surveyed nearly 2,100 n.miles of survey trackline and documented a total of 529 sightings of nine cetacean species. Photo-identification data (122 individually identified individuals from five species), acoustic recordings (229 sonobuoys deployed with 820 monitoring hours) and biopsy samples (75 samples from five whale species) were obtained. The cruise also documented the distribution and characteristics of floating marine debris. The survey was successfully completed and provided new information on cetaceans in an area where limited survey effort had been allocated in recent years. The data will be analysed during the coming year and results presented at next year's Committee meeting. Finally, the Committee expresses its sincere thanks to Matsuoka for his excellent leadership in acting as Cruise Leader for 10 years.

21.1.2 Report of the IWC-POWER Steering Group

The Committee received the report of the IWC-POWER Steering Group (SC/68B/ISG/03) that incorporated the work of both the Planning Meeting for the 2020 cruise and the Technical Advisory Group during intersessional meetings in Tokyo in January 2020 (SC/68B/REP/01 and SC/68B/REP/02).

The Steering Group highlighted the achievements of the IWC-POWER programme since 2010, recognising that they cover pelagic waters of the central and eastern North Pacific that have rarely if ever been covered by systematic line transect surveys and have not been surveyed at all in decades. This has important scientific conservation and management value and the results have contributed greatly to the work of the Committee. The IWC agreed (IWC, 2012b) that the long-term IWC-POWER programme:

> *'will provide information to allow determination of the status of populations (and thus stock structure is inherently important) of large whales that are found in North Pacific waters and provide the necessary scientific background for appropriate conservation and management actions. The programme will primarily contribute information on abundance and trends in abundance of populations of large whales and try to identify the causes of any trends should these occur. The programme will learn from both the successes and weaknesses of past national and international programmes and cruises, including the IDCR/SOWER programme.'*

The medium-term objectives were reviewed and updated by the Technical Advisory Group (TAG) in light of the results of the programme thus far. These are given in Table 1 of SC/68B/REP/01.

The Steering Group report also summarised the results of the programme with a focus on the following: stock structure and movements (genetic and individual identification); and distribution, abundance and trends (sightings and acoustics). Some 475 biopsy samples from nine large whale species (including the rare blue and North Pacific right whales) and one small cetacean species have been collected and analysed. The results are summarised in SC/68B/ASI/16 and discussed under Item 10.4.4. Similarly, individual photo-identification data have been collected from over 1,100 individuals (the same ten species). A photographic database of over 100,000 photographs has been coded and keyworded to provide an invaluable resource for a number of potential studies and uses. Abundance estimates have been developed for five large whale species for the first time in the research area covered. The information from the cruises has proved invaluable to the assessment work by the Committee on Bryde's whales, sei whales and humpback whales.

Last year (IWC, 2020j, items 24.1, 27.8) the Committee had reiterated to the Commission:

> *'…the great value of the data contributed by the Committee-designed IWC-POWER cruises which cover many regions of the North Pacific Ocean not surveyed in recent years and addresses an important information gap for several cetaceans species, providing fundamental information on abundance necessary for developing conservation and management advice'*

and

> *'…that it would be valuable for the scientific, conservation, management and assessment work of the Committee for these cruises to continue, particularly in light of the information being provided on the status of species once heavily exploited by whaling including blue, fin, sei, humpback, gray, and right whales.'*

The Committee again **concurred** with these sentiments and reiterated the small cost to the Scientific Committee compared to the donation of a vessel and crew for around 60 days or more.

The Committee also noted the options for the 2020 cruise in light of the unprecedented difficulties posed by the COVID-19 pandemic (Appendix 1 of SC/68B/ISG/03). It **commends** the work undertaken by the Steering Group and Japan to try to ensure that the 2020 cruise goes ahead and **strongly encourages** the efforts being made by Japan and the USA to enable international participation, and conduct maximum photo-identification and biopsy work and at least some acoustic work despite the problems of COVID-19.

The Committee also noted the proposal of the Steering Group and TAG to hold a Workshop or pre-meeting to develop detailed plans for the post-2021 cruises after the identified preparatory work had been undertaken. In addition to the present work, this should have 'an emphasis on participation from all range states and also include consideration of more methodologically focussed cruises in some years (e.g. use of a towed acoustic array, telemetry work, use of SeaGlider)' (SC/68B/REP/01).

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. The programme addresses important information gaps for several species and has already contributed greatly to the ongoing assessment work of the Committee. The Committee* **endorses** *the report of the Technical Advisory Group (SC/68B/REP/01) and* **recommends** *that the programme continues.*

The Committee also:

(1) **thanks** *the government of Japan (which generously supplies the vessel, crew and many of the researchers) and the government of the United States (which generously provides acoustic equipment and acoustic experts), for their continued support of this IWC programme, as well as the scientists from other range states including Korea and Mexico who have participated in these cruises;*
(2) **agrees** *that the 2019 cruise was duly conducted following the Requirements and Guidelines of the Committee (IWC, 2012b) and* **looks forward** *to receiving abundance estimates based on these data;*
(3) **endorses** *the plans for the 2020 POWER cruise and* **looks forward** *to receiving a report from this survey at the next meeting of the Committee;*
(4) **endorses** *the report and work plan set out by the Technical Advisory Group (TAG) for continuation of work related to the IWC-POWER cruises, including the updated medium-term objectives; and*
(5) **endorses** *the proposal for the 2021 cruise in Russian waters in the Bering Sea, the associated TAG Workshop to plan for the post-2021 cruise and the work to incorporate the 2019 photographs into the photographic database.*

21.2 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 delivering coordinated and cooperative Southern Ocean cetacean science to the IWC. The Partnership currently has 13 member countries: Argentina, Australia, Belgium, Brazil, Chile, France, Germany, Italy, Luxembourg, New Zealand, Norway, South Africa, the United States of America. New members are warmly welcomed.

There are six endorsed 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 predator-prey 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;
(5) 'Acoustic trends in abundance, distribution, and seasonal presence of Antarctic blue whales and fin whales in the Southern Ocean'; and
(6) 'The right sentinel for climate change: linking foraging ground variability to population recovery in the southern right whale'.

The initiation of a seventh Theme, *Recovery status and ecology of Southern Hemisphere fin whale*s, was agreed by this Committee at SC68A and awaits endorsement by the Commission.

The Committee welcomed the IWC-SORP Annual Report 2019/20 on the continued progress of research undertaken under the auspices of these themes since last year (SC/68B/SH/04). This progress includes the production of 21 peer-reviewed publications during 2019/20, bringing the total number of peer-reviewed publications produced since the start of the initiative to 165. In addition, 145 IWC-SORP related papers have been submitted to the Scientific Committee to date, 12 of them this year.

IWC-SORP members continue to develop, test and implement leading-edge methodology and technology, including neural network algorithms to support the use of long-range UAVs to assess and monitor cetacean populations, and sophisticated acoustic analyses (see SC/68B/SH/04 and SC/68B/SH/05 for details). Updates on new initiatives to progress satellite tag and drone technologies are anticipated in 2021 (see SC/68B/O/01).

A report on the progress of projects funded by the IWC-SORP Research Fund following two open, competitive grants rounds was also received (SC/68B/SH/05). A new Call for Proposals was opened in late 2019; the nine eligible proposals were assessed and six have been recommended for funding totaling £129,955 GBP in 2021 (SC/68B/O/01).

If the Commission agrees to fund the six recommended projects then £25,569 GBP remains unallocated in the IWC-SORP Research Fund. The Committee acknowledged and thanked all contributors to the IWC-SORP Research Fund for their voluntary contributions. The Committee also noted that substantial vessel time has been secured by IWC-SORP researchers for the 2020/21 austral field season, but that expeditions are subject to COVID-19 restrictions being lifted.

Table 23

Work plan for the Southern Ocean Research Partnership.

Item	Intersessional 2020/21	2021 Annual Meeting (SC/68C)
Analyses	Continued analysis of data/samples from previous IWC-SORP voyages/fieldwork	Report
Voyages	- Baleen whale and krill research voyages on ships of opportunity along Western Antarctic Peninsula.	Report
	- *ARA Almirante Irizar*, 2021, to Antarctic Peninsula, islands at 60°30’-60°48’S, 44°25’S-46°43’W and 61°00’-63°37’S, 53°83’-62°83’W and Weddell Sea.	Report
	- *RV Maria S. Merian* voyage to the shelf area from the islands at 60°30’-60°48’S, 44°25’S-46°43’W and 61°00’-63°37’S, 53°83’-62°83’W.	Progress report on rescheduled voyage
Fieldwork	Continued fieldwork around Marion Island.	Report
Acoustics	Retrieval and redeployment of passive acoustic recorders.	Report
Funded research	Progress on IWC-SORP Research Fund funded research projects endorsed by IWC.	Report

Attention: SC, C

Acknowledging the great value of the IWC-SORP (Southern Ocean Research Partnership) programme to its work, the Committee:

(1) **encourages** *the continuation and growth of IWC-SORP;*

(2) **commends** *the researchers involved who are key to the overall success of 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, including photo-ID, to IWC-SORP and the wider Committee.*

21.3 National cruises that require IWC oversight

The Committee welcomed plans for national research cruises to be conducted in 2020 and thereafter. One of the main goals of these cruises is to estimate abundance of various cetacean species. The cruises will be conducted in the Okhotsk Sea in 2020 by Russia (SC/68B/ASI/11), in the North Atlantic Ocean in 2020-25 by Norway (SC/68B/ASI/13), in the western North Pacific Ocean in 2020 by Japan (SC/68B/ASI/14) and in the IWC Area III W in the Antarctic in 2020/21 by Japan (as part of the Japanese Abundance and Stock Structure Surveys in the Antarctic [JASS-A], SC/68B/ASI/19). The Committee appointed the following scientists to provide IWC oversight of these cruises: Matsuoka (Japanese surveys in the western North Pacific and in the Antarctic), Miyashita (Russian cruise in the Okhotsk Sea), and Øien (Norwegian survey in the North Atlantic).

The Committee also received cruise reports from surveys conducted by Russia in the Okhotsk Sea (SC/68B/ASI/12), by Norway in the northern North Atlantic Ocean (Small Management Area ES off Svalbard, SC/68B/ASI/15), and by Japan in the Antarctic (SC/68B/ASI/17) and the western North Pacific (SC/68B/ASI/18). The Committee noted that these cruises provide valuable information for the assessment of whale stocks.

In discussion, the Committee noted the importance of the results for the Okhotsk Sea (an area logistically challenging to survey), in particular the sightings of endangered North Pacific right whales. The Committee also noted that some of the photographs in document SC/68B/ASI/12 were useful for photo-identification of individuals, and that sharing of these images could be useful to assess connectivity of right whales in the eastern and western North Pacific. In response to a question regarding species identification on this cruise, a revised document was provided to the Committee.

21.4 Work plan

The Committee **agrees** to the work plan provided in Table 24. Item 1 in this table (IWC-POWER cruises) has financial implications for the Committee. The Committee **strongly endorses** this proposal. Intersessional Correspondence Groups are detailed in Annex K.

22. SCIENTIFIC COMMITTEE BUDGET FOR 2021

During the May 2020 virtual Committee meeting, the Commission decided to postpone the IWC68 meeting originally planned for September 2020 until 2021 because of the situation with COVID-19. This altered the Committee’s plans for developing work plans and budgets. Instead of proposing a biennial work plan and budget, as has become typical, the Bureau directed the Committee to develop a work plan and budget for only 2021 because the Commission would be holding a mail ballot to approve a budget for 2021. At SC68C, the Committee anticipates that it will develop a two-year work plan and budget for 2022 and 2023.

Table 24

Work plan for multinational research programmes and national research cruises that require IWC oversight.

Item	Topic	Intersessional 2019-20	SC68C	Agenda Item
1	IWC-POWER Cruise in the North Pacific Ocean.	Conduct 2020 survey and planning meeting for the 2021 cruise (IWC, Japan, USA)	Review cruise report, report from the planning meeting and new abundance estimates from IWC-POWER cruises.	21.1
2	Review and provide advice on plans for future surveys.	-	Receive, review and provide feedback to research plans to conduct abundance estimates	21.3

22.1 Status of funded research

SC/68B/O/06Rev1 provides information regarding the position on the Committee's research budget at the end of the 2019 financial year, and year-to-date up to 30 April 2020.

Projects undertaken in 2019 were either in line with, or under budget. It should be noted that due to the COVID-19 pandemic, a number of projects had to be postponed and these projects were reviewed by the Committee.

The Committee's Rules of Procedure allow for a contingency fund at a level equivalent to 10% of its core budget to deal with uncertainty on approved projects. At the end of 2019, the balance on the contingency fund was *ca* £33,000, which equates to 14% of the budget. Whilst slightly above target, the minor increase in contingency funds will help to mitigate risk from any potential impact from COVID-19 related to travel in 2021.

In 2019, the Research Fund gratefully received voluntary contributions as follows:

(1) £3,400 from the Government of France to support Invited Participants;
(2) £12,800 from Animal Welfare Institute to fund the preparation of a Pre-Workshop report on cetaceans and ecosystem functioning and to support participants attending the Ecosystem Functioning Workshop (now due to be held in 2021); and
(3) £1,267 (EUR 1,500) from Pro Wildlife to support the Ecosystem Functioning Workshop.

It was noted that a total of approximately £71,000 remained in the Small Cetaceans Fund as at 30 April 2020.

At the 2020 meeting, the Committee approved funding for 6 new projects from the Southern Ocean Research Partnership (IWC-SORP) Research Fund, totalling £129,955. After this allocation, £25,569 remains in the IWC-SORP fund.

22.2 Proposed budget for 2021

The Committee proposed a research programme for 2021 in Table 25. The total amount requested from the Commission is equivalent to **the same level of funding requested in 2020, a budget freeze.**

The proposals noted in Table 26 have already received Commission approval; however, primarily due to COVID-19 these projects have not yet taken place. Work on these projects will continue as soon as possible and this Table is included for information only.

22.2.1 Invited participants

Invited participants (IPs) are a vital component of the working of the Committee. IPs contribute in many ways including as sub-committee and Working Group Convenors, co-Convenors and rapporteurs, subject area experts and Convenors of intersessional groups. All sub-committees and Working Groups benefit from this budget item. The 2021 budget request for IPs is higher than usual due to having only virtual meetings this year, and agenda items being postponed until the 2021 meeting. Additional IPs will be required in order to address these postponed items next year.

22.2.2 Workshops

SC/68B/RP/11 Workshop on the IWC CMP for the Southern Right Whale Southwest Atlantic Population: A Comprehensive Review

During the last Workshop of the SRWSWA CMP held in 2016 in Peninsula Valdes, Argentina, the nine CMP priorities related to research, management, education and monitoring of this plan were reviewed. Notwithstanding, four years have passed since the last CMP revision, therefore, in order to continue increasing the knowledge and conservation of this population, a review of the established actions, as well as the establishment of new actions, if necessary, should be carried out.

SC/68B/RP/12 Workshop to Develop a Proposed CMP on Central American Humpback Whales

Scientists and government personnel of the countries where the humpback whale population of Central America is distributed will participate in a Workshop to develop the humpback whale CMP for this region, which was recommended by the CMP sub-committee at SC68A. A Workshop Steering Group has been established to prepare the Workshop agenda, as well as inviting the scientific community involved in the monitoring of humpback whales in Central America and the appropriate government personnel to provide the support required by the CMP. The Workshop will be held in the City of La Paz, Baja California Sur, Mexico, and will last three days.

Table 25

Summary of budget requests for 2021. For explanation and details of each project see text.

Sub-committee	Project title	Brought forward (£)	Reallocated from other projects (£)	2021 Core Budget (£)	Total (£)		Co-funding/ in-kind
	General						
ALL	Invited Participants 2021	67,809	7,044	**25,147**	100,000		-
ALL	Contingency Fund	32,620	-	**3,284**	35,904		-
	Meetings/Workshops						
CMP	RP11 SWA RW CMP workshop	-	-	**7,600**	7,600		5,660
CMP	RP12 CAHW workshop		-	**11,460**	11,460		-
ASI	RP19 ASI pre meeting	2,000	-	**4,000**	6,000		-
CMP	RP23 Franciscana workshop	-	1,350	**15,250**	16,600		10,000
E	RP24 Climate change workshop	-	13,621	**6,379**	20,000		20,000
IA	RP28 WNP minke IR workshop	14,273	727	-	15,000		-
WW	RP30 Chile-Peru whale watching workshop	-	-	**4,210**	4,210		7,400
	Modelling/Computing						
IA	RP15 Computing support WNP minke whales	7,594	-	**5,906**	13,500		-
IA	RP17 NP sei whale assessment	-	-	**2,500**	2,500		-
	Research						
SH	RP01Rev Pygmy blue whale pre-assessments	-	6,582	**7,535**	14,117		-
SH	RP02 Acoustics blue whale Oman	-	-	**12,000**	12,000		34,450
SH	RP05 Acoustic catch separation Durban	-	5,010	-	5,010		34,490
SH	RP06 Acoustics Antarctic blue whale west Africa	-	-	-	-		-
SH	RP07 Mid latitude Antarctic blue whale acoustics	-	1,040	**3,360**	4,400		-
CMP	RP08 ASHW songs India	-	-	**11,897**	11,897		2,000
CMP	RP09 ASHW body condition and fisheries mapping	-	-	**12,825**	12,825		26,324
CMP	RP10 SEP right whale acoustics	-	-	**20,000**	20,000		-
IA	RP16 NPHW mixed stock analysis	-	-	**13,200**	13,200		-
ASI/IA/NH	RP21 IWC-POWER cruise	32,320	-	-	32,320		800,000
SM/CMP	RP27 *Franciscana* aerial survey	-	-	**23,820**	23,820		105,220
	Databases						
HIM	RP29 Ship strike database coordinator	1,114	-	**8,886**	10,000		-
SH	RP03 SH blue whale catalogue	-	2,106	**15,494**	17,600		-
SH	RP33 SH blue whale catalogue (Chile)	-	5,010	**5,418**	10,428		-
SH	RP04 Reconciling Chilean blue whale catalogue	-	2,000	-	2,000		-
Secretariat	RP22 Database hosting	-	3,771	**2,229**	6,000		-
	Reports						
E	RP18 SOCER	-	-	**4,000**	4,000		-
	TOTALS	157,730	48,261	**226,400**	432,391		1,045,544

Table 26

Previously funded projects which have been postponed.

Project Title	Budget (£)
RP-13 Ecosystem functioning workshop	20,300
RP-14 NPHW workshop 2	11,040
RP-20 Gray whale workshop	10,500
RP-31 Focused session on disease	3,817
RP-25 Strandings initiative	9,000
Cetacean Diseases of Concern	6,000
MAWI Workshop	17,000
Comparative biology, health, status and future of NA right whales	10,000
Development of Blue Whale Song Reference Library	4,000
Historic catch data	2,988

SC/68B/RP/13 Cetaceans and 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 in Resolution 2016-3 (IWC, 2017b). 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'. This Workshop was due to be held immediately prior to SC68B but was postponed due to COVID-19.

SC/68B/RP/14 Second Workshop on the Comprehensive Assessment of North Pacific Humpback Whales
This relates to the work of the In-depth Assessments (IA) sub-committee and follows on from the first Workshop on the Comprehensive Assessment of North Pacific Humpback Whales that was held in Seattle in April 2017 and reported on at SC67A. The Workshop will continue the work with a view to completing or significantly advancing the assessment, including the relevant population modelling.

SC/68B/RP/19 Pre-meeting of the Abundance Steering Group and the Intersessional Steering Group on Status of Stocks
Funding is required for a pre-meeting prior to SC68C for the Intersessional Steering Group on Status of Stocks and the Abundance Steering Group to meet and evaluate intersessional work and abundance estimates required by the Scientific Committee's various sub-groups during the 2021 Annual Meeting.

SC/68B/RP/20 Workshop to Complete the Updating of the IUCN/IWC CMP on Western Gray Whales
The CMP is over 10 years old and requires updating. Initial work has been undertaken. However, the results of the rangewide Workshops 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.

SC/68B/RP/23 Franciscana Assessment Workshop
The franciscana is considered the most threatened marine cetacean species in South America and is listed as 'Vulnerable' by the IUCN. The Committee first reviewed the status of the franciscana in 2004. A task team for FMA I was established in 2015. A year later, the IWC created a Conservation Management Plan (CMP) for the franciscana. This year a review of the status of the franciscana was begun but, due to the COVID-19 pandemic, it was not possible to complete it. A Workshop will complete the review of the status of the franciscana and make recommendations for future studies and conservation actions.

SC/68B/RP/24 Climate Change Workshop
The Workshop would include representatives from relevant IGOs and selectively review and consolidate the conclusions and recommendations from previous IWC climate change initiatives and Workshops in light of recent new information and developments. The focus would include advice on: (1) how to better integrate this issue into the Scientific Committee's work plan; (2) identification of research programmes/areas to fill priority knowledge gaps; and (3) identify areas/issues for which mitigation and management are likely to be a priority for the IWC and other international and national authorities (e.g. IMO, RFMOs, CMS).

SC/68B/RP/31 Cetacean Diseases of Concern: Morbillivirus and Brucella and their Interaction with Other Immune Suppresive Stressors
A focussed session will be held at SC68C in which participants and SC members will: (1) review the current state of knowledge on the individual and population level impact of two key infectious diseases on cetaceans: morbillivirus and brucella, including the importance of co-infections; (2) identify gaps in our knowledge on their pathological effects, transmission routes, and epidemiological consequences; and (3) determine the potential interactions with other stressors, particularly with contaminants and biotoxins where concomitant exposure is relatively common.

SC/67B/RP/30 Chile-Peru CMP Workshop on Experience Exchange on Whale Watching Regulation and Research Permit Systems
The Workshop will cover all cetacean species and take special emphasis on southern right whales. It will give a general overview of existent whale watching regulations and research permit systems, review research and rescue proceedings in Chile and Peru, identify challenges and propose standardised processes for both States. The government of Peru has kindly offered to host the Workshop.

22.2.3 Modelling/computing
SC/68B/RP/15 Essential Computing Support to the Secretariat
The Committee is currently engaged in an In-depth assessment of Western North Pacific common minke whales. The Committee has developed a complex assessment model structure towards this end. A key task in this process is to develop

and validate the code for this model, together with its variants which are required for the associated sensitivity tests; these are the core components of this process. Experience has shown that the Secretariat staff do not have enough time to complete this process themselves, so computing support is needed.

SC/68B/RP/17 Assessment Modelling for an In-Depth Assessment of North Pacific Sei Whales
The IA sub-committee is currently conducting an *In-Depth Assessment* for North Pacific sei whales. Part of an *In-Depth Assessment* is evaluating the status of a population using some sort of population dynamics model that is specific to the biological and behaviour parameters of that particular population and is fitted to monitoring data. During the intersessional period after the 2020 SC meeting it is expected the population dynamics models will be refined using the existing data. This will result in an assessment of the status of the population.

SC/67B/RP/28 Workshop to Further in In-Depth Assessment of Western North Pacific Minke Whales with a Focus on J-Stock(s)
This Workshop is update of the final year of the already approved RMP Workshop proposal (SC/67B/RP/21) that become an *In-Depth Assessment* Workshop at the end of SC68A in light of Japan's withdrawal from the IWC. The Workshop will provide the support for conducting an *In-Depth Assessment* with a focus on the status of J-stock(s) and bycatches.

22.2.4 Research
SC/68B/RP/01Rev1 Pygmy Blue Whale Pre-assessments
Five pygmy blue whale populations will be assessed under this work. This project will provide crucial catch separation data and the pre-assessments to guide decisions made during *In-Depth Assessments*, for four of the five pygmy blue whale populations.

SC/68B/RP/02 Passive Acoustic Monitoring for Blue Whales and Other Baleen Whales off Oman
The status and population identity of blue whales in the Arabian Sea are poorly understood, and recent acoustic evidence indicates that the whales off Oman belong to an acoustic population that has not been previously described. A year of passive acoustic monitoring will be used in deep water off the coast of Oman to achieve the following goals: (1) commence dedicated research program for NIO blue whales in the waters of Oman; (2) describe seasonal variation in presence of blue whales; and (3) collect acoustic data on Arabian Sea humpback and Bryde's whales and other cetaceans.

SC/68B/RP/05 Using Bioacoustics to Separate Historic Catches of Antarctic and Pygmy Blue Whales from the Former Durban Whaling Ground
Blue whale catches from the former Durban whaling ground, South Africa, are difficult to apportion to subspecies because pygmy blue whales were only identified as a separate subspecies late in the history of exploitation. Available biological data are also insufficient to separate Durban catches. The project will be the first to collect passive acoustic monitoring data off Durban to apportion historic blue whale catches among Antarctic and pygmy blue whales.

SC/68B/RP06 Acoustic Occurrence and Behaviour of Antarctic Blue Whales and Other Whales off the West Coast of South Africa in Relation to Environmental Conditions
This project will use passive acoustic monitoring to investigate the seasonal occurrence and acoustic behaviour of Antarctic blue whales and other whales (e.g. southern right whales, fin whales, minke whales, sperm whales, and humpback whales) off the west coast of South Africa.

SC/68B/RP/07 Assessing Regional Variation in Antarctic Blue Whale Regional Song Calls from Mid-latitude Sites in the Southern Hemisphere
This project will compare the characteristics (frequency, temporal) of Antarctic blue whale song calls from mid- and low-latitude regions in order to assess any regional variation in Antarctic blue whale song calls, with a view to contribute information on Antarctic blue whale population structure.

SC/68B/RP/08 Songs of Arabian Sea Humpback Whales off the West Coast of India
Since the initiation of the IWC funded Arabian Sea humpback whale (ASHW) research in India in 2015, five hotspots for the species have been identified along the west coast of India and two ASHWs from the Oman catalogue have been confirmed from Indian waters. The team plans to deploy acoustic recorders off Kanyakumari, Tamil Nadu and off Dwarka, Gujarat in early 2021. These deployments will allow for comparison of songs during the same season within India, and with Oman as per funding availability for collaborators there.

SC/68B/RP/09 Assessment of Arabian Sea Humpback Whale Body Condition and Co-occurrence with Human Activities in Oman
This project builds on existing funding and planned fieldwork to allow a more thorough assessment of the health and conservation status of endangered Arabian Sea humpback whales, as well as more accurate assessment of human activity,

including fisheries, in their core habitats in Oman. It will address recommendations made in two papers presented to SC68B by: (1) conducting a desk-based study that will use spectral filtering of free sentinel imagery to map the density of human activities, including artisanal gillnet fleets (fishing dhows) in key humpback whale habitat off the coast of Oman; and (2) facilitating fieldwork in either November 2020 or March 2021 that will allow ground truthing of the fisheries mapping exercise, as well as a second assessment of ASHW body condition.

SC/68B/RP/10 Passive Acoustic Monitoring of the Eastern South Pacific Southern Right Whale

Eastern South Pacific southern right whales are considered Critically Endangered by IUCN. In 2012, the IWC adopted a CMP for this population and since 2016 the Committee has supported the 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 along its known distribution range.

SC/68B/RP/16 Mixed-stock Analysis and Population Assignment of North Pacific Humpback Whales to Assist in Allocation of Catches

Work towards a Comprehensive Assessment of North Pacific humpback whales began in 2016, and included an intersessional Workshop held in April 2017. Included in the work plan from the Workshop and subsequence reports of the intersessional working group is the recommendation to 'Initiate and document genetics-based mixed-stock analysis in the feeding grounds and apply genetic assignments to breeding areas from feeding grounds'. The intent of the mixed-stock analysis and population assignment is to inform the allocation of catches for the assessment model in light of population structure hypotheses. The recommended analyses will be undertaken using available DNA profiles held in an updated 'DNA register' developed for the SPLASH program (Baker *et al.*, 2013).

SC/68B/RP/21 POWER Cruise

The POWER programme has been running since 2010 and has contributed greatly to the work of the Committee and its assessment work. Objectives have been developed for the overall plan and funding will allow for the finalisation of the initial phase and progress on developing the medium-term phase. The amount of money is extremely small when seen in the context of Japan providing the vessel and associated costs, which it wishes to do although it has now left the IWC.

SC/68B/RP/25 IWC Strandings Initiative

This funding remains unspent due to its nature of being an emergency response fund and in this biennium no eligible requests being received. This funding will therefore be carried forward to 2021 with the same main purpose. Currently, a consultancy project let by the IWC Secretariat is underway to review the progress of the IWC Strandings Initiative overall and to develop a new four-year work programme. The outcome of this may indicate the need for revised Terms of Reference for the emergency response funding and thus any proposals for change in use of this funding will be made to the next meeting of the Scientific Committee in 2021.

SC/68B/RP/27 Franciscana Aerial Survey in Uruguay

Incidental mortality in the gillnet fisheries is the major threat to the franciscana dolphin. One of the greatest challenges to improve management of the species relates to the difficulty in estimating abundance in the Franciscana Management Area III (FMA III) where bycatch estimates are the highest across the species range. The issue relates to the fact that FMA III is shared between Uruguay and Brazil. The establishment of a Franciscana CMP by the IWC coupled with the current availability of multiple sources of funding provide a unique and unprecedented opportunity to develop an aerial survey to compute an abundance estimate for franciscanas in FMA III (both Brazil and Uruguay). Funds are available to survey the whole Brazilian portion of this area and part of Uruguay. Additional funds are requested to be able to complete a full survey in Uruguay. This estimate would be important for the ongoing review of franciscana status by the Committee and will be used in future assessments of the species.

22.2.5 Databases and catalogues

SC/68B/RP/29 Progressing the Development and Use of the IWC Ship Strikes Database

The purpose of this proposal is to further progress the development of the ship strikes database and to ensure the increased reporting of ship strikes incidents into this IWC database including through: (1) systematic outreach to data providers; (2) review and provision of data; (3) promoting access to information in the database; (4) increase use of the database; and (5) outreach to other organisations.

SC/68B/RP/03 Southern Hemisphere Blue Whale 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 1,700 individual blue whales have been contributed to the SHBWC from research groups working on areas off Antarctica, Chile, Peru, Ecuador, Galapagos, Eastern Tropical Pacific, Australia, Timor Leste, New Zealand, Indonesia, Sri Lanka and Madagascar. The 2021 project will focus on: (1) matching new photo-IDs received; (2) consolidating Sri Lanka catalogues for future assessments; (3) photo-quality coding of new entries from New Zealand and Chile; and (4) upgrade of the SHBWC software.

SC/68B/RP/33 Southern Hemisphere Blue Whale Catalogue (Chile)
Within the framework of the Southern Hemisphere blue whale catalogue (SHBWC, see SC/67B/RP/03), this project will focus on matching and quality control of ~200 new right-side photo-IDs received from a large blue whale catalogue held by Centro Ballena Azul and Universidad Austral de Chile, in order to proceed towards regional assessment of the Southeast Pacific blue whales.

SC/68B/RP/04 Reconciling a Long-term Photo-ID Database for Blue Whales in Chilean Patagonia
In 2006 the Committee agreed to initiate an *In-Depth Assessment* of Southern Hemisphere blue whales and in 2008, the Committee endorsed a proposal to establish a central web-based catalogue of blue whale identification photographs, known as the Southern Hemisphere Blue Whale Catalogue (SHBWC). This project will reconcile 10+ years of blue whale photo-ID work in northern Patagonia and consolidate these into the SHBWC.

SC/67B/RP/18 Compilation of the State of the Cetacean Environment Report (SOCER)
SOCER is in response to several Commission resolutions requesting regular updates on the state of the world's oceans as relevant to cetaceans. For 2021 the focus will be a regional overview of the state of the Pacific Ocean as relevant to cetaceans, including matters of global concern, based on the published literature in reviewed scientific journals in the period *ca* 2018-21. After the 5-year cycle of regional seas, this information will be incorporated into a 5-year global compendium.

SC/67B/RP/22 Ongoing Database Hosting by the Secretariat
The IWC Secretariat hosts several databases for the Committee. These have annual service costs associated with them including, web/database servers, storage, backups, software licences and other associated infrastructure or costs.

22.2.6 Gray Whale Tagging Fund
The Scientific Committee proposes that unspent voluntary contributions in the Gray Whale Tagging Fund are allocated to 'Research on and Monitoring of Endangered Western North Pacific Gray Whales Feeding off Sakhalin Island in 2020' (SC/68B/RP/32). This does not impact the Commission's core budget.

23. COMMITTEE PRIORITIES FOR THE BIENNIUM 2021-22 AND INITIAL AGENDA FOR 2021

Committee priorities can be found in the work plans incorporated by topic in this report. These will form the basis for the initial agenda for 2021.

24. WORKING METHODS OF THE COMMITTEE

24.1 Scientific Committee Handbook
The Scientific Committee Handbook has been updated by the Chair, vice-Chair and Scientist Emeritus and made ready for upload in a web-friendly manner. Some final technical adjustments are being made to ensure that it functions correctly on the website before going live by August 2020.

Suydam and Zerbini will review the Handbook intersessionally and propose updates at SC68C.

24.2 Biennial reporting to the Commission and related matters
The Committee's report will be made available to the Commission and the public in late June 2020. Because the Commission postponed IWC68 until September 2021, the Chair and vice-Chair will provide a report from the 2019, 2020, and 2021 Committee meetings at IWC68.

24.3 Capacity building and succession plan for Scientific Committee
The work of Punt continues to be followed by Wilberg (University of Maryland Center for Environmental Science) as part of ensuring ongoing expertise within the Committee.

Within the Secretariat, on 9 May 2020 after more than 40 years with the IWC, Donovan moved from Head of Science to Scientist Emeritus, a part-time, one-year position. His primary duty in that role is to complete legacy projects (reports and articles related to SOWER, the RMP, AWMP and ASW). The Committee **expresses deep appreciation** for the many decades of guidance and advice provided by Donovan to the Committee and is pleased that he will continue to be involved in the work of the Committee, including as Convenor for IST, as an independent scientist.

The Committee **welcomes** Staniland, the Secretariat's new Lead for Science in the Secretariat, who took on the role on 9 May 2020. Donovan will provide guidance for Staniland, as needed, during his Emeritus year.

24.4 Update on Data Availability requests and consideration of potential updates/clarifications
The Chair and vice-Chair are expected to propose an update to the Data Availability Agreement at SC68C.

24.5 Committee involvement in the IWC recommendations database
An update on the IWC Database of Recommendations (DoR) is provided in SC/68B/O/03. Further development of the database has been conducted over the past year, including addressing bugs, quality control of data and developing new permission levels for data entry (e.g. by SC Convenors).

The Secretariat has populated the database with all the recommendations from IWC67, including those of the 2017 and 2018 Scientific Committee meetings. Recommendations from SC68A in 2019 have also been entered, along with those of several Workshops. Back data entry is a priority, and options for this might include: (1) back data entry by paid Secretariat interns or casual contracts; (2) data entry by other interns; or (3) data entry by the Secretariat. The Secretariat has actively used the database to review implementation of IWC67 recommendations, particularly those actions directed at the Secretariat and keeps progress against these recommendations updated in the database. Release of the database online remains a high priority and it is anticipated it will be made publicly available on the IWC website in summer 2020. In the meantime, access is available for IWC stakeholders to test the database.

At this meeting, a range of outputs from the database were provided to facilitate the Committee's work including an output of 2017-19 recommendations for each sub-group. The Secretariat will update the database on progress with past recommendations and enter new recommendations. The Committee **welcomed** the progress made with the DoR and noted that several sub-groups had used the outputs from the database to review progress, providing the Secretariat with detailed updates. Feedback had also been given for quality control purposes.

The Committee **agreed** that it would be useful for Convenors to receive outputs from the DoR as soon as possible after recommendations from this meeting had been entered, and an update a month before the next Scientific Committee meeting.

It was noted that a new tool has been developed to allow Convenors and rapporteurs to enter recommendations directly into the database. This was welcomed and several individuals volunteered to enter data for their sub-committees.

Attention: S, SC
The Committee **welcomes** *progress on the IWC Database of Recommendations,* **encourages** *its further development (including back data entry) and its use by sub-committees and Working Groups to review implementation of recommendations.*

24.6 Governance Review: Review of papers from the Working Group on Operational Effectiveness

The Working Group on Operational Effectiveness (WGOE) was tasked at IWC67 to assess the Independent Panel Report (IWC, 2018b) on IWC governance, and review and propose a plan for implementation of appropriate recommendations. This process was established under Commission Resolution 2018-1 at IWC67. The WGOE met in July 2019 in London for a two-day Workshop and a report of that Workshop is available on the IWC website. The Chair of the SC served as a member of the WGOE and participated in the Workshop. Drafting groups were then formed to prepare four documents which were circulated amongst the WGOE members for a final review. Those documents were then posted in three languages on the IWC website[35] on 3 February 2020 for a three-month review. Comments were received from Contracting Governments as well as observers with a deadline of 1 May 2020 which was later extended to 15 May 2020. The WGOE co-Chairs agreed to receive comments from the Committee following the SC68B meeting. During SC68B, the WGOE proposed a new timeline given the postponement of the 2020 Commission meeting to 2021.

DeMaster developed a draft set of comments for consideration by the Committee. Suydam and Zerbini worked with the Heads of Delegation (HoD) and past Committee Chairs to review and modify the draft comments. Interim Committee comments will be submitted to the WGOE after the SC68B report is posted on the IWC website. It is expected that the WGOE will revise its documents and distributed them in September for additional review and another request for comments. Once those revised documents are available, the Chair and vice-Chair will again work with the HoD and past Chairs to review and comment, as appropriate.

24.7 Work plan

The Chair and vice-Chair will review intersessionally the Working Methods of the Committee and will make relevant proposals, in consultation with the Secretariat, for consideration at SC68C.

25. PUBLICATIONS

Publications at the IWC continue to strengthen, with advances being made over the past year to enable greater involvement of the Associate Editors in the editorial process and successful moves to raise the profile of the *Journal of Cetacean Research and Management* (*JCRM*) through the use of social media.

Issue 20 of the *Journal of Cetacean Research and Management* (JCRM 20, 2019) was published at the end of 2019, with papers uploaded throughout the year as they became available. In keeping with *JCRM* policy of open source free download, this volume is freely available online[36].

[35] *https://archive.iwc.int/pages/search.php?search=%21collection29736&k=.*

[36] *https://www.iwc.int/documents.*

A wide variety of papers were published in Issue 20, including notably 'Best practice guidelines for cetacean tagging' by Andrews *et al*. Five papers have already been published online this year in *JCRM* Issue 21, 2020[37]. Submissions to this volume will close on 31 December 2020. At that time papers not yet ready for upload will be rolled over into Issue 22, to be published in 2021. At present over 30 papers are progressing though the system.

The responsibilities of the Associate Editors in their oversight of the peer review process were consolidated during the year through increased use of the Online Journal System chat and e-mail facility, and the offer of individual help to those struggling to use the system. The use of the OJS system continues to be challenging. The Associate Editors are to be highly commended for their hard work and their increasingly proactive approach to their tasks. Regretfully Caterina Fortuna resigned during the year as an Associate Editor, we thank her for her diligence and patience and will miss her contributions. A new Associate Editor, Karen Stockin, has recently joined us. A system of monthly overall updates on progress of papers through the system, in the form of a general 'status report' to the Editorial Board, will soon be forthcoming.

Greater visibility for *JCRM* regular issues has been achieved by use of the IWC Twitter account (@iwc.int) to Tweet new papers as they are published. Authors are encouraged to supply relevant photographs to accompany Tweets and to share and retweet where possible, to further increase *JCRM* exposure on this and associated social media.

Improvements to the IWC's online archiving system (which *JCRM* currently uses to publish its volumes online) are still in the pipeline. The use of the DOI online numbering system to increase the web presence of papers published in *JCRM* as well as for other media such as data and photo-archives is being investigated, but this and other initiatives will require financial support.

The Report of the Scientific Committee (and intersessional Workshops) is published annually as a Supplement to *JCRM*. The report of the 2019 Scientific Committee meeting held in Nairobi, Kenya in 2019 has been made available for free download online as of April 2020[38]. All copies of the Supplement are freely available for download. Printing of the Supplement volume in the traditional way requires a relatively small monetary outlay, and the Secretariat intends to continue to produce a small number of printed copies each year.

The aim continues to be completion and publication of the IDCR/SOWER Cruises Commemorative *Special Issue* of the *JCRM* as soon as possible. It had been intended to have the majority of papers uploaded by the end of 2019 with the printed volume available for May 2020. Due to unforeseen delays, this was not possible and a number of the Editors of the volume (Brownell, Donovan, Palka and Kato) met briefly earlier in the year to develop a work plan to ensure that it is completed by the end of 2020. This will be facilitated by Donovan's transition to Scientist Emeritus. Papers will be uploaded as they become available and the first batch of at least ten will be ready for upload by the end of August 2020. It has also been agreed that the Secretariat will use the data within the IWC-DESS (Database Estimation System Software) to ensure consistency of style for the many maps that have been submitted in different styles and projections by the various authors.

In his capacity as Science Lead, Staniland took up the role of *JCRM* Editor as of May 2020 as part of his recent appointment as the new Lead for Science to the IWC Secretariat. The previous Editor, Greg Donovan, will continue to oversee the publication of the IDCR/SOWER Cruises Commemorative *Special Issue* of *JCRM* in his new role as Scientist Emeritus. The team has also welcomed back Andrea Cooke and Jessica Rowley from their recent maternity leaves. Special thanks to Jessica Haskell and Elsie Whittle for stepping in to temporarily cover *JCRM* system management and production roles last year; their help was much appreciated.

26. ADOPTION OF REPORT

The report was adopted on 7 July 2020.

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Annex B

Agenda

1. Introductory items
    - 1.1 Chair's welcome and opening remarks
    - 1.2 Remembrances
    - 1.3 Appointment of Rapporteurs
    - 1.4 Meeting procedures and time schedule
    - 1.5 Establishment of sub-committees and Working Groups

2. Adoption of Agenda

3. Review of available data, documents and reports
    - 3.1 Documents submitted
    - 3.2 National Progress Reports on research
    - 3.3 Data collection, storage and manipulation
    - 3.4 Guidance for the format of recommendations and discussion of Database of Recommendations
    - 3.5 Review of Commission Resolutions from 2018

4. Cooperation with other organisations
    - 4.1 Summary of Secretariat cooperation with other organisations
    - 4.2 African States Bordering the Atlantic Ocean (ATLAFCO)
    - 4.3 Arctic Council
    - 4.4 Convention on Biological Diversity (CBD)
    - 4.5 Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)
    - 4.6 Convention on the Conservation of Migratory Species (CMS)
        - 4.6.1 Scientific Council
        - 4.6.2 Conference of Parties
        - 4.6.3 Agreement on Small Cetaceans of the Baltic and North Seas (ASCOBANS)
        - 4.6.4 Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS)
    - 4.7 Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)
    - 4.8 Food and Agriculture Organisation of the United Nations (FAO)
    - 4.9 Inter-American Tropical Tuna Commission (IATTC)
    - 4.10 IUCN Task Force on Marine Mammal Protected Areas (formerly ICMMPA)
    - 4.11 International Council for the Exploration of the Sea (ICES)
    - 4.12 International Maritime Organisation (IMO)
    - 4.13 International Union for the Conservation of Nature (IUCN)
    - 4.14 North Atlantic Marine Mammal Commission (NAMMCO)
    - 4.15 North Pacific Marine Science Organisation (PICES)
    - 4.16 Protocol on Specially Protected Areas and Wildlife (SPAW) of the Cartagena Convention for the Wider Caribbean
    - 4.17 Other

5. General assessment and modelling issues
    - 5.1 Evaluate the energetics-based model and the relationship between $MSYR_{1+}$ and $MSYR_{mat}$
    - 5.2 Implications of ISTs for consideration of species' and populations' status
    - 5.3 Progress on previous recommendations and on the work plan

6. AWMP *Implementation*-related matters
    - 6.1 Common minke whales off Greenland
        - 6.1.1 Synthesis paper on testing framework and results for the 'G-common minke *SLA*' for common minke whales off West and East Greenland
        - 6.1.2 Conclusions on carryover and interim allowance for the 'G-common minke *SLA*'

6.2 *Implementation Review* for North Pacific gray whales (Chukotka and Makah hunts)
   6.2.1 Review of new information
   6.2.2 Undertake new modelling if deemed necessary
   6.2.3 Conclusions and workplan if required to complete the Implementation Review
   6.2.3 Conclusions on carryover and interim allowance for Eastern North Pacific gray whales
6.3 Progress on previous recommendations
6.4 Biennial work plan

7. Stocks subject to Aboriginal Subsistence Whaling (ASW)
   7.1 New information and progress on recommendations
      7.1.1 Eastern Canada/West Greenland bowhead whales
      7.1.2 North Pacific gray whales (see Item 6.2)
      7.1.3 Bering-Chukchi-Beaufort Seas bowhead whale
      7.1.4 Common minke whale stocks off East Greenland (see Item 6.1)
      7.1.5 Common minke whale stocks off West Greenland (see Item 6.1)
      7.1.6 Fin whales off West Greenland
      7.1.7 Humpback whales off West Greenland (see Item 8.1.4)
      7.1.8 Humpback whales off St. Vincent and The Grenadines (see Item 8.1.4)
   7.2 Biennial work plan

8. Whale stocks not subject to directed takes
   8.1 Comprehensive or In-depth Assessments
      8.1.1 Comprehensive Assessment of North Pacific humpback whales
      8.1.2 Comprehensive Assessment of North Pacific sei whales
      8.1.3 Progress on in-depth assessment of western North Pacific common minke whales
      8.1.4 Preparation for in-depth assessment of North Atlantic humpback whales (see Items 7.1.7 and 7.1.8)
      8.1.5 Biennial work plan
   8.2 Potential new assessments: progress on previous recommendations and prioritised work plan*
      8.2.1 Non-Antarctic blue whales in the Southern Hemisphere
      8.2.2 Antarctic blue whales
      8.2.3 Southern Hemisphere right whales not the subject of CMPs
      8.2.4 North Pacific blue whales
      8.2.5 North Atlantic sei whales
      8.2.6 North Atlantic right whales
      8.2.7 Gulf of Mexico Bryde’s whales
      8.2.8 Omura’s whale
      8.2.9 Biennial work plan
   8.3 New information for other northern stocks
      8.3.1 North Atlantic blue whales
      8.3.2 North Atlantic common minke whales
      8.3.3 Biennial work plan
   8.4 New information for other Southern stocks
      8.4.1 Southern Hemisphere humpback whales
      8.4.2 Southern Hemisphere fin whales
      8.4.3 Biennial work plan
   8.5 Progress on previous recommendations

9. Stocks that are or have been suggested to be the subject of Conservation Management Plans (CMPs)
   9.1 Stocks with existing CMPs: new information and progress with previous recommendations
      9.1.1 Southeast Pacific southern right whales
      9.1.2 Southwest Atlantic southern right whales
      9.1.3 North Pacific gray whales
      9.1.4 Franciscana
   9.2 Progress with identified priorities
      9.2.1 Humpback whales in the northern Indian Ocean including the Arabian Sea
      9.2.2 Central American humpback whales
      9.2.3 Mediterranean sperm whales
      9.2.4 Mediterranean fin whales
      9.2.5 South American river dolphins
      9.2.6 South Asian river dolphins

- 9.3 Progress on previous recommendations
- 9.4 Biennial work plan

10. Stock definition and DNA testing
    - 10.1 DNA testing and advice on stock structure to other sub-groups as required
        - 10.1.1 New techniques for species, stock, and individual identification
        - 10.1.2 Reference databases and standards for DNA registries
    - 10.2 DNA data quality and genetic analyses guidelines
        - 10.2.1 Review and finalise updated DNA quality guidelines (including Next Generation Sequencing data and precautions when using GenBank)
    - 10.3 Recommendations on the avoidance of sample depletion
    - 10.4 Review terminology used for stock structure related terms used within the IWC
    - 10.5 New genetic approaches of use to the Scientific Committee in addition to stock structure issues
    - 10.6 Progress on previous recommendations
    - 10.7 Biennial work plan

11. Cetacean abundance estimates, stock status
    - 11.1 Review of abundance estimates
    - 11.2 Review and provide advice on surveys (past and future)
    - 11.3 Methodological issues
        - 11.3.1 Amendments to RMP guidelines to consider model-based abundance estimates
        - 11.3.2 Progress on simulation software to evaluate methods for abundance estimates
        - 11.3.3 Consider diagnostic methods for mark-recapture models
        - 11.3.4 Review new survey techniques/equipment
    - 11.4 Provide advice to the Commission on the status of stocks
    - 11.5 Progress on previous recommendations
    - 11.6 Biennial work plan

12. Bycatch and entanglements
    - 12.1 IWC's Bycatch Mitigation Initiative
        - 12.1.1 Update on progress of Expert Panel
        - 12.1.2 Identification of pilot projects
        - 12.1.3 Review of other activities and provision of advice, if requested
    - 12.2 Review new methods and estimates of entanglement rates, risks and mortality
    - 12.3 Review mitigation measures for preventing bycatch and entanglement
    - 12.4 Reporting of bycatch (including small cetaceans) and large whale entanglements
        - 12.4.1 Review progress on the global entanglement database
        - 12.4.2 National progress reports
    - 12.5 Collaboration on bycatch mitigation with IGOs (including FAO, Regional Fisheries Management Organisations and others)
    - 12.6 Provide advice on observer schemes in South Africa
    - 12.7 Progress on previous recommendations
    - 12.8 Biennial work plan

13. Ship strikes
    - 13.1 Review new methods and estimates of rates of ship strikes, risk of ship strikes and mortality (including review progress on Ship Strike Database)
    - 13.2 Mitigation of ship strikes in high risk areas
        - 13.2.1 Review progress towards assessing and mitigating ship strikes in previously identified high risk areas
        - 13.2.2 Provide advice on routeing measures
        - 13.2.3 Review new research relevant to mitigation
    - 13.3 Co-operation with IMO Secretariat and relevant IMO committees
    - 13.4 Approach for requesting/providing marine traffic data
    - 13.5 Progress on previous recommendations
    - 13.6 Biennial work plan

14. Environmental concerns
    - 14.1 Chemical pollution
        - 14.1.1 Final report of the Pollution 2020 project

14.1.2 Review Terms of Reference and recommend a biennial work plan for Pollution 2025
14.2 Diseases of concern
14.3 Strandings and mortality events
14.3.1 Update on the IWC Strandings Initiative and work plan 2020-22
14.3.2 New information on unusual mortality events
14.4 Progress from workshop on noise
14.5 Review the Report of the Workshop on Marine Debris
14.6 SOCER Report (Atlantic Ocean)
14.7 Progress on previous recommendations
14.8 Biennial work plan

15. Ecosystem modelling
15.1 Cooperation with CCAMLR and CMS on multi-species modelling including progress from workshop(s)
15.1.1 Plan for postponed Workshop on the Role of Cetaceans in Ecosystem Functioning: Gap Analysis
15.1.2 Finalise response to Commission's request on review of contributions of cetaceans to ecosystem functioning (Resolution 2016-3)
15.1.3 Planning of the future joint IWC-CCAMLR workshop(s) and possible MoU
15.2 Progress on species distribution models (SDMs)
15.3 Modelling of competition among whales including progress with IBEMs
15.4 Standing topics
15.4.1 Progress on considering effects of long-term environmental variability on whale populations
15.4.2 Review progress on evaluation of krill distribution and abundance
15.5 Progress on previous recommendations
15.6 Biennial work plan

16. Small cetaceans
16.1 Review and consolidation of previous recommendations
16.2 Poorly documented hunts of small cetaceans for food, bait or cash and changing patterns of use including summary of workshops and databases
16.3 Small Cetacean Task Team
16.4 Review of intersessional workshops on *Sotalia guianensis*
16.5 Review direct takes and live captures of small cetaceans
16.6 Status of the Voluntary Fund for Small Cetacean Conservation Research
16.7 Biennial work plan

17. Whale watching
17.1 Assess the impacts of whale watching and swim-with-whale operations on cetaceans
17.1.1 Studies on assessing impacts: (i) short-term; (ii) mid- to long-term; (iii) swim-with operations; and (iv) emerging areas of concern
17.1.2 Progress on plans for 3rd Workshop on Modelling and Assessment of Whale Watching Impacts (MAWI)
17.2 Finalise IWC's General Principles for Whale Watching
17.3 Progress with regional reviews of whale watching
17.3.1 Sri Lanka
17.3.2 Latin America
17.4 Collaborative work within the IWC
17.4.1 IWC's Whale Watching Handbook
17.4.2 Work of the Conservation Committee Standing Working Group on Whale Watching
17.4.3 Collaboration with other SC sub-committees on platforms of opportunity and citizen science
17.5 Progress on previous recommendations
17.6 Biennial work plan

18. Whale sanctuaries
18.1 Updates from relevant sub-committees on new information relevant to the SOS management plan
18.2 New information for other sanctuaries
18.3 Biennial work plan

19. IWC list of recognised species

20. IWC databases and catalogues
    20.1 Guidelines for IWC catalogues and photo-ID databases
    20.2 Progress with existing or proposed new catalogues
        20.2.1 Southern Hemisphere right whale photo catalogues
        20.2.2 Happywhale database
        20.2.3 Arabian Sea Whale Network's Flukebook
        20.2.4 Southern Hemisphere Blue Whale Catalogue (SHBWC)
        20.2.5 Antarctic Blue Whale Catalogue (ABWC)
        20.2.6 Fin whale photo catalogues
        20.2.7 Western gray whale catalogue
    20.3 Progress with existing IWC databases
    20.4 Potential future IWC databases
        20.4.1 Global database for disentanglement activities
        20.4.2 Global bycatch database

21. IWC multinational research programmes and national research cruises that require IWC endorsement
    21.1 IWC-POWER and co-operation with Japan
    21.2 Southern Ocean Research Partnership (IWC-SORP)
    21.3 National cruises that require IWC oversight
    21.4 Work plan

22. Scientific Committee budget for the current biennium
    22.1 Status of funded research, workshop proposals, data processing and computing needs
        22.1.1 Funded proposals for the current biennium 2019-20
        22.1.2 Funded proposals in previous years still ongoing
        22.1.3 Report on funds reallocations and contingencies for the Research Fund, Voluntary Fund for Small Cetaceans and SORP Voluntary Fund
    22.2 Proposed budget for 2021-22 developed under the Committee's guidelines

23. Committee priorities for the biennium 2021-22 and initial Agenda for 2021

24. Working methods of the Committee
    24.1 Updates on Rules of Procedure and Handbook of the Scientific Committee
    24.2 Biennial reporting to the Commission and related matters
    24.3 Capacity building and succession plan for Scientific Committee
    24.4 Update on Data Availability requests and consideration of potential updates/clarifications
    24.5 Committee involvement in the IWC Database of Recommendations
    24.6 Governance Review: Review of papers from the Working Group on Operational Effectiveness
    24.7 Any other matters
    24.8 Biennial work plan

25. Publications

26. Adoption of Report

Annex C

List of Documents

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01. Calambokidis, J., Pérez, A. and Laake, J. Updated analysis of abundance and population structure of seasonal gray whales in the Pacific Northwest, 1996-2017. 73pp.
02. Givens, G.H., George, J.C., Suydam, R. and Tudor, B. Bering-Chukchi-Beaufort Seas bowhead whale (*Balaena mysticetus*) abundance estimate from the 2019 ice-based survey. 19pp.
03. Crespo, E.A., Coscarella, M.A., Arias, M. and Sueyro, N. Abundance estimation of franciscana dolphins by means of aerial surveys in Buenos Aires Province, Argentina. 8pp.

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04. Sucunza, F., Danilewicz, D., Secchi, E.R., Andriolo, A., Cremer, M., Flores, P.A.C., Ferreira, E., de S. Alves, L.C.P., de Castro, F., Pretto, D., Sartori, C.M., Schulze, B., Denuncio, P., Perez, M.S. and Zerbini, A.N. Assessing bias in aerial surveys for threatened cetaceans: results from experiments conducted with the Franciscana (*Pontoporia blainvillei*). 33pp.

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05. Sucunza, F., Danilewicz, D., Ott, P.H., Neves, M., Berchieri, N., Farro, A., P., Martins, A. and Zerbini, A.N. Population size and IUCN Red Listing of the isolated population of the franciscana (*Pontoporia blainvillei*). 25pp.
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09. Ferguson, M.C. Bering-Chukchi-Beaufort Seas bowhead whale (*Balaena mysticetus*) abundance estimate from the 2019 aerial line-transect survey. 48pp.
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13. Øien, N. Plan for conducting annual partial sighting surveys in the Northeastern Atlantic over the six-year period 2020-2025 to estimate abundance of minke whales. 4pp.
14. Hakamada, T., Takahashi, M., Matsuoka, K. and Miyashita, T. Outline of the research plan for Japan's dedicated cetacean sighting surveys in the western North Pacific Ocean in summer 8pp.
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08. Moazzam, M., Nawaz, R., Khan, B. and Ahmed, S. Whale distribution in the Northern Arabian Sea along coast of Pakistan in 2019 based on the information obtained through Fisheries Crew-Based Observer Programme. 11pp.
09. Urbán R., J., Swartz, S.L., Martínez, A.S. and Viloria, G.L. 2020 gray whale abundance in Laguna San Ignacio and Bahía Magdalena.B.C.S., Mexico. 16pp.
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11. IWC. WGOE Paper 4. IWC Budget Reform Strategy draft version 2.1, 3 February. For consultation. 72pp.
12. IWC Secretariat. Secretariat update to the Scientific Committee on cooperation with other organisations. 6pp.

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14. Research Proposal for IA - Second Workshop on the Comprehensive Assessment of North Pacific Humpback Whales. 7pp.
15. Research Proposal for IA - Essential computing support to the Secretariat for IA for the in-depth assessment of Western North Pacific common minke whales. 9pp.
16. Research Proposal for IA - Mixed-stock analysis and population assignment of North Pacific humpback whales to assist in allocation of catches. 11pp.
17. Research Proposal for IA - Assessment modelling for an in-depth assessment of North Pacific sei whales - 8pp.
18. Research Proposal for E - Compilation of the State of the Cetacean Environment Report (SOCER) for 2021. 10pp.
19. Research Proposal for ASI - Pre-meeting of the Abundance Steering Group and the Intersessional Steering Group on Status of Stocks. 7pp.
20. Research Proposal for IST - 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 - updated proposal from last year. 7pp.
21. Research Proposal for ASI - IWC-POWER cruise in 2021 including associated meetings and processing. 9pp.
22. Research Proposal for Secretariat - Ongoing database hosting by the Secretariat. 5pp.
22rev1. Research Proposal for Secretariat - Ongoing database hosting by the Secretariat. 4pp.
23. Research Proposal for CMP - Franciscana assessment workshop. 11pp.
24. Research Proposal - Climate Change Workshop: Charting a path for the IWC Scientific Committee - a review of available information on effects on cetaceans and recommendations for a way forward.: 12pp.
25. Research Proposal for E - IWC Strandings Initiative - emergency response and investigations. 14pp.
26. NO PAPER.
27. Research Proposal for SM - A franciscana aerial survey in Uruguay: overcoming a challenge. 10pp.
27rev1. Research Proposal for SM - A franciscana aerial survey in Uruguay: overcoming a challenge. 13pp.
28. Research Proposal for IA - Workshop to further the in-depth assessment of Western North Pacific minke whales with a focus on J-stock(s). 7pp.
29. Research Proposal for HIM - Progressing the development and use of the IWC Ship Strikes Database. 11pp.
30. Research Proposal for WW - Chile-Peru Workshop of Experience Exchange on Whale Watching Regulation and Research Permit Systems. 11pp.
31. Research Proposal for E - Cetacean diseases of concern, morbillivirus and brucella and their interaction with other immune suppressive stressors. 10pp.
32. Research Proposal for CMP - Research on and monitoring of endangered Western North Pacific gray whales feeding off Sakhalin Island in 9pp.
33. Research Proposal for SH - RP03B - Southern Hemisphere Blue Whale Catalogue 2021 - matching of new photo-IDs (right hand side only) from Centro Ballena Azul and Universidad Austral de Chile. 10pp.

REPORTS OF INTERSESSIONAL MEETINGS

SC/68B/Rep/

01. Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG), 18-19 January 2020, Tokyo, Japan. 24pp.
02. Report of the Planning Meeting for the 2020 IWC-POWER Cruise, 20 January 2020, Tokyo, Japan. 15pp.
03. Report of the IWC Workshop on Marine Debris: The Way Forward. 3-5 December 2019, La Garriga, Catalonia, Spain. 39pp.
04. Report of the South Asian River Dolphin Task Team Workshop, Kuala Lumpur, Malaysia, 19-21 July 2019. 31pp.
04rev1. Report of the South Asian River Dolphin Task Team Workshop, Kuala Lumpur, Malaysia, 19-21 July 2019. 31pp.
05. Report of the *Sotalia guianensis* Pre-assessment Workshop, 26-28 November 2019, São Paulo, Brazil. 64pp.
06. Report of the Pre-Meeting on Advancing Efforts to Address Underwater Noise from Shipping, 11 May 2020, Virtual Meeting. 7pp.

Annex D

The AWMP/RMP *Implementation Simulation Trials* for the North Atlantic Minke Whales

The operating model for the trials used in the development of *SLA*s for East and West Greenland 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), IWC (2004a, p.12-13) and IWC (2009, p.138).

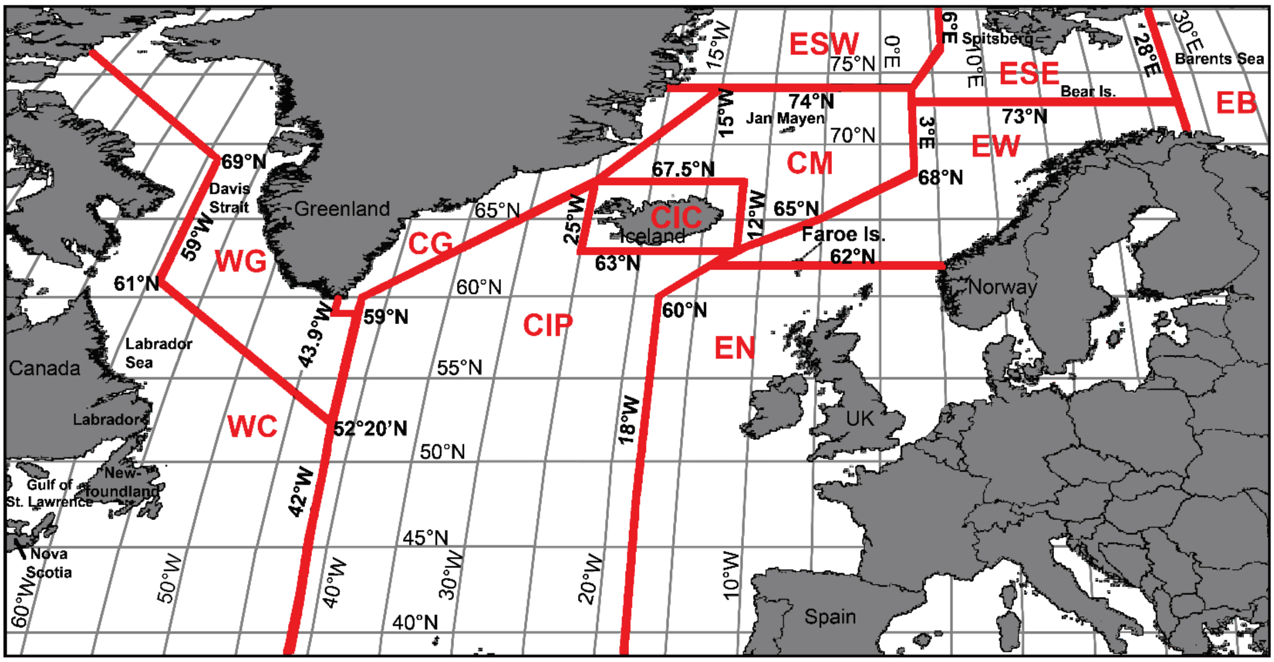

Fig. 1. Map of the North Atlantic showing the sub-areas defined for the North Atlantic minke whales.

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 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).

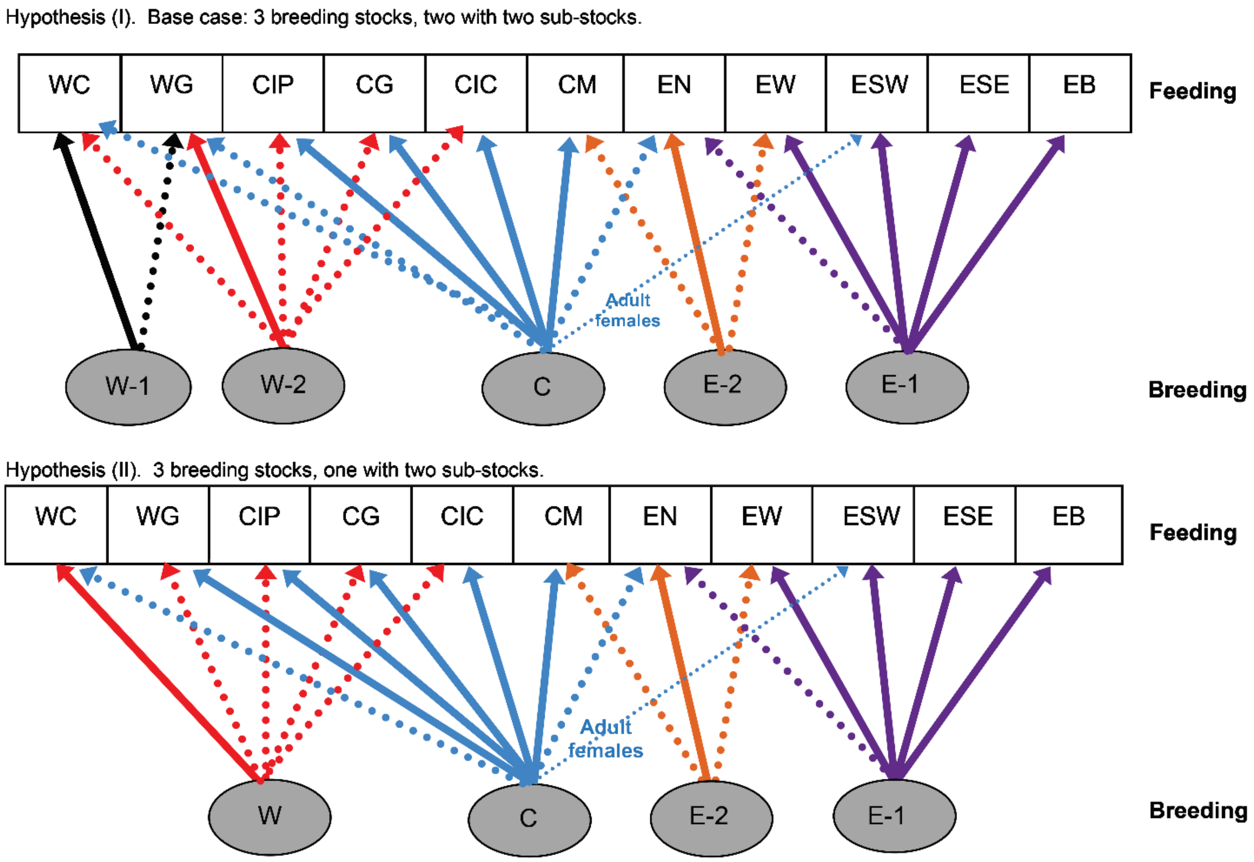

Fig. 2. Stock structure hypotheses for North Atlantic Minke whales. [The ranges of the W and C stocks are updated from the model used in the RMP *Implementation Review* based on results of genetic analyses (IWC, 2019, item 3.2)].

[1]Hypotheses III and IV tested in the RMP *Implementation Review* were dropped from further consideration because the results of the genetic analyses (IWC, 2019, item 3.2) indicate that these stock structure hypotheses are not consistent with the available information.

B. Basic dynamics

The dynamics of the animals in stock/sub-stock j are governed by equation B.1:

$$N^{g,j}_{t+1,a}=\begin{cases}0.5b^{j}_{t+1} & \text{if } a=0\\ (N^{g,j}_{t,a-1}-C^{g,j}_{t,a-1})\tilde{S}_{a-1} & \text{if } 1\le a<x\\ (N^{g,j}_{t,x}-C^{g,j}_{t,x})\tilde{S}_{x}+(N^{g,j}_{t,x-1}-C^{g,j}_{t,x-1})\tilde{S}_{x-1} & \text{if } a=x\end{cases} \tag{B.1}$$

where:

$N^{g,j}_{t,a}$ is the number of animals of gender g and age a in stock/sub-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/sub-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/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.

$$b^{j}_{t}=B^{j}N^{\mathrm{f},j}_{t}\{1+A^{j}(1-(N^{1+,j}_{t}/K^{1+,j})^{z^{j}})\} \tag{C.1}$$

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;

$N^{\mathrm{f},j}_{t}$ is the number of 'mature' females in stock/sub-stock j at the start of year t:

$$N^{\mathrm{f},j}_{t}=\sum_{a=3}^{x}\beta_a N^{\mathrm{f},j}_{t,a} \tag{C.2}$$

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:

$$K^{\mathrm{f},j}=\sum_{a=3}^{x}\beta_a N^{\mathrm{f},j}_{-\infty,a} \tag{C.3}$$

$N^{1+,j}_{t}$ is the number of 1+ animals in stock/sub-stock j at the start of year t:

$$N^{1+,j}_{t}=\sum_{g}\sum_{a=1}^{x}N^{g,j}_{t,} \tag{C.4}$$

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 ratios 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 are given in sections E and G.

$$C_{t,a}^{g,j} = \sum_{k}\sum_{h \in k} F_t^{g,h} V_{t,a}^{g,j,k} \tilde{S}_a^{g,h} N_{t,a}^{g,j} \tag{D.1}$$

$$F_t^{g,h} = \frac{C_t^{g,h}}{\sum_{j'}\sum_{a'} V_{t,a'}^{g,j',k} \tilde{S}_{a'}^{g,h} N_{t,a'}^{g,j'}} \tag{D.2}$$

where:

$F_t^{g,h}$ is the exploitation rate in hunt h (within sub-area k) on fully recruited ($S_a^g \rightarrow 1$) whales of gender g during year t;

$V_{t,a}^{g,j,k}$ is the fraction of animals in stock/sub-stock j of gender g and age a that is in sub-area k during year t;

$\tilde{S}_{a'}^{g,h}$ is the fishing selectivity on animals of gender g and age a by hunt h (within sub-area k), which is based on the reference selectivity $R_a^{g,h \in k}$ (see Equation G.7):

$C_t^{g,h}$ 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.9).

The maximum exploitation rate for future removals from the WG sub-area (catch as a proportion of the number of 1+ whales) is set equal to twice the maximum historical aboriginal exploitation rate achieved by aboriginal hunters (IWC, 2018b, pp.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.

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 sub-areas 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^{2}s (see Table 2).

This variation in future abundance is implemented by applying a power parameter to the mixing matrix entries for each sub-area and year. The power parameters are generated every year from $U\left[\max\left(0,1-\chi_k\right),1+\chi_k\right]$, where the χ_k parameters defining the power parameter distributions are selected such that the realised 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.

[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.

Table 1

The mixing matrices. The γs and Ωs indicate that the entry concerned is estimated during the conditioning process.

	WC	WG	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB
Stock structure hypothesis I											
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											
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}	-	-	-

Density dependent mixing

The hunt of minke whales in West Greenland is relatively large compared with the estimates of absolute abundance for the area, but a constant female biased sex ratio in catches over the last 20 years indicates that the hunt is sustainable and that the hunt is likely to be supported by whales from other areas. Operating model variants that allow for density-dependent mixing were also developed that involved:

$$V_{t,a}^{g,j,k} = V_{t,a}^{g,j,k} Q_t^{g,k} \Big/ \sum_{k'} V_{t,a}^{g,j,k'} Q_t^{g,k'} \tag{E.1}$$

where $Q_t^{g,k}$ is a quantity that accounts for the attractiveness of sub-area *k* for animals of gender *g* relative to the other sub-areas during year *t*, defined as:

$$Q_t^{g,k} = (\tilde{Q}^g)^{(1-\tilde{N}_t^{g,k}/\tilde{N}_{-\infty}^{g,k})} \tag{E.2}$$

for the WG sub-area and 1 otherwise;

$\tilde{Q}^g$ are the two parameters (for male and female) that define how mixing rates change with density; and

$$\tilde{N}_t^{g,k} = \sum_j \sum_{a\ge1} V_{t,a}^{g,j,k} N_{t,a}^{g,j} \qquad \tilde{N}_{-\infty}^{g,k} = \sum_j \sum_{a\ge1} V_{-\infty,a}^{g,j,k} N_{-\infty,a}^{g,j} \tag{E.3}$$

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 sub-area. 'Adjusted' CVs equal 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 (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.

Table 3

The estimates of abundance and their sampling standard errors.

Year	Sub-area	Abundance	CV	Year	Sub-area	Abundance	CV	Year	Sub-area	Abundance	CV
2007	WC	20,741	0.3	1987	CIC	24,532	0.32	1989	EW	20,991	0.17
1987	WG*	3,266	0.31	2001	CIC	43,633	0.19	1995	EW	34,986	0.12
1993	WG*	8,371	0.43	2007	CIC	20,834	0.35	1996	EW	23,522	0.13
2005	WG	10,792	0.59	2009	CIC	9,588	0.24	2006	EW	27,152	0.218
2007	WG	9,066	0.39	2015	CIC	12,710	0.53	2011	EW	21,218	0.32
2015	WG	5,095	0.46	1988	CM	4,732	0.23	1995	ESW	2,691	0.29
1988	CIP	8,431	0.245	1995	CM	12,043	0.28	1999	ESW	1,932	0.68
2001	CIP	3,391	0.82	1997	CM	26,718	0.14	2008	ESW	5,009	0.29
2007	CIP	1,350	0.38	2005	CM	26,739	0.39	1989	ESE	13,370	0.19
2015	CIP	6,306	0.345	2010	CM	10,991	0.36	1995	ESE	23,278	0.11
1995	CIP+CG*	4,854	0.27	1989	EN	8,318	0.25	1999	ESE	16,241	0.25
1987	CG	1,555	0.26	1995	EN	22,536	0.23	2003	ESE	19,377	0.33
2001	CG	7,349	0.31	1998	EN	13,673	0.25	2008	ESE	22,281	0.18
2007	CG	1,048	0.6	2004	EN	6,246	0.47	1989	EB	21,868	0.21
2015	CG	5,489	0.35	2009	EN	6,891	0.31	1995	EB	29,712	0.18
								2000	EB	25,885	0.24
								2007	EB	28,625	0.23
								2013	EB	34,125	0.34

*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*).

Table 4a

Sighting survey plan. The pattern of surveys from 2020-25 will be repeated every 6 years in the E sub-areas, every 7 years in the C sub-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).

	Country			
Season	Norway	Iceland	Greenland	Assessment year
2014	-	-	-	-
2015	-	CIC, CIP, CG	WG	-
2016	CM*, EB, EW, ESW, ESE[Δ]	-	-	Yes
2017	EN	-	-	-
2018	-	-	-	-
2019	-	-	-	-
2020	EW	-	-	-
2021	ESW, ESE	-	-	Yes
2022	EB	CIC, CIP, CG, CM	-	-
2023	EN	-	-	-
2024	-	-	-	-
2025	-	-	WG	-

*CM was covered as a NAMMCO joint effort in TNASS-2015 but the combined survey estimate is not yet available. [Δ]The results of the surveys conducted in sub-areas CM, EW, ESW and ESE during 2014 and 2015 are not yet available and are therefore assumed to apply to 2016.

Table 4b

List of past and planned sightings surveys and the constituents of estimates for areas that are combinations of sub-areas. -=No survey, 1=survey.

	CIP	CG	CIC	CM	CIP, CIC, CM	All C sub-areas	EN	EW	ESW	ESE	EB	EB, ESW, ESE, EW	EB, EW	ESW, ESE	All E sub-areas
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

*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.

F. Generation of Data

The actual historical estimates of absolute abundance provided to the RMP (and their associated CVs) 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 in setting the catch limit for 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):

$$\hat{P} = PYw \,/\, \mu = P^* \beta^2 Yw \qquad \text{(F.1)}$$

where:

Y is a lognormal random variable $Y = e^{\varepsilon}$ where $\varepsilon \sim N(0;\sigma_{\varepsilon}^2)$ and $\sigma_{\varepsilon}^2 = \ell n(1+\alpha^2)$;

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:

$$P = P_t^K = \sum_{k\in F}\sum_j\sum_g\sum_{a\geq 1} V_{t,a}^{g,j,k} N_{t,a}^{g,j} \qquad \text{(F.2)}$$

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; 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; 1994, p.85), the ratio $\alpha^2 : \beta^2 = 0.12 : 0.025$, so that:

$$CV^2(\hat{P}) = \tau(0.12 + 0.025P^* \,/\, P) \qquad \text{(F.3)}$$

The value of τ is calculated from the survey sampling CV's of earlier surveys in area *K*. If $\overline{CV^2}$ is the average value of CV^2 estimated for each of these surveys, and $\overline{P}$ is the average value of the total (1+) population sizes in area K in the years of these surveys, then:

$$\tau = \overline{CV^2} \,/ (0.12 + 0.025P^* \,/\, \overline{P}) \qquad \text{(F.4)}$$

Note therefore that:

$$\alpha^2 = 0.12\tau \qquad \beta^2 = 0.025\tau \qquad \text{(F.5)}$$

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:

$$\sigma_{\varepsilon}^2 = \ell n\left(1 + \alpha^2 + CV_{add}^2\right) \qquad \text{(F.6)}$$

An estimate of the *CV* is generated for each sighting survey estimate of abundance $\hat{P}$:

$$CV\left(\hat{P}\right)_{est}^2 = \sigma^2 \chi^2 \,/\, n \qquad \text{(F.7)}$$

where $\sigma^2 = \ell n\left(1 + \alpha^2 + \beta^2 P^* / \hat{P}\right)$, and

χ^2 is a random number from a Chi-square distribution with *n* degrees of freedom (where *n*=10, as used for the North Pacific minke whale *Implementation Trials*; IWC (2004b)).

The CVs used by Norway when applying the RMP to the E *Medium Area* during the *catch cascading* process account for process error. However, the trials considered at the 2016 Scientific Committee ignored process error, which led to larger catch limits than would be expected in reality. The trials were therefore modified to multiply the CVs of abundance estimates for the E *Medium Area* by the slope of a regression of the CVs for the E *Medium Area* which took process error into account against the CVs for this Area when process error is ignored (1.43) (IWC, 2018b).

G. Parameters and conditioning

The values for the biological and technological parameters are listed in Table 5a.

Table 5a

The values for the biological parameters that are fixed and the selectivity parameters by area

Parameter	Value
Plus group age, x	20 years
Natural mortality, M	$M_a = \begin{cases} 0.085 & \text{if } a \le 4 \\ 0.0775 + 0.001875a & \text{if } 4 < a < 20 \\ 0.115 & \text{if } a \ge 20 \end{cases}$
Maturity (first parturition), β_a	$a_{50} = 8$; $\delta = 1.2$
Maximum Sustainable Yield Level, *MSYL*	0.6 in terms of the 1+ population
Selectivity 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 trials with density-dependent mixing estimate two additional parameters ($\tilde{Q}$ for males and females). 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 four components (or five in trials that allow for density-dependent mixing). Equations G.2, G.3, G.5, G.8 and G.11 list the negative of the logarithm of the likelihood for each of these components so the objective function minimised is $L_1+L_2+L_3+L_4$. 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:

$$P_t^k = O_t^k \exp\left[\mu_t^k - \left(\sigma_t^k\right)^2 / 2\right];\ \mu_t^k \sim N\left[0;\left(\sigma_t^k\right)^2\right] \tag{G.1}$$

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 negative log-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 nth estimate of abundance P_n (the target abundances).

(b) Mixing Proportions

Table 5b 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 IWC (2019, item 3.4). In order to ensure that the conditioning leads to the specified model predictions, the mixing proportions are fixed (not generated) in the conditioning process and assigned low CVs (0.01).

Table 5b

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-area				
		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

The contribution of the mixing proportions to the negative log-likelihood is given by:

$$L_2 = 0.5 \sum_n \tfrac{1}{\sigma_n^2} (\rho_n - \hat{\rho}_n)^2 \tag{G.3}$$

where:

ρ_n is the *n*th stock mixing proportion; and

$\hat{\rho}_n$ is the model-estimate corresponding to the *n*th stock mixing proportion, i.e.:

$$\hat{\rho}_n = \sum_{t\in t^*} \sum_g \sum_a V_{t,a}^{g,j^*,k^*} N_{t^*,a}^{g,j^*} \Big/ \sum_{t\in t^*} \sum_j \sum_g \sum_a V_{t,a}^{g,j,k^*} N_{t,a}^{g,j} \tag{G.4}$$

t^*, k^*, j^* are the year range (2000-2015), sub-area and stock corresponding to the *n*th stock mixing proportion.

(c) Average sex ratios

The parameters used to define the catch and the sightings mixing matrices are estimated during the conditioning process. The data on catch sex-ratios by month for North Atlantic minke whales (see Adjunct 2) 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 the WG sub-area and in July for all other sub-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 for those for sub-areas 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 negative log- likelihood from the survey sex ratios is given by:

$$L_3 = 0.5\sum_k \left(\hat{\lambda}^{1,k} - \lambda^{1,k}\right)^2 / \left(\sigma^{1,k}\right)^2 \qquad \text{(G.5)}$$

where:

$\lambda^{1,k}$ is the target sex-ratio (proportion of females) for sub-area k in the pristine population during the month in which surveys take place;

$\hat{\lambda}^{1,k}$ is the model-estimate of the sex-ratio for sub-area *k* in the pristine population:

$$\hat{\lambda}^{1,k} = \frac{\sum_a \sum_j V^{f,j,k}_{-\infty,a} S^{f,k}_a N^{f,j}_{-\infty,a}}{\sum_g \sum_{a'} \sum_{j'} V^{g,j',k}_{-\infty,a'} S^{g,k}_a N^{g,j'}_{-\infty,a'}} \qquad \text{(G.6)}$$

$\sigma^{1,k}$ is the between-period variation in the sex-ratios for sub-area k during the month in which surveys take place (see SEs given in Table 6).

$S^{g,k}_a$ is the survey selectivity for gender g in sub-area k and is equal to the 'Reference' selectivity $R^{g,h\in k}_a$ where:

$$R^{g,h}_a = (1+e^{-(a-a^{g,h}_{50}/\delta g,h)})^{-1} \qquad \text{(G.7)}$$

$a^{g,h}_{50}, \delta^{g,h}$ are the parameters of the (logistic) selectivity ogive for gender g and hunt h (see Table 5a); and

in sub-area WG (where there are two hunts), the survey selectivity is based on the reference selectivity of the commercial hunt ($R^{g,h=\text{WG-com}}_a$) rather than the aboriginal hunt (see Table 7 for the relationship between the 'Reference' selectivity and the survey selectivity values).

Table 7

Relationship between hunts, sub-areas and the selectivity arrays.

Hunt (*h*)	**WC**	**WG-com**	**WG-ab**	**CIP**	**CG**	**CIC**	**CM**	**EN**	**EW**	**ESW**	**ESE**	**EB**
Sub-area (*k*)	**WC**	**WG**	**-**	**CIP**	**CG**	**CIC**	**CM**	**EN**	**EW**	**ESW**	**ESE**	**EB**
Parameters used in setting the Reference selectivity $R_a^{g,h}$ (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 best reflect 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 $\sigma^{2,\text{h}}$	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

$$L_4 = 0.5\sum_h \left(\hat{\lambda}^{2,h} - \lambda^{2,h}\right)^2 / \left(\sigma^{2,h}\right)^2 \qquad \text{(G.8)}$$

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:

$$\hat{\lambda}^{2,h} = \sum_t \left\{ \left(C_t^{\mathrm{m},h} + C_t^{\mathrm{f},h}\right) \frac{\sum_a \sum_j \sum_{k\in h} V_{t,a}^{\mathrm{f},j,k} \tilde{S}_a^{\mathrm{f},h} N_{t,a}^{f,j}}{\sum_g \sum_{a'} \sum_{j'} \sum_{k\in h} V_{t,a'}^{g,j',k} \tilde{S}_{a'}^{g,h} N_{t,a'}^{f,j'}} \right\} / \sum_{t'} \left(C_{t'}^{\mathrm{m},h} + C_{t'}^{\mathrm{f},h}\right) \qquad \text{(G.9)}$$

$\tilde{S}_a^{g,h}$ is the fishing selectivity on animals of gender g and age a by hunt h (within sub-area k) which is based on the reference selectivity $R_a^{g,h}$ (see Equation G.5 and Table 7):

$$\tilde{S}_a^{\mathrm{m},h} = \omega^h R_a^{\mathrm{m},h} \quad \text{and} \quad \tilde{S}_a^{\mathrm{f},h} = R_a^{\mathrm{f},h} \qquad \text{(G.10)}$$

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).

(d) Time-series of sex ratios for West Greenland

The trials that allow for density-dependent mixing include an additional component to the negative log-likelihood that reflects the time series of sex ratios for West Greenland.

$$L_5 = \sum_t \left(\ell n\sigma_C + \frac{1}{2\sigma_C^2}[\mathrm{logit}(\phi_t^{\mathrm{WG}}) - \mathrm{logit}(\hat{\phi}_t^{\mathrm{WG}})]^2 \right) \qquad \text{(G.11)}$$

where:

ϕ_t^{WG} is the observed catch sex ratio in the West Greenland sub-area during year t for years 1994-2015,

$\hat{\phi}_t^{WG}$ is the model-estimate corresponding to ϕ_t^{WG} :

$$\hat{\phi}_t^{WG} = \frac{\sum_a \sum_j V_{t,a}^{\mathrm{f},j,WG} \tilde{S}_a^{\mathrm{f},h} N_{t,a}^{f,j}}{\sum_g \sum_{a'} \sum_{j'} V_{t,a'}^{g,j',WG} \tilde{S}_{a'}^{g,h} N_{t,a'}^{f,j'}} \qquad \text{(G.12)}$$

σ_C quantifies the extent of variability in catch sex-ratio.

The additional estimable parameters for the model are the density-dependence parameter $\tilde{Q}^g$ for the two sexes.

H. Trials

Table 9 summarises the factors considered in the trials. Table 10 lists the set of trials. Need envelopes for West Greenland 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). The need envelope for East Greenland is constant and equal to 20 per year.

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 and Robustness Trials*.

Factor	Values
MSYR	1% (1+), 4% (mature), 4% (1+)
Need envelope (West Greenland)	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.

Table 10

The final set of trials. Trials M03, M05 and M07 were initially included in the *Evaluation Trials*, but at the SC meeting in 2018 it was agreed trials using 94% proportions (mixing proportions A2,A4 and A6) would be relegated to *Robustness Trials*. Trials are performed for each of the Need envelopes (A, B or C)

Trial	*MSYR*	Stock Hypothesis	Mixing Proportions	Mixing	Survey Bias	Survey period	Survey CV	Condition
Evaluation Trials								
M01	1% (1+) & 4 % (mat)	1	A1	Independent	1	10	Base	Yes
M02	1% (1+) & 4 % (mat)	2	B1	Independent	1	10	Base	Yes
M04	1% (1+) & 4 % (mat)	1	A3	Independent	1	10	Base	Yes
M06	1% (1+) & 4 % (mat)	1	A5	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
Robustness Trials								
M03	1% (1+) & 4 % (mat)	1	A2	Independent	1	10	Base	Yes
M05	1% (1+) & 4 % (mat)	1	A4	Independent	1	10	Base	Yes
M07	1% (1+) & 4 % (mat)	1	A6	Independent	1	10	Base	Yes
M21	1% (1+) & 4 % (mat)	1	A1	Independent	0.8	10	Base	Yes
M22	1% (1+) & 4 % (mat)	2	B1	Independent	0.8	10	Base	Yes
M23	1% (1+) & 4 % (mat)	1	A1	Independent	1.2	10	Base	Yes
M24	1% (1+) & 4 % (mat)	2	B1	Independent	1.2	10	Base	Yes
M25	1% (1+) & 4 % (mat)	1	A1	Independent	1	15	Base	
M26	1% (1+) & 4 % (mat)	2	B1	Independent	1	15	Base	
M27	1% (1+) & 4 % (mat)	1	A1	Independent	1	10	Base + 0.05	
M28	1% (1+) & 4 % (mat)	2	B1	Independent	1	10	Base + 0.05	
M29	1% (1+) & 4 % (mat)	1	A1	Independent	1	10	Base - 0.05	
M30	1% (1+) & 4 % (mat)	2	B1	Independent	1	10	Base - 0.05	
M31	4% (1+)	1	A1	Independent	1	10	Base	Yes
M32	4% (1+)	2	B1	Independent	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 I 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 involve (a) using the interim *SLA* to set the strike limit for the WG and CG sub-areas 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) $\leq$ the aboriginal strike limit (as set by the *SLA*), 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 catch limit for that *Combination Area* or *Small Area* is set to the RMP catch limit less the aboriginal strike limit.

J. Output Statistics

The risk- and recovery-related performance statistics are computed both 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). $P_t^*(0)$ is used to denote the population size in year t under a scenario of zero strikes or removals of any kind, and $P_t^*(inc) = P_t^*$ 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)= $P_T / P_T^*(\mathrm{inc})$.

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: $\sum_{t=0}^{T-1} C_t \Big/ \sum_{t=0}^{T-1} Q_t$.

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): $\sum_{b-0}^{T^*-1}|C_{b+1}-C_b| / \sum_{b-0}^{T^*-1}C_b$.

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): $\sum_{b-0}^{T^*-1}|\min(C_{b+1} - C_{b^2}, 0)| / \sum_{b-0}^{T^*-1}C_b$

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 of minke whales in the North Atlantic. Details of the sources of the direct catch data are given in Allison (2015) and of the indirect catches in IWC (2015, pp.123-4). Two catches known to have been taken prior to 1900 are ignored. Catches from the Faroes (125 whales) are allocated to the EW sub-area, as they were all taken from land stations in the north of the Faroes. Data for catches by Norway from 1938 onwards includes detailed positions for all except 16 records; these have been allocated to sub-area in accordance with the ratio of other catches in the same year.

Catches known by sex are listed by sex and sub-area/hunt in Table 2. The average sex ratio for the hunt is assumed for any other catches.

Table 1

The 'Best' Catch Series.

Year	WC	WG-comm.	WG-aborig.	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB	Total
1914	0	0	0	0	0	1	0	0	0	0	0	0	1
1915	0	0	0	0	0	10	0	0	0	0	0	0	10
1916	0	0	0	0	0	6	0	0	0	0	0	0	6
1917	0	0	0	0	0	6	0	0	0	0	0	0	6
1918	0	0	0	0	0	6	0	1	0	0	0	0	7
1919	0	0	0	0	0	6	0	5	3	0	0	0	14
1920	0	0	0	0	0	6	0	0	0	0	0	0	6
1921	0	0	0	0	0	20	0	0	0	0	0	0	20
1922	0	0	0	0	0	20	0	0	0	0	0	0	20
1923	0	0	0	0	0	20	0	0	0	0	0	0	20
1924	0	0	0	0	0	20	0	0	0	0	0	0	20
1925	0	0	0	0	0	20	0	0	0	0	0	0	20
1926	0	0	0	0	0	9	0	0	4	0	0	0	13
1927	0	0	0	0	0	9	0	0	4	0	0	0	13
1928	0	0	0	0	0	9	0	0	0	0	0	0	9
1929	0	0	0	0	0	9	0	2	4	0	0	0	15
1930	0	0	0	0	0	9	0	28	10	0	0	0	47
1931	0	0	0	0	0	7	0	0	175	0	0	0	182
1932	0	0	0	0	0	5	0	0	350	0	0	0	355
1933	0	0	0	0	0	10	0	0	525	0	0	0	535
1934	0	0	0	0	0	4	0	30	670	0	0	0	704
1935	0	0	0	0	0	2	0	50	828	0	0	0	880
1936	0	0	0	0	0	1	0	84	909	0	30	30	1,054
1937	0	0	0	0	0	1	0	125	996	0	60	50	1,232
1938	0	0	0	0	0	1	0	266	907	0	112	68	1,354
1939	0	0	0	0	0	1	0	137	762	1	12	6	919
1940	0	0	0	0	0	1	0	35	503	0	1	13	553
1941	0	0	0	0	0	5	0	186	1,914	0	4	6	2,115
1942	1	0	0	0	0	18	0	158	1,976	0	0	0	2,153
1943	0	0	0	0	0	16	0	158	1,455	0	0	0	1,629
1944	0	0	0	0	0	15	0	97	1,252	0	0	0	1,364
1945	0	0	0	0	0	16	0	165	1,611	0	0	10	1,802
1946	0	0	0	0	0	34	0	305	1,337	0	140	101	1,917
1947	16	0	0	0	0	34	0	373	1,810	0	136	237	2,606
1948	38	0	4	0	0	102	0	358	2,035	0	559	535	3,631
1949	38	0	5	0	0	106	7	241	1,206	0	701	1,693	3,997
1950	3	0	9	0	0	80	0	106	1,173	0	274	437	2,082
1951	55	0	16	0	0	63	0	89	1,836	0	155	672	2,886
1952	17	0	32	0	0	64	0	122	1,273	0	101	1,829	3,438
1953	0	0	32	0	0	79	0	63	1,231	0	62	1,079	2,546
1954	0	0	22	0	0	54	0	359	1,508	0	88	1,544	3,575
1955	13	0	22	0	6	57	1	435	2,138	1	56	1,679	4,408
1956	57	0	22	0	0	21	3	441	1,611	10	483	1,111	3,759
1957	37	0	24	1	0	37	0	593	1,417	12	612	1,000	3,733
1958	42	0	30	0	0	36	0	639	1,658	3	498	1,543	4,449
1959	18	0	55	0	14	35	2	575	900	15	495	1,091	3,200
1960	11	0	56	4	12	82	0	628	1,039	14	369	1,223	3,438
1961	22	0	35	1	3	108	72	377	1,322	13	208	1,187	3,348

Year	WC	WG-comm.	WG-aborig.	CIP	CG	CIC	CM	EN	EW	ESW	ESE	EB	Total
1962	50	0	72	0	3	134	158	400	1,302	22	113	1,225	3,479
1963	18	0	166	5	10	115	80	340	1,043	5	324	1,355	3,461
1964	54	0	162	1	8	153	151	400	1,057	10	233	769	2,998
1965	41	0	196	3	0	147	255	268	1,062	5	534	253	2,764
1966	11	0	225	15	87	123	88	330	633	1	288	671	2,472
1967	40	0	244	44	143	193	66	181	901	91	536	118	2,557
1968	0	20	315	62	211	409	45	355	893	90	656	114	3,170
1969	60	165	269	22	94	214	21	479	667	22	397	467	2,877
1970	88	126	207	8	159	222	13	350	632	20	628	282	2,735
1971	84	263	196	38	29	228	17	410	385	0	524	483	2,657
1972	214	123	156	32	139	199	0	319	231	0	158	1467	3,038
1973	3	221	276	24	222	147	0	200	267	3	253	839	2,455
1974	3	252	217	12	102	127	15	172	291	0	26	931	2,148
1975	4	102	222	15	217	193	0	186	269	0	324	651	2,183
1976	3	187	191	3	81	216	0	186	148	0	365	1190	2,570
1977	1	75	285	0	1	194	0	118	281	0	749	551	2,255
1978	2	75	180	0	130	199	3	83	312	0	162	826	1,972
1979	9	75	250	0	119	198	1	76	446	0	62	1202	2,438
1980	10	78	258	0	119	202	0	67	259	0	477	1004	2,474
1981	8	61	204	0	45	201	0	62	385	0	714	610	2,290
1982	4	66	250	0	109	212	0	60	344	0	655	723	2,423
1983	4	68	268	0	98	204	15	36	158	0	623	871	2,345
1984	6	70	235	0	25	178	90	19	219	0	183	209	1,234
1985	7	52	222	0	44	145	55	23	171	0	209	231	1,159
1986	4	0	145	0	2	0	50	33	129	0	128	39	530
1987	8	0	86	0	4	0	50	34	92	0	157	40	471
1988	9	0	109	0	10	0	0	0	29	0	0	0	157
1989	10	0	63	0	10	0	0	0	1	0	16	0	100
1990	11	0	89	0	6	0	0	0	5	0	0	0	111
1991	5	0	109	0	10	0	0	0	1	0	0	0	125
1992	8	0	110	0	11	0	0	0	37	0	36	22	224
1993	5	0	113	0	9	0	13	8	120	0	51	34	353
1994	5	0	104	0	5	0	41	9	94	0	31	105	394
1995	7	0	155	0	9	0	42	3	38	0	46	89	389
1996	0	0	170	0	13	0	40	24	75	0	112	137	571
1997	2	0	148	0	14	0	20	40	74	0	129	240	667
1998	5	0	169	0	10	0	57	137	85	0	129	217	809
1999	9	0	172	0	14	0	58	122	158	0	112	141	786
2000	1	0	147	0	10	0	57	65	192	0	103	70	645
2001	10	0	139	0	17	0	31	104	247	0	120	50	718
2002	9	0	140	0	10	2	35	74	253	0	146	126	795
2003	6	0	185	0	14	37	21	98	157	0	150	221	889
2004	8	0	179	0	11	25	17	93	199	0	113	125	770
2005	6	0	176	0	4	41	5	9	244	0	99	284	868
2006	2	0	181	0	3	62	0	34	373	0	118	23	796
2007	7	0	167	0	2	45	0	99	176	0	295	28	819
2008	6	0	154	0	1	38	31	98	160	0	230	22	740
2009	0	0	165	0	4	81	0	50	182	0	250	4	736
2010	5	0	187	0	9	60	1	35	145	0	270	18	730
2011	4	0	179	0	10	58	0	14	218	0	201	100	784
2012	0	0	148	0	4	52	0	14	200	0	244	6	668
2013	0	0	175	0	6	35	0	2	242	0	282	68	810
2014	0	0	146	0	11	24	0	20	231	0	377	108	917
2015	0	0	133	0	6	29	0	4	137	0	426	93	828
Total	1,244	2,079	9,973	290	2,479	6,423	1,727	13,574	55,002	338	18,720	36,596	148,445

Table 2
Catches known by sex.

	WC		WG-com		WG-ab		CIP		CG		CIC		CM		EN		EW		ESW		ESE		EB	
Year	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1914	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1915	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1916	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1917	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1918	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1919	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1920	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1921	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1922	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1923	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1924	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1925	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1926	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0
1927	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0
1928	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1929	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	1	0	0	0	0	0	0
1930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	13	0	0	0	0	0	0	0	0
1931	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1932	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1933	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1934	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1935	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0
1936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0
1937	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0
1938	0	0	0	0	0	0	0	0	0	0	0	0	0	0	143	98	463	386	0	0	50	50	47	19
1939	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	70	383	323	1	0	5	7	4	2
1940	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	25	257	207	0	0	0	0	9	4
1941	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	78	1,003	863	0	0	2	2	3	3
1942	0	0	0	0	0	0	0	0	0	0	0	0	0	0	94	64	1,112	853	0	0	0	0	0	0
1943	0	0	0	0	0	0	0	0	0	0	0	0	0	0	88	69	844	592	0	0	0	0	0	0
1944	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	52	658	585	0	0	0	0	0	0
1945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	104	55	891	705	0	0	0	0	7	3
1946	0	0	0	0	0	0	0	0	0	0	0	0	0	0	190	114	737	588	0	0	58	78	65	35
1947	0	0	0	0	0	0	0	0	0	0	9	3	0	0	202	166	1,013	779	0	0	47	89	162	72
1948	24	14	0	0	0	0	0	0	0	0	38	28	0	0	207	148	1,100	905	0	0	234	317	321	200
1949	24	14	0	0	0	0	0	0	0	0	38	33	3	4	141	99	652	542	0	0	250	446	841	826
1950	2	1	0	0	0	0	0	0	0	0	0	0	0	0	61	44	649	510	0	0	62	212	179	254
1951	26	29	0	0	0	0	0	0	0	0	0	0	0	0	68	20	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	1,185
1953	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	26	721	504	0	0	37	24	436	642
1954	0	0	0	0	0	0	0	0	0	0	0	0	0	0	204	149	795	702	0	0	54	34	688	852
1955	5	8	0	0	7	8	0	0	1	5	4	9	0	1	244	181	1,156	972	1	0	18	37	620	1,053
1956	27	27	0	0	5	15	0	0	0	0	0	0	3	0	288	149	906	694	4	6	159	323	451	659
1957	6	12	0	0	6	18	1	0	0	0	1	0	0	0	380	210	772	634	1	11	151	457	347	651
1958	0	0	0	0	5	6	0	0	0	0	0	0	0	0	412	225	950	704	2	1	152	346	470	1,052
1959	6	12	0	0	2	17	0	0	9	5	1	0	0	2	423	149	483	414	1	14	121	373	594	480
1960	5	6	0	0	3	15	3	1	4	8	7	2	0	0	436	187	531	482	2	12	114	253	443	779
1961	8	14	0	0	7	9	1	0	3	0	42	8	45	27	236	140	779	530	9	4	65	143	349	821
1962	0	0	0	0	18	43	0	0	3	0	48	24	82	75	261	137	704	583	8	14	34	79	364	839
1963	2	16	0	0	32	47	3	2	9	1	40	28	33	47	214	126	592	450	2	3	115	209	517	836
1964	12	42	0	0	26	37	1	0	5	3	85	22	88	63	278	121	549	500	4	6	65	168	289	478
1965	7	4	0	0	19	30	2	1	0	0	51	36	112	143	175	93	583	477	3	2	151	381	112	137
1966	0	0	0	0	24	49	13	2	69	18	31	28	12	76	218	111	362	249	1	0	96	192	171	498
1967	15	25	0	0	7	42	31	13	108	35	78	38	42	24	125	53	553	338	31	60	154	381	59	59
1968	0	0	7	13	10	47	33	29	106	104	163	157	32	13	233	117	528	329	51	39	346	304	59	54
1969	33	27	119	46	14	42	11	11	64	30	37	17	6	15	300	173	444	221	12	10	80	317	177	289
1970	22	66	74	52	12	20	4	4	91	68	56	32	6	7	197	148	383	245	7	13	239	389	62	218
1971	20	63	86	177	6	25	2	4	23	6	47	34	6	11	281	115	212	166	0	0	177	345	183	299
1972	84	130	32	91	6	40	16	16	74	65	42	23	0	0	189	126	116	111	0	0	39	119	446	1,014
1973	0	0	67	154	8	39	17	6	159	62	13	7	0	0	109	90	149	117	0	3	54	199	334	503
1974	1	0	43	209	6	34	7	4	73	28	60	62	1	14	89	81	144	136	0	0	3	23	290	636
1975	0	0	11	91	1	17	7	8	84	132	89	80	0	0	131	55	156	109	0	0	66	257	246	405
1976	0	1	38	149	2	20	3	0	57	23	114	87	0	0	115	71	64	74	0	0	85	279	351	839

	WC		WG-com		WG-ab		CIP		CG		CIC		CM		EN		EW		ESW		ESE		EB	
Year	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1977	0	0	21	54	15	39	0	0	0	0	103	86	0	0	70	48	186	90	0	0	231	517	223	328
1978	0	0	10	65	2	13	0	0	72	58	85	113	3	0	54	29	152	159	0	0	13	148	251	574
1979	0	1	31	44	0	1	0	0	75	43	111	87	1	0	41	32	296	148	0	0	14	48	409	783
1980	2	2	14	64	0	0	0	0	77	39	120	81	0	0	54	12	182	73	0	0	155	320	388	604
1981	0	0	15	46	1	1	0	0	10	35	113	77	0	0	36	25	209	168	0	0	257	454	256	354
1982	0	0	24	42	0	0	0	0	84	24	127	85	0	0	44	16	168	174	0	0	184	471	233	476
1983	0	0	25	42	0	0	0	0	51	38	117	87	1	14	23	13	88	67	0	0	182	440	315	543
1984	0	0	20	49	0	0	0	0	6	9	91	71	28	62	17	2	164	54	0	0	65	118	89	119
1985	0	0	28	24	0	0	0	0	15	15	92	50	3	52	19	2	142	28	0	0	56	153	103	126
1986	0	0	0	0	0	0	0	0	0	0	0	0	6	44	24	9	109	19	0	0	66	62	27	12
1987	0	0	0	0	14	29	0	0	0	4	0	0	12	38	20	14	46	46	0	0	61	96	27	13
1988	0	0	0	0	5	35	0	0	1	4	0	0	0	0	0	0	21	8	0	0	0	0	0	0
1989	0	0	0	0	16	34	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	15	0	0
1990	0	0	0	0	14	62	0	0	0	5	0	0	0	0	0	0	4	1	0	0	0	0	0	0
1991	0	0	0	0	19	63	0	0	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	1	0	0	18	75	0	0	0	8	0	0	0	0	0	0	22	13	0	0	15	20	14	8
1993	1	0	0	0	25	71	0	0	0	2	0	0	5	8	1	7	79	36	0	0	4	45	6	26
1994	0	0	0	0	20	77	0	0	0	5	0	0	3	38	5	3	61	29	0	0	5	25	57	47
1995	0	1	0	0	46	105	0	0	0	2	0	0	4	38	1	2	14	23	0	0	2	43	13	76
1996	0	0	0	0	37	126	0	0	1	12	0	0	1	39	5	18	18	56	0	0	2	110	27	107
1997	0	0	0	0	42	102	0	0	1	10	0	0	0	19	9	29	33	41	0	0	1	126	70	168
1998	1	0	0	0	41	124	0	0	1	9	0	0	8	49	50	82	31	53	0	0	2	125	37	177
1999	0	3	0	0	35	133	0	0	1	13	0	0	9	46	47	69	67	81	0	0	2	104	37	95
2000	0	0	0	0	37	103	0	0	2	8	0	0	23	33	25	39	101	85	0	0	1	96	24	43
2001	0	0	0	0	32	91	0	0	0	14	0	0	4	27	31	71	150	92	0	0	0	116	11	39
2002	0	2	0	0	33	97	0	0	0	10	1	1	6	29	37	33	140	111	0	0	21	114	22	102
2003	2	2	0	0	57	118	0	0	1	11	23	13	1	19	45	48	73	82	0	0	5	135	89	127
2004	0	3	0	0	44	129	0	0	4	7	10	15	0	17	35	55	95	102	0	0	2	109	23	100
2005	1	0	0	0	34	135	0	0	3	1	20	15	4	1	6	3	108	133	0	0	5	92	31	249
2006	0	0	0	0	44	127	0	0	2	0	31	28	0	0	11	21	200	166	0	0	9	108	0	22
2007	0	1	0	0	38	121	0	0	0	1	14	28	0	0	52	44	86	88	0	0	12	271	20	8
2008	0	1	0	0	55	87	0	0	0	1	28	7	5	26	44	50	99	55	0	0	9	220	12	10
2009	0	0	0	0	47	107	0	0	3	1	64	14	0	0	29	21	83	98	0	0	13	237	1	3
2010	1	0	0	0	54	122	0	0	4	2	47	12	0	1	5	29	80	65	0	0	11	256	6	12
2011	0	0	0	0	39	133	0	0	0	9	45	13	0	0	1	13	121	95	0	0	26	173	15	83
2012	0	0	0	0	34	108	0	0	0	4	38	11	0	0	1	13	113	84	0	0	26	214	4	2
2013	0	0	0	0	37	127	0	0	1	3	13	22	0	0	1	0	144	94	0	0	28	253	21	47
2014	0	0	0	0	27	115	0	0	1	9	16	7	0	0	7	11	122	108	0	0	79	297	28	79
2015	0	0	0	0	26	101	0	0	0	6	21	8	0	0	3	1	60	77	0	0	75	351	21	72
Total	347	535	665	1,412	1,214	3,531	155	101	1,360	1,021	2,425	1,690	598	1,122	8,036	5,058	28,011	21,840	140	198	5,050	13,444	13,481	22,758

References

Allison, C. 2015. IWC Summary catch database version 6.1. IWC Secretariat, Cambridge, UK.

International Whaling Commission. 2015. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure, Appendix 5. *J. Cetacean Res. Manage. (Suppl.)* 17:120-24.

Adjunct 2: Data used to estimate the Survey and Fishery Sex Ratios (see Annex D, 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 Annex D, Section G).

'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. The 'survey' sex ratios for the sub-areas where the catches in the survey month are relatively small (WC, CIP, CG, CIC and CM) are estimated using data from all years (see Table 1). Catches in the CIC sub-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 with 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	M	F
1948	10	5	-	-	-	-	-	-	16	10	-	-	-	-
1949	15	6	-	-	-	-	-	-	21	18	3	4	-	-
1950	0	1	-	-	-	-	-	-	-	-	-	-	-	-
1951	8	4	-	-	-	-	-	-	-	-	-	-	-	-
1952	2	2	-	-	-	-	-	-	1	1	-	-	-	-
1953	5	3	-	-	-	-	-	-	-	-	-	-	-	-
1954	9	14	-	-	-	-	-	-	-	-	-	-	-	-
1955	2	1	-	-	-	-	-	-	3	7	0	1	-	-
1956	8	6	-	-	-	-	-	-	-	-	3	0	-	-
1957	4	8	-	-	-	-	-	-	-	-	-	-	-	-
1959	3	7	-	-	-	-	-	-	-	-	-	-	-	-
1960	4	2	0	1	-	-	-	-	1	1	-	-	-	-
1961	4	7	1	2	-	-	3	0	20	3	10	5	-	-
1962	0	0	6	11	-	-	0	0	6	3	42	41	6	10
1963	0	0	-	-	-	-	1	0	3	3	11	25	0	0
1964	0	2	-	-	-	-	1	3	6	4	29	25	1	2
1965	5	3	-	-	-	-	0	0	22	18	50	29	0	0
1966	1	3	-	-	6	1	0	0	6	4	1	3	0	0
1967	3	11	-	-	6	3	52	14	39	27	32	1	0	0
1968	0	0	0	0	0	0	7	11	22	17	14	3	8	7
1969	9	12	0	0	0	1	3	1	0	0	3	7	1	0
1970	4	12	11	13	3	2	30	24	31	15	2	3	0	3
1971	3	4	11	16	0	0	1	1	20	26	5	11	-	-
1972	22	22	1	0	2	1	7	4	29	16	-	-	-	-
1973	-	-	0	0	10	3	26	16	5	1	-	-	-	-
1974	-	-	0	1	1	0	9	6	6	4	-	-	-	-
1975	-	-	0	0	1	2	25	55	24	18	-	-	-	-
1976	-	-	0	0	-	-	22	6	25	21	-	-	-	-
1977	-	-	0	0	-	-	0	0	44	28	-	-	-	-
1978	-	-	0	0	-	-	55	36	51	39	-	-	-	-
1979	-	-	6	4	-	-	43	28	37	25	1	0	-	-
1980	-	-	0	0	-	-	17	8	63	32	-	-	-	-
1981	-	-	1	0	-	-	-	-	26	32	-	-	-	-
1982	-	-	2	2	-	-	-	-	30	19	-	-	-	-
1983	-	-	8	6	-	-	-	-	30	28	1	5	-	-
1984	-	-	7	15	-	-	-	-	40	22	25	52	-	-
1985	-	-	5	2	-	-	6	14	31	21	0	10	-	-
1986	-	-	-	-	-	-	-	-	-	-	4	29	-	-

Month:	July		September		July		July		July		July		July	
Years:	All		<1986		All		All		All		All		All	
Sub-area:	WC		WG		CIP		CG		CIC		CM		ESW	
Year	M	F	M	F	M	F	M	F	M	F	M	F	M	F
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	-	-
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).

	WG-ab	WG-ab	CG	CG	CIC	CIC	CM	CM	EN	EN	EW	EW	ESE	ESE	EB	EB
Year	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
2002	33	97	0	10	0	0	6	29	37	33	140	111	21	114	22	102
2003	57	118	1	11	23	13	1	19	45	48	73	82	5	135	89	127
2004	44	129	4	7	10	15	0	17	35	53	95	102	2	109	23	100
2005	34	135	3	1	20	14	4	1	6	1	108	133	5	92	31	249
2006	44	127	2	0	31	28	0	0	10	20	200	166	9	108	0	22
2007	38	121	0	1	14	28	0	0	52	44	86	88	12	271	20	8
2008	55	87	0	1	28	7	5	25	43	48	99	55	9	220	12	10
2009	47	107	3	1	64	14	0	0	28	21	83	98	13	237	1	3
2010	54	122	4	2	47	12	0	1	4	29	80	65	11	256	6	12
2011	39	133	0	9	45	13	0	0	1	13	121	95	26	173	15	83
2012	34	108	0	4	38	11	0	0	1	13	113	84	26	214	4	2
2013	37	127	1	3	13	22	0	0	1	0	144	94	28	253	21	47

Reference

International Whaling Commission. 2015. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure, Appendix 5. *J. Cetacean Res. Manage. (Suppl.)* 17:120-24.

Annex E

Status Updates on DNA Registries

Appendix 1

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 and Freshwater Research Institute, Reykjavik, is responsible for the establishment and maintenance of the registry that is of the same format as the Norwegian DNA registry. An ORACLE database has now been created and contains all genotyped individuals information as well as tissue collected ID of individuals collected but not genotyped. In parallel, a DNA tissue bank has been achieved and is now fully functional.

Table 1 gives the present status of the registry. Samples from all the common minke whales landed as a part of the Icelandic research program (2003-07) and recent commercial catches (2008-17), as well as from commercial North Atlantic fin whale catches have been genotyped and information stored in the database (note that two hybrid blue-fin were caught in 2018).

Footnote number:	1	2	3	4	5	6	7	8	9	10	11	12
Species/year	Type	No. whales	No. duplicates	No. missing	No. lab problem	No. mtDNA	%mtDNA	No. msat	%msat	Sex analysed	% sexed	Note
NA minke whale												
2003-07	SP	189	0	0	0	189	100	189	100	189	100	-
2008-17	C	437	0	0	0	379	89	382	88	382	89	-
NA fin whale												
2006-18	C	834	0	0	0	834	100	834	98	834	100	-

[1]Key to sample types: SP=special permit catch, C=commercial catch, BC=bycatch, ST=stranding.
[2]Number of whales that potentially entered by the previous years and enters (new year) the markets.
[3]Number of occurrences (tissues) sample switching on board the vessels as detected by comparison of genetic profiles.
[4]Number of individuals for which tissue samples are missing for reasons other than sample switching.
[5]Genetic laboratory not able to obtain microsatellite profiles mtDNA haplotypes from tissue samples.
[6]Number of samples analysed for mitochondrial control region.
[7]% of total samples analysed for mitochondrial control region.
[8]Number of samples analysed for microsatellites.
[9]% of total samples analysed for microsatellites.
[10]Number of samples analysed for sex.
[11]% of samples analysed for sex.
[12]Other problems or information.

Appendix 2

AN UPDATE OF THE NORWEGIAN MINKE WHALE DNA REGISTER (MAY 7, 2020)

Hans J. Skaug

University of Bergen and *Institute of Marine Research*

Footnote number:	1	2	3	4	5	6/13	7	8	9	10	11	14	13	12
Species/year	Type	No. whales	No. duplicates	No. missing	No. lab problem	No. mtDNA	%mtDNA	No. msat	%msat	Sex analysed	% sexed	SNP	% SNP	Note
NA minke whale														
1997-2018	C	12,192	116	80	3	10,652	87	12,109	99	12,109	99	1,457	12	-
2019	C	427	1	2	0	0	0	425	100	425	100	425	100	-

[1]Key to sample types: SP=special permit catch, C=commercial catch, BC=bycatch, ST=stranding.
[2]Number of whales that potentially entered by the previous years and enters (new year) the markets.
[3]Number of occurrences (tissues) sample switching on board the vessels as detected by comparison of genetic profiles.
[4]Number of individuals for which tissue samples are missing for reasons other than sample switching.
[5]Genetic laboratory not able to obtain microsatellite profiles mtDNA haplotypes from tissue samples.
[6]Number of samples analysed for mitochondrial control region.
[7]% of total samples analysed for mitochondrial control region.
[8]Number of samples analysed for microsatellites.
[9]% of total samples analysed for microsatellites.
[10]Number of samples analysed for sex.
[11]% of samples analysed for sex.
[12]Other problems or information.
[13]Discontinued starting from 2016.
[14]Started in 2016.

Appendix 3

AN UPDATE OF THE JAPANESE DNA REGISTER FOR LARGE WHALES

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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 (JARPN/JARPNII and NEWREP-NP) and by the commercial whaling in the North Pacific, in the Antarctic (JARPA/JARPAII and NEWREP-A), and from bycatches. 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 2019 is as follows. SP: special permit catch, CW: commercial whaling and BC: bycatch.

Footnote number:	1	2	3	4	5	6	7	8	9	10	11	12
Species/year	Type	No. whales	No. duplicates	No. missing	No. lab problem	No. mtDNA	%mtDNA	No. msat	%msat	Sex analysed	% sexed	Note
North Pacific minke whale												
1994-2018	SP	2,978	0	0	8	2,970	99.73	2970	99.73	2978	100.00	
2019	SP	79	0	0	0	79	100.00	79	100.00	79	100.00	
2019	CW	44	0	0	0	44	100.00	44	100.00	44	100.00	
2001-18	BC	2,259	0	26	2	2,259	100.00	2231	98.76	2229	98.67	
2019	BC	104	0	0	0	104	100.00	104	100.00	104	100.00	
North Pacific sei whale												
2002-18	SP	1622	0	0	4	1618	99.75	1622	100.00	1622	100.00	
2019	CW	25	0	0	0	25	100.00	25	100.00	25	100.00	
2019	BC	1	0	0	0	1	100.00	1	100.00	1	100.00	
North Pacific Bryde's whale												
2000-17	SP	730	0	0	3	727	99.56	730	100.00	730	100.00	
2019	CW	187	0	0	0	187	100.00	187	100.00	187	100.00	
2001-18	BC	5	0	0	0	5	100.00	4	80.00	4	80.00	Include three Omura's whale and one from the East China Sea stock
2019	BC	0	0	0	0	0	0.00	0	0.00	0	0.00	No BC
North Pacific humpback whale												
2001-18	BC	67	0	0	0	67	100.00	67	100.00	67	100.00	
2019	BC	5	0	0	0	5	100.00	5	100.00	5	100.00	
North Pacific right whale												
2001-18	BC	3	0	1	0	3	100.00	2	66.67	2	66.67	Missing by the 2011 tsunami, no microsats
2019	BC	0	0	0	0	0	0.00	0	0.00	0	0.00	No BC
North Pacific fin whale												
2001-18	BC	11	0	0	0	11	100.00	11	100.00	11	100.00	
2019	BC	0	0	0	0	0	0.00	0	0.00	0	0.00	No BC
North Pacific sperm whale												
2000-17	SP	56	0	0	0	56	100.00	56	100.00	56	100.00	
2001-18	BC	2	0	0	0	2	100.00	2	100.00	2	100.00	
2019	BC	0	0	0	0	0	0.00	0	0.00	0	0.00	No BC
Antarctic minke whale												
1987/88-2004/05	SP	6794	0	10	0	1,118	16.50	6271	92.30	6,794	100.00	Incl. dwarf; 87/88-88/89. no microsats
2005/06-2017/18	SP	4883	0	549	162	3,644	74.63	4172	85.44	4,883	100.00	Some missing by the 3/11 tsunami in 2011
2018/19	SP	333	0	0	0	333	100.00	333	100.00	333	100.00	
Antarctic fin whale												
2005/06-2011/12	SP	18	0	0	0	18	100.00	18	100.00	18	100.00	

[1]Key to sample types: SP=special permit catch, C=commercial catch, BC=bycatch, ST=stranding. [2]Number of whales that potentially entered by the previous years and enters (new year) the markets. [3]Number of occurrences (tissues) sample switching on board the vessels as detected by comparison of genetic profiles. [4]Number of individuals for which tissue samples are missing for reasons other than sample switching. [5]Genetic laboratory not able to obtain microsatellite profiles mtDNA haplotypes from tissue samples. [6]Number of samples analysed for mitochondrial control region. [7]% of total samples analysed for mitochondrial control region. [8]Number of samples analysed for microsatellites. [9]% of total samples analysed for microsatellites. [10]Number of samples analysed for sex. [11]% of samples analysed for sex. [12]Other problems or information.

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International Whaling Commission. 2006. Report of the Scientific Committee. Annex N. Report of the Working Group on DNA Testing. *J. Cetacean Res. Manage. (Suppl.)* 8: 252-258.

Kanda, N., Goto, M., Oikawa, H. and Pastene, L.A. 2014. Update of note on sampling and laboratory procedure protocols of the genetic work at the Institute of Cetacean Research (SC/65b/J27Rev). Paper SC/65b/DNA01 presented to the IWC Scientific Committee, May 2014 (unpublished). 6pp. [Paper available from the Office of this Journal].

Annex F

Summary of Gray Whale Stock Structure Hypotheses

At the last Rangewide Workshop on the Population Structure and Status of Gray Whales in the North Pacific (IWC, 2019), it was 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.

At SC68B, new information pertaining to the stock structure of gray whales was reviewed (SC/68B/SDDNA/01-03, SC/68B/ASI/01, Brykov *et al.* (2019). In light of this and previously reviewed information, the Committee agreed that existing hypothesis 4a should be given high plausibility and existing hypothesis 4b should be given medium plausibility (see Item 10.4.1). In addition, the Committee agreed that additional medium plausibility hypotheses should be added that are the same as 3c and 3e but incorporate a lack of random mating between the Western Feeding Group whales and other whales considered part of the Eastern Breeding Stock under hypothesis 3. It was noted, however, that hypothesis 3 and its variants and hypothesis 4 and its variants are functionally the same and thus elevating the plausibility of Hypothesis 4a and its variants (4b and the newly added 4c and 4e) does not entail adding additional trials for testing under the gray whale *Implementation Review*.

It was further noted at SC68B some of the terminology used to describe the hypotheses needs to be clarified and there is a need to assess if further changes are needed to ensure that all plausible scenarios and their respective plausibilities are represented. An intersessional correspondence group was formed to complete these tasks and report on their findings at SC68C (see Item 10.7).

TERMINOLOGY (IWC, 2018)

Feeding groups or aggregations: There are up to three feeding groups or aggregations. There is dispersal between the Pacific Coast Feeding Group (PCFG) and the North Feeding Group (NFG). The dynamics of the Western Feeding Group (WFG) are defined within each of the hypotheses; no permanent movement of animals from the NFG or PCFG to the WFG is modelled.

Table 1

Feeding groups.

Name	Abbreviation	Definition (may vary with hypothesis)
Western Feeding Group	WFG	Animals that feed off Sakhalin Island* according to photo-identification data.
Pacific Coast Feeding Group	PCFG	Animals that are observed in the feeding season (June to November) in the PCFG area (41°N to 52°N, excluding Puget Sound) in more than one year according to photo-identification data (IWC, 2015).
North Feeding Group	NFG	Animals found in other feeding areas (and for which there is relatively little photo-ID and genetic information).

*May need revising with regard to southern Kamchatka animals given Cooke *et al.* (2017).

Breeding stocks: There are up to three extant breeding stocks. These breeding stocks are the Western (WBS) and eastern (EBS) stocks, and a third stock comprised of WFG whales that interbreed largely with each other while migrating to the Mexican wintering ground (hypothesis 4 and its variants).

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.

Table 2

Sub-areas.

Sub-area	Abbreviation	Sub-area	Abbreviation
Vietnam-South China Sea	VSC	Southeast Alaska	SEA
Korea and western side of the Sea of Japan	KWJ	British Columbia to Northern California	BCNC
Eastern side of the Sea of Japan and the Pacific coast of Japan	EJPJ	California	CA
Northeastern Sakhalin Island	SI	Mexico	M
Southern Kamchatka and Northern Kuril Islands*	SKNK	Latent subarea	Calif-3
Areas of the Okhotsk Sea not otherwise specified	OS	Latent subarea	BC-BCA-3
Northern Bering and Chukchi Sea	BSCS		

*replaced the old East Kamchatka and Kuril Islands sub-area to recognise the information from telemetry and photo-ID.

Table 3 [updated from Table 6, IWC (2018)].
A summary of the stock structure hypotheses and their status after consideration at SC68B.

Description	Plausibility	Comment
(3) Maternal feeding ground fidelity, one migratory route/wintering region used by Sakhalin whales, random mating		
(a) A single breeding stock (EBS) exists. The EBS includes three feeding groups: NFG, PCFG, WFG. SKNK is used by some whales that belong to the WFG and some whales that belong to the NFG. Although two breeding stocks (WBS and EBS) may once have existed, the WBS is assumed to have been extirpated.	High	
(b) The EBS is as described in 3a, except that NFG whales do not feed off SKNK. In addition, a WBS exists that overwinters in VSC and feeds in the OS (but not SI) and SKNK. Thus SKNK is used by both the WFG whales and the whales of the WBS.	Medium	Originally considered there to be few or no data to assess plausibility (IWC, 2015), but availability of abundance estimates for combined SKNK + SI (Cooke *et al.*, 2017) made feasible to assess.
(c) Same as 3a except that WFG whales migrating from SI to M occasionally travel through BSCS.	Medium	Sensitivity test
(e) Same as 3a except that a WBS exists that feeds in the OS (but not SI), EJPJ, and KWJ and overwinters in VSC. This hypothesis is also similar to 3b, with the exception that SKNK region is not used regularly by whales part of the WBS.	Medium	Originally ranked as high (IWC, 2015). At the SC in 2018, the Workshop reviewed Scordino and Bickham (2018), which argues that if a WBS was extent it would be unlikely that they do not feed off SI. The Workshop agreed that the plausibility of Hypothesis 3e would be changed to medium (sensitivity test).
(4) Maternal feeding ground fidelity, one migratory route/wintering region used by Sakhalin whales, non-random mating		
(a) Two breeding stocks exist and overwinter in M. One breeding stock includes NFG and PCFG, and the second breeding stock includes WFG whales that mate largely with each other while migrating to M. SKNK is used by some whales that belong to the breeding stock comprised of WFG whales and some whales that belong to the NFG. Although a third breeding stock (the WBS) may once have existed, the WBS is assumed to have been extirpated.	High	Initially regarded as low priority because it is represented in the same way as other hypotheses in modeling (IWC, 2015). After re-evaluation at SC68B, the SDDNA WG advised that this hypothesis be ranked as high plausibility based on genetic evidence that WFG whales do not mate at random with NFG and PCFG whales (see report Item 10.4.1).
(b) Same as 3b except that a third breeding stock comprised of WFG whales that largely breed with each other while on migration to M exists.	Medium	Initially regarded as low priority because it is represented in the same way as other hypotheses in modeling (IWC, 2015). After re-evaluation at SC68B, the SDDNA WG advised that this hypothesis be ranked as medium plausibility (in accordance with the plausibility of 3b) after raising 3a to high plausibility.
(c) Same as 3c except that a second breeding stock comprised of WFG whales that largely breed with each other while on migration to M exists. Whales that are part of this second breeding stock occasionally travel through BSCS.	Medium	Added as a medium plausibility hypothesis (in accordance with the plausibility of 3c) after the status of hypothesis 4a was raised to high upon re-evaluation by the SDDNA WG at SC68B.
(e) Same as 3e except that a third breeding stock comprised of WFG whales that largely breed with each other while on migration to M exists. A WBS exists that feeds in the OS (but not SI), EJPJ, and KWJ and overwinters in VSC	Medium	Added as a medium plausibility hypothesis (in accordance with the plausibility of 3e) after the status of hypothesis 4a was raised to high upon re-evaluation by the SDDNA WG at SC68B.
(5) Maternal feeding ground fidelity, two migratory routes/wintering grounds used by Sakhalin whales, random mating		
(a) Two breeding stocks exist: EBS and WBS. The EBS includes three feeding groups: PCFG, North, and the WFG that feeds off SI. The WBS whales feed in SI, OS, and SKNK and then migrate to VSC to overwinter. SKNK is used by the WFG, the NFG, and the feeding whales that are part of the WBS.	High	
(6) Maternal feeding ground fidelity, Sakhalin whales use two migratory routes/wintering grounds without fidelity, random mating		
(b) Two breeding stocks (WBS and EBS) and three feeding groups (WFG, NFG, and PCFG) exist. SKNK is used by both the WFG and NFG. The WBS stock includes WFG whales, while the EBS stock includes NFG and PCFG whales. WBS whales use both wintering grounds (M and VSC). WBS individuals do not show fidelity for a particular wintering ground but do breed largely with each other during migration. EBS whales overwinter in M.[1]	Medium	Initially considered to be of low priority because modelling framework represented in the same way as other hypotheses (IWC, 2015); when revisited, the Workshop determined that this hypothesis does differ from 5a, in that: (1) all catches off Japan are assumed to be Western stock animals; and (2) the abundance estimates off Sakhalin Island are assumed to relate only to the Western stock. Thus the Workshop agreed to change the status of this hypothesis to high priority (IWC, 2017). However, upon reconsideration, the Workshop noted that, while the possibility that gray whales use multiple wintering grounds could not be ruled out, hypotheses 6b would be considered as a sensitivity test (IWC, 2019).

[1]In some previous descriptions of the hypotheses, EBS whales were described as also using both wintering grounds (M and VSC), showing no fidelity to either. However, in the model structure only WBS whales use both wintering grounds, and so the description has been amended here.

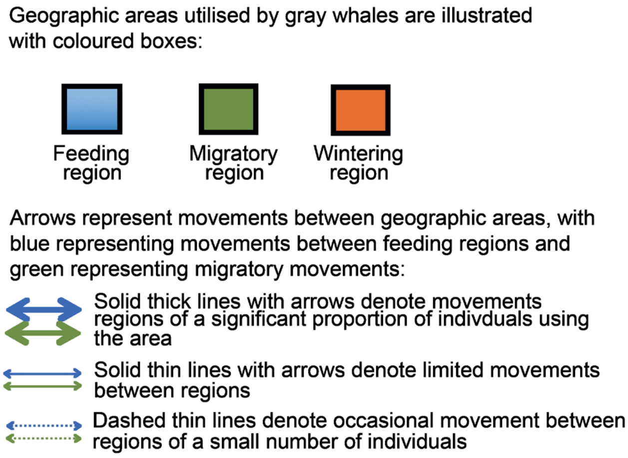

Fig. 1. Key to interpreting the stock structure schematics.

Figure 2 (a) Hypothesis 3a/4a

3a: Maternal feeding ground fidelity, one migratory route/wintering region used by Sakhalin whales, random mating. A single breeding stock (EBS) exists. The EBS includes three feeding groups: NFG, PCFG, WFG. SKNK is used by some whales that belong to the WFG and some whales that belong to the NFG. Although two breeding stocks (WBS and EBS) may once have existed, the WBS is assumed to have been extirpated.

4a: Maternal feeding ground fidelity, one migratory route/wintering region used by Sakhalin whales, non-random mating. Two breeding stocks exist and overwinter in M. One breeding stock includes NFG and PCFG, and the second breeding stock includes WFG whales. Separation between breeding stocks is maintained by WFG whales mating largely with each other while migrating to M. SKNK is used by some whales that belong to the breeding stock comprised of WFG whales and some whales that belong to the NFG. Although a third breeding stock (the WBS) may once have existed, the WBS is assumed to have been extirpated.

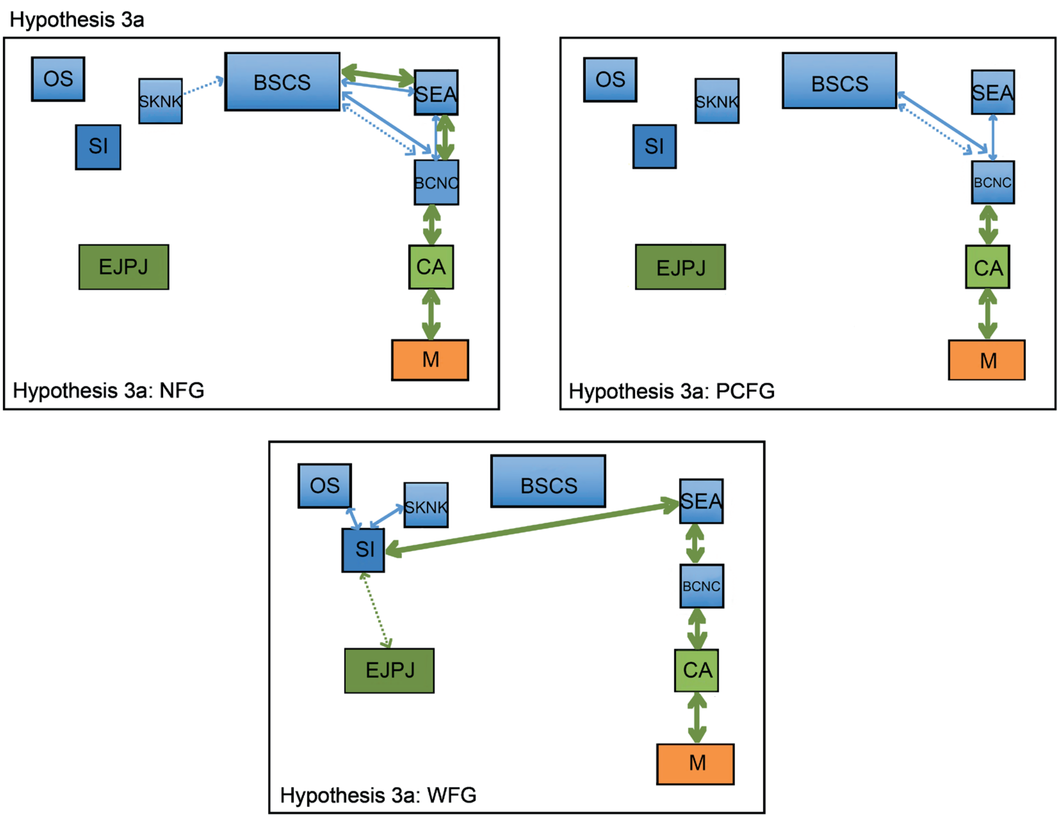

Figure 2 (b) Hypothesis 5a

Hypothesis 5a. Maternal feeding ground fidelity, two migratory routes/wintering grounds used by Sakhalin whales, random mating. Two breeding stocks exist: EBS and WBS. The EBS includes three feeding groups: PCFG, North, and the WFG that feeds off SI. The WBS whales feed in SI, OS, and SKNK and then migrate to VSC to overwinter. SKNK is used by the WFG, the NFG, and the feeding whales that are part of the WBS.

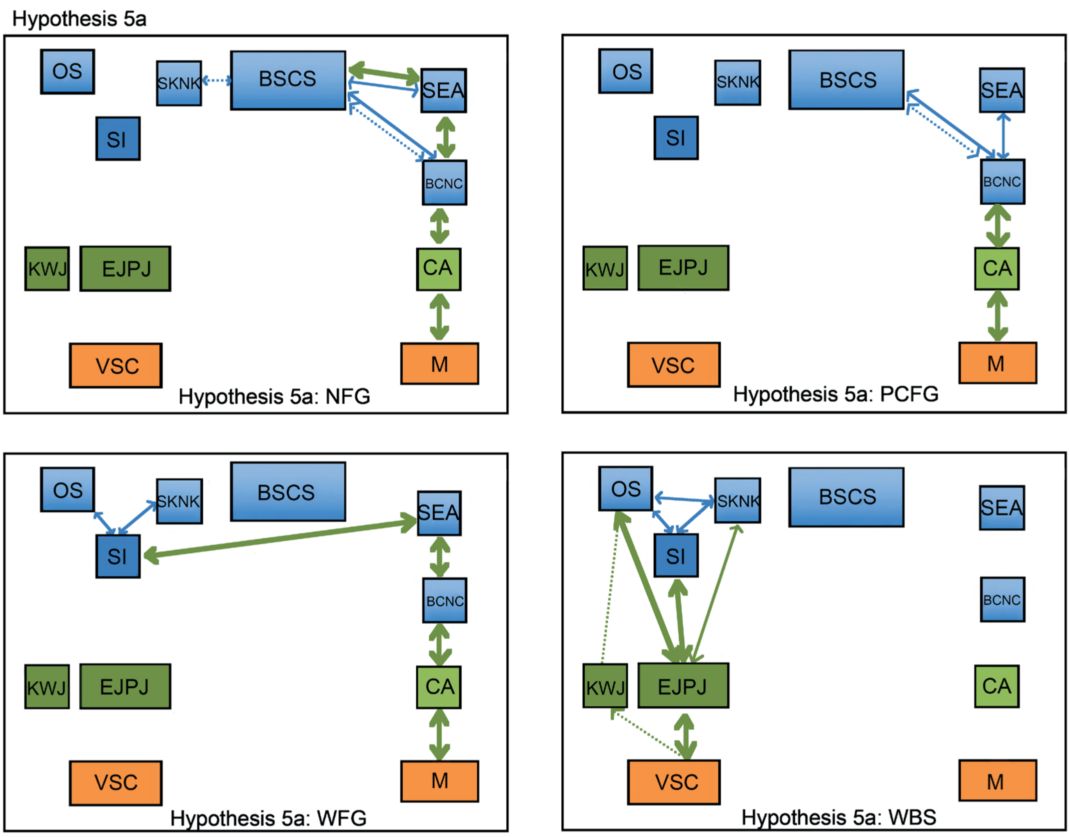

Fig. 2. Schematics of the stock structure hypotheses currently considered to have high plausibility.
Note that Hypothesis 4a is functionally equivalent to Hypotheses 3a, and thus the schematic shown in (a) represents both hypotheses.

Figure 3 (a) Hypothesis 3b/4b:

Hypothesis 3b: Maternal feeding ground fidelity, one migratory route/wintering region used by Sakhalin whales, random mating. An EBS exists that includes three feeding groups (NFG, PCFG, and WFG). In addition, a WBS exists that overwinters in VSC and feeds in the OS (but not SI) and SKNK. SKNK is used by both the WFG whales and the whales of the WBS.

Hypothesis 4b: Maternal feeding ground fidelity, one migratory route/wintering region used by Sakhalin whales, non-random mating. An EBS exists that includes two feeding groups (NFG and PCFG). A WBS exists that overwinters in VSC and feeds in the OS (but not SI) and SKNK. A third breeding stock includes WFG whales that mate largely with each other while migrating to M. SKNK is used by both the WFG whales and the whales of the WBS.

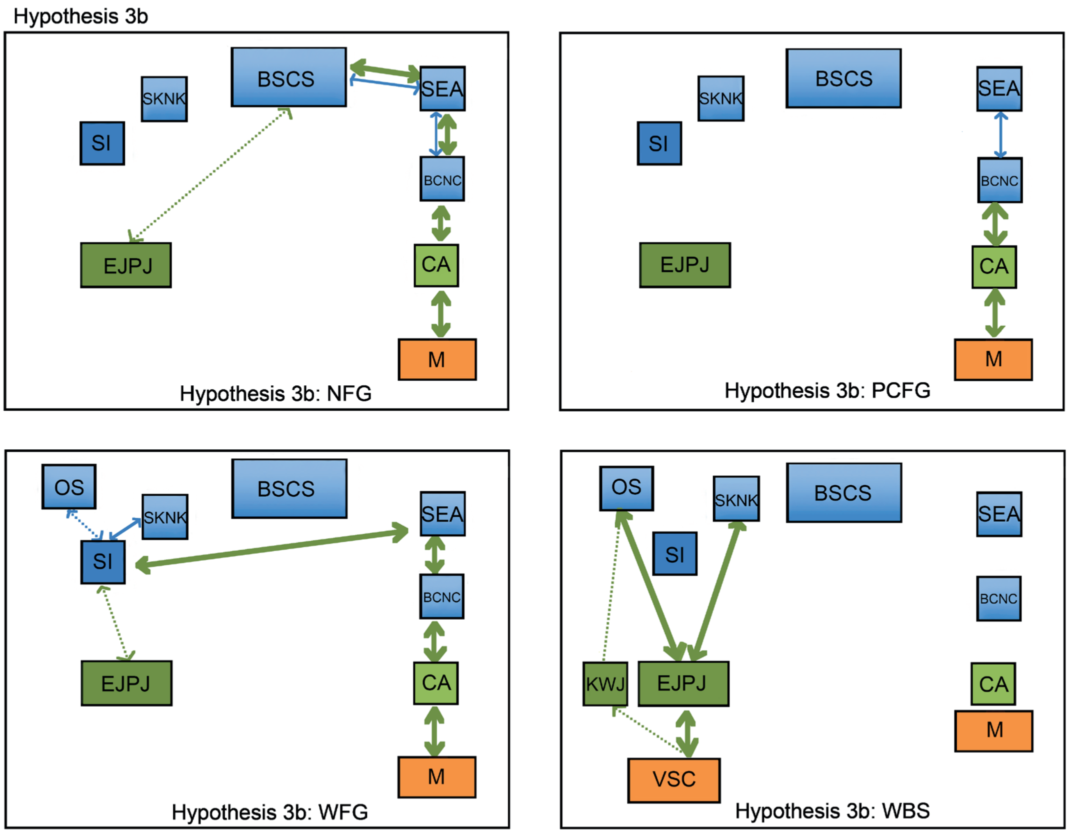

Figure 3(b) Hypothesis 3c/4c:

Hypothesis 3c: Maternal feeding ground fidelity, one migratory route/wintering region used by Sakhalin whales, random mating. A single breeding stock (EBS) exists. The EBS includes three feeding groups: NFG, PCFG, WFG. SKNK is used by some whales that belong to the WFG and some whales that belong to the NFG. Although two breeding stocks (WBS and EBS) may once have existed, the WBS is assumed to have been extirpated. WFG whales migrating from SI to M occasionally travel through BSCS.

Hypothesis 4c: Maternal feeding ground fidelity, one migratory route/wintering region used by Sakhalin whales, non-random mating. An EBS exists that includes two feeding groups: NFG and PCFG. A second breeding stock exist that is comprised of WFG whales that overwinter in M. SKNK is used by some whales that belong to the WFG and some whales that belong to the NFG. Although a third breeding stock (WBS) may once have existed, the WBS is assumed to have been extirpated. WFG whales migrating from SI to M occasionally travel through BSCS.

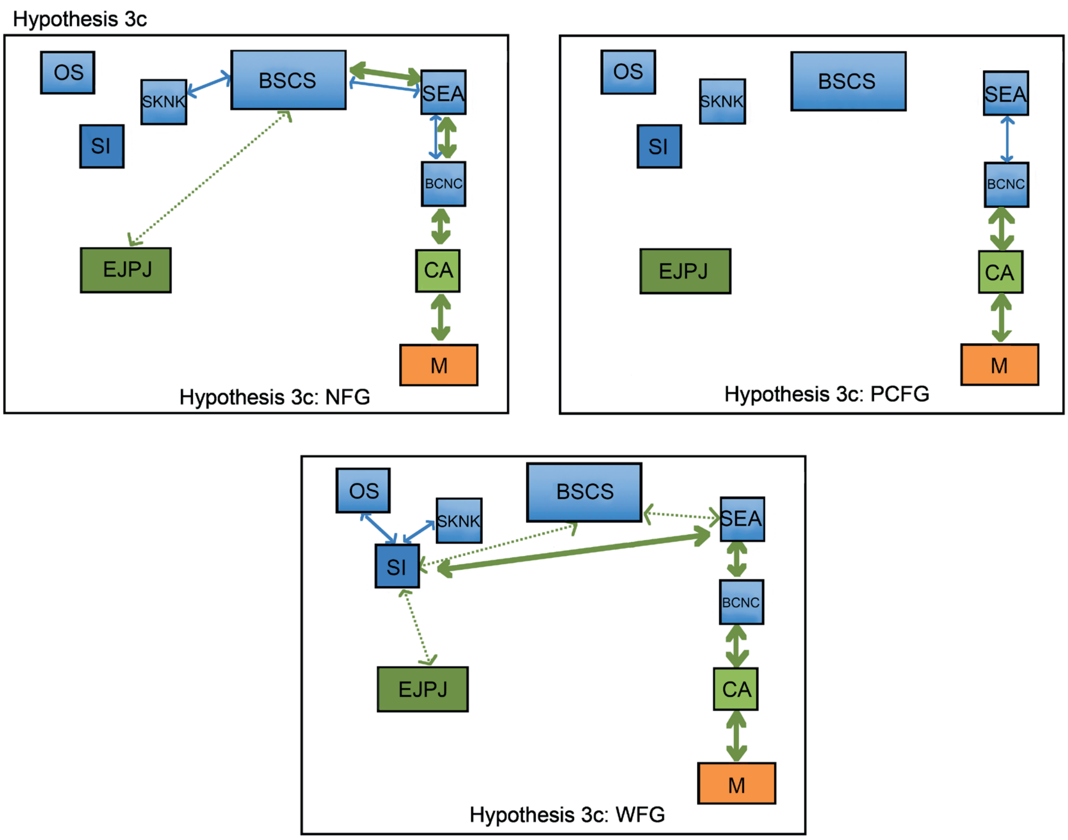

Figure 3 (c) Hypothesis 3e/4e

Hypothesis 3e: Maternal feeding ground fidelity, one migratory route/wintering region used by Sakhalin whales, random mating. A single breeding stock (EBS) exists. The EBS includes three feeding groups: NFG, PCFG, WFG. A WBS exists that feeds in the OS (but not SI), EJPJ, and KWJ and overwinters in VSC. SKNK is used by some whales that belong to the WFG and some whales that belong to the NFG, but not regularly by whales that are part of the WBS.

Hypothesis 4e: Maternal feeding ground fidelity, one migratory route/wintering region used by Sakhalin whales, non-random mating. The EBS includes two feeding groups: NFG and PCFG. A WBS exists that feeds in the OS (but not SI), EJPJ, and KWJ and overwinters in VSC. A third breeding stock comprised of the WFG whales that overwinter in M exists. SKNK is used by some whales that belong to the WFG and some whales that belong to the NFG but not regularly by whales that are part of the WBS.

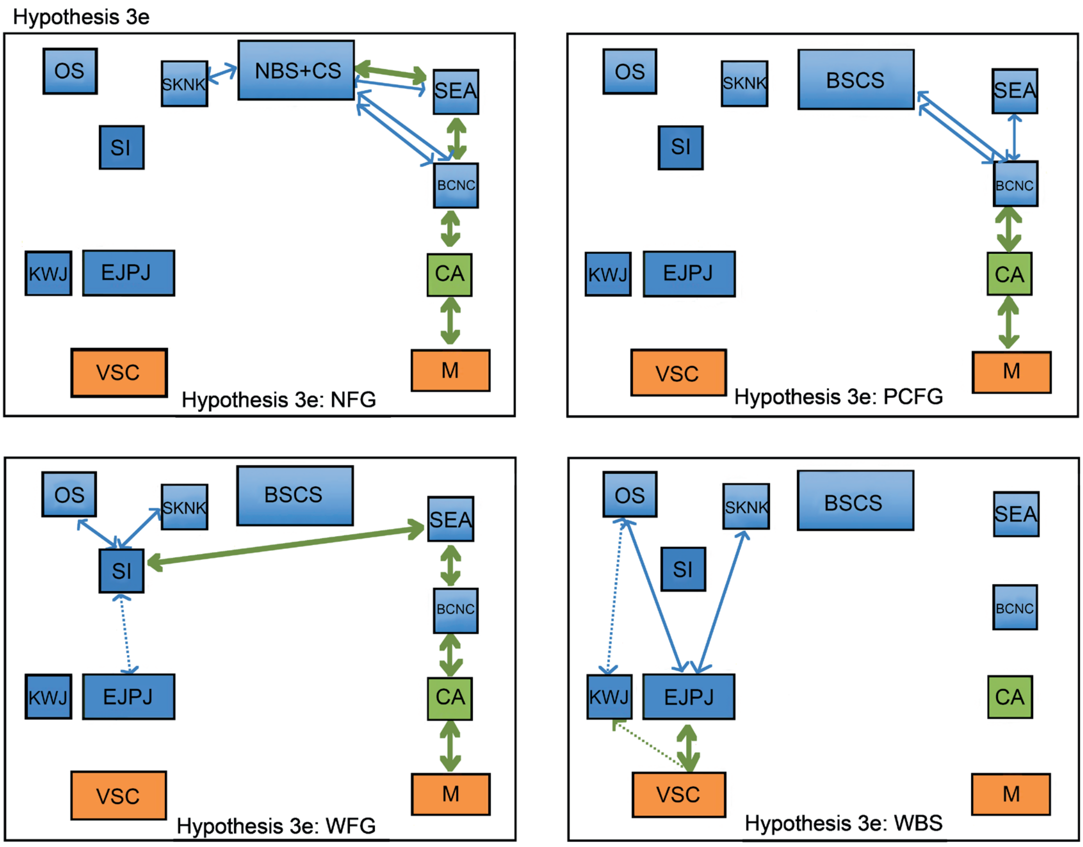

Figure 3 (d) Hypothesis 6b

Hypothesis 6b. Maternal feeding ground fidelity, Sakhalin whales use two migratory routes/wintering grounds without fidelity, random mating. Two breeding stocks (WBS and EBS) and three feeding groups (WFG, NFG, and PCFG) exist. SKNK is used by both the WFG and NFG. The WBS stock includes WFG whales, while the EBS stock includes NFG and PCFG whales. WBS whales use both wintering grounds (M and VSC). WBS individuals do not show fidelity for a particular wintering ground but do breed largely with each other during migration. EBS whales overwinter in M.

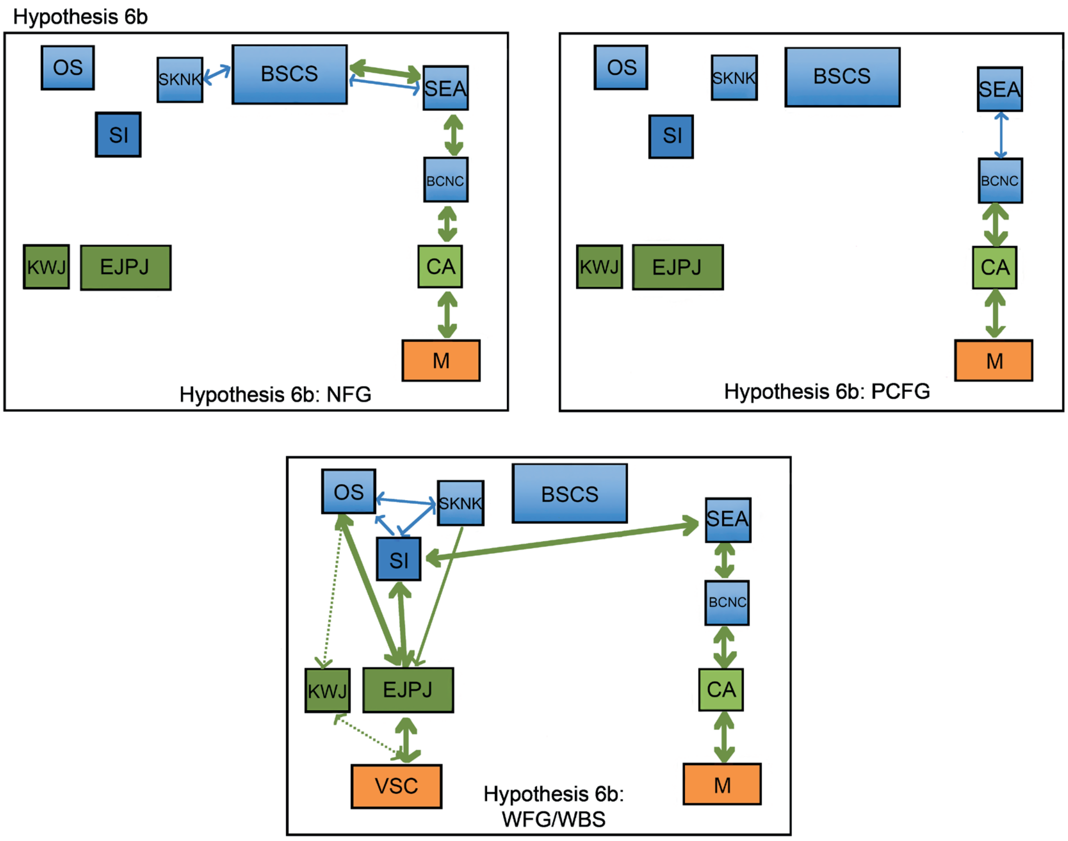

Fig. 3. Schematics of the stock structure hypotheses currently considered to have medium plausibility. Hypotheses that are functionally the same are represented by a single diagram with descriptions of both.

Table 4 [copied from Table 2, IWC (2019)].

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.

	Sub-area													
Breeding stock/ Feeding Aggregation	VSC	KWJ	EJPJ	OS	SI	SKNK	BSCA	SEA (J-N)	SEA (D-M)	BCNC (J-N)	BCNC (D-M)	CA (J-N)	CA (D-M)	M
a. Hypothesis 3a (no extant WBS)														
Eastern	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WFG	-	-	1	1	1	1	-	-	$\gamma 6$	-	$\gamma 3$	-	$\gamma 6$	1
North	-	-	$\gamma 1$	-	-	1	1	1	1	1	1	1	1	1
PCFG	-	-	-	-	-	-	1 [A]	$\gamma 8$ [B]	$\gamma 7$	$\gamma 2$	$\gamma 4$	$\gamma 5$	$\gamma 7$	1
b. Hypothesis 3b (extant WBS)														
Western	1	1	$\gamma 1$	1	-	-	-	-	-	-	-	-	-	-
Eastern	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WFG	-	-	-	1	1	1	-	-	$\gamma 6$	-	$\gamma 3$	-	$\gamma 6$	1
North	-	-	1	-	-	1	1	1	1	1	1	1	1	1
PCFG	-	-	-	-	-	-	-	1	$\gamma 7$	$\gamma 2$	$\gamma 4$	$\gamma 5$	$\gamma 7$	1
c. Hypothesis 3c (extant WBS, WFG in BSCS)														
Western	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Eastern	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WFG	-	-	1	1	1	1	1	-	$\gamma 6$	-	$\gamma 3$	-	$\gamma 6$	1
North	-	-	$\gamma 1$	-	-	1	1	1	1	1	1	1	1	1
PCFG	-	-	-	-	-	-	-	1	$\gamma 7$	$\gamma 2$	$\gamma 4$	$\gamma 5$	$\gamma 7$	1
d. Hypothesis 3e (extant WBS; WFG in EJPJ)														
Western	1	1	$\gamma 1$	1	-	1	-	-	-	-	-	-	-	-
Eastern	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WFG	-	-	1	1	1	1	-	-	$\gamma 6$	-	$\gamma 3$	-	$\gamma 6$	1
North	-	-	-	-	-	1	1	1	1	1	1	1	1	1
PCFG	-	-	-	-	-	-	-	1	$\gamma 7$	$\gamma 2$	$\gamma 4$	$\gamma 5$	$\gamma 7$	1
e. Hypothesis 5a (WBS in SI)														
Western	1	1	$\gamma 1$	1	1	1	-	-	-	-	-	-	-	-
Eastern	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WFG	-	-	1	1	1	1	-	-	$\gamma 6$	-	$\gamma 3$	-	$\gamma 6$	1
North	-	-	-	-	-	1	1	1	1	1	1	1	1	1
PCFG	-	-	-	-	-	-	1 [C]	$\gamma 8$ [D]	$\gamma 7$	$\gamma 2$	$\gamma 4$	$\gamma 5$	$\gamma 7$	1
f. Hypothesis 6b (no WFG)														
Western	1	1	1	1	1	1	-	-	$\gamma 6$	-	$\gamma 3$	-	$\gamma 6$	1
Eastern	-	-	-	-	-	-	-	-	-	-	-	-	-	-
North	-	-	-	-	-	1	1	1	1	1	1	1	1	1
PCFG	-	-	-	-	-	-	-	1	$\gamma 7$	$\gamma 2$	$\gamma 4$	$\gamma 5$	$\gamma 7$	1

[A] Sensitivity test (12) only.
[B] Sensitivity test (9) only.
[C] Sensitivity test (12) only.
[D] Sensitivity test (9) only.

References

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Annex G

Fishery Bycatch and Vessel Strikes of Large Whales Entered into the Progress Report Database in 2020

Complied by Marion Hughes, IWC Secretariat

(F = female, M = male, US = unknown sex, D = dead, SI = seriously injured, I = injured, FU = Fate Unknown)

A. Fishery Bycatch

ID	Data year	Large Area	Species	Local area	Local area (Long/Lat)	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Individual data available from the contact	Targeted fishery species	Fishing gear	Other fishing gear	Contacts
Australia																						
PR/R/14748	2019	Southern Ocean	Humpback whale	Victor Harbor (PO), 3.5km ENE (800m off Chiton Rocks), Encounter Bay	- 35 32 45 S; 138 39 30 E	-	-	-	-	-	-	-	-	-	-	-	1	Yes	-	LX; FPO	Craypot lines	PR/C/573 | C. Kemper (South Australian Museum) *Catherine.Kemper@samuseum.sa.gov.au*
PR/R/14751	2019	Southern Ocean	Humpback whale	Coffin Bay (PO), 32.5km NNW (Greenly Beach), Coffin Bay	34 20 57 S; 135 21 21 E	-	-	-	-	-	-	-	-	-	-	-	1	Yes	-	RG; FPO	Craypot lines	PR/C/573 | C. Kemper (as above)
PR/R/14754	2019	Southern Ocean	Southern right whale	Weirs Cove, Kangaroo Island	36 03 00 S; 136 43 15 E	-	-	-	-	-	-	-	-	-	-	-	1	Yes	-	MIS	Rope	PR/C/857 | C. Kemper (as above)
PR/R/14757	2019	Southern Ocean	Humpback whale	Port Elliot (PO), ~ 2km SSE (1.5km SE of Pullen Island), Encounter Bay	35 33 00 S; 138 41 30 E	-	-	-	-	-	-	-	-	-	-	-	1	Yes	-	MIS	Heavy rope	PR/C/573 | C. Kemper (as above)
PR/R/14760	2019	Southern Ocean	Unidentified large whale	Southend (PO), 25km SSE, Southern Ocean	37 46 S; 140 16 E	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Rock lobster	LX; FPO	-	PR/C/857 | C. Kemper (as above)
PR/R/15006	2019	Southern Ocean	Humpback whale	Barwon Heads, Port Phillip Bay	-38.4906, 144.6125	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Rock lobster	FPO	-	PR/C/465 | M. Watson *mandy.watson@delwp.vic.gov.au*
PR/R/15009	2019	Southern Ocean	Humpback whale	Cape Nelson	-38.6808, 141.6514	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Rock lobster	FPO	-	PR/C/465 | M. Watson (as above)
PR/R/15012	2019	Pacific Ocean - South	Humpback whale	Crowdy Head	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1020 | S. Crocetti *susan.crocetti@environment.nsw.gov.au*
PR/R/15015	2019	Pacific Ocean - South	Humpback whale	Barwon Heads	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15018	2019	Pacific Ocean - South	Humpback whale	Cronulla	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	NK	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15030	2019	Southern Ocean	Humpback whale	Cape Nelson	-38.4717, 141.5351	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Rock lobster	FPO	-	PR/C/465 | M. Watson (as above)
PR/R/15039	2019	Pacific Ocean - South	Humpback whale	Royal National Park	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15042	2019	Pacific Ocean - South	Humpback whale	Boomerang Beach	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15045	2019	Pacific Ocean - South	Humpback whale	Ballina	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15048	2019	Pacific Ocean - South	Humpback whale	Port Stephens	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15051	2019	Pacific Ocean - South	Humpback whale	Terrigal	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15072	2019	Pacific Ocean - South	Humpback whale	Crowdy Head	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)

ID	Data year	Large Area	Species	Local area	Local area (Long/Lat)	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Individual data available from the contact	Targeted fishery species	Fishing gear	Other fishing gear	Contacts
Australia cont.																						
PR/R/15114	2019	Pacific Ocean - South	Humpback whale	Queensland	Rainbow Beach to the Gold Coast				1								5	Yes	White, bull and tiger sharks	NSC; LX	-	PR/C/493 | Queensland Department of Agriculture and Fisheries; PR/C/718 | J. Meager *justin.meager@des.qld.gov.au*
PR/R/15144	2019	Pacific Ocean - South	Humpback whale	Terrigal	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15147	2019	Pacific Ocean - South	Humpback whale	North Head Sydney	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15150	2019	Pacific Ocean - South	Humpback whale	Bermagui	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15153	2019	Pacific Ocean - South	Humpback whale	Smoky Cape	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15156	2019	Pacific Ocean - South	Humpback whale	Muttonbird Island	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15159	2019	Pacific Ocean - South	Humpback whale	Port Stephens	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15162	2019	Pacific Ocean - South	Humpback whale	Forster	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15165	2019	Pacific Ocean - South	Humpback whale	-	-	0	0	0	0	0	0	0	0	1	0	0	0	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15168	2019	Pacific Ocean - South	Humpback whale	Angourie	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15171	2019	Pacific Ocean - South	Humpback whale	Crowdy Head	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15174	2019	Pacific Ocean - South	Humpback whale	Narooma	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15177	2019	Pacific Ocean - South	Humpback whale	Lennox Head	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15180	2019	Pacific Ocean - South	Humpback whale	Tuncurry	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15183	2019	Pacific Ocean - South	Humpback whale	Port Macquarie	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15186	2019	Pacific Ocean - South	Humpback whale	Byron Bay	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15189	2019	Pacific Ocean - South	Humpback whale	Diamond Beach	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	NSC	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15192	2019	Pacific Ocean - South	Humpback whale	One Mile Beach	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	NSC	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15204	2019	Pacific Ocean - South	Humpback whale	McMasters Beach	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15207	2019	Pacific Ocean - South	Humpback whale	Ballina	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	NSC	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15210	2019	Pacific Ocean - South	Humpback whale	Hastings Point	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15213	2019	Pacific Ocean - South	Humpback whale	Barrack Point	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15774	2019	Pacific Ocean - South	Humpback whale	Tyagerah	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)

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Australia cont.																						
PR/R/15777	2019	Pacific Ocean - South	Humpback whale	Split Solitary Island	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	LX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15780	2019	Pacific Ocean - South	Humpback whale	Bass Point	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15783	2019	Pacific Ocean - South	Humpback whale	Broughton Island	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15786	2019	Pacific Ocean - South	Humpback whale	Whale Beach	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	NSC	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15789	2019	Pacific Ocean - South	Humpback whale	Point Plomer	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15792	2019	Pacific Ocean - South	Humpback whale	Scotts Head	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15795	2019	Pacific Ocean - South	Humpback whale	Long Reef	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15801	2019	Pacific Ocean - South	Humpback whale	Mcauleys Head, Coffs Harbour	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15804	2019	Pacific Ocean - South	Humpback whale	Ballina	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15807	2019	Pacific Ocean - South	Humpback whale	Scotts Head	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	NSC	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15810	2019	Pacific Ocean - South	Humpback whale	Kingscliff Beach	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15813	2019	Pacific Ocean - South	Humpback whale	Tallebudgera	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	NSC S	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15816	2019	Pacific Ocean - South	Humpback whale	Ballina	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	LX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15819	2019	Pacific Ocean - South	Humpback whale	Woolgoolga	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15822	2019	Pacific Ocean - South	Humpback whale	Tallows Beach, Byron Bay	-	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	Unknown	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15840	2019	Pacific Ocean - South	Humpback whale	Shelly Beach	-34.064444, 151.191389	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15843	2019	Pacific Ocean - South	Humpback whale	Green Island	-30.911389, 153.093333	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	MIS	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15846	2019	Pacific Ocean - South	Humpback whale	Oftord Beach	-34.214444, 151.016111	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15849	2019	Pacific Ocean - South	Humpback whale	Redhead Beach Newcastle	-33.018056, 151.713056	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15852	2019	Pacific Ocean - South	Humpback whale	Forster	-32.341667, 152.540278	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	FIX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/15855	2019	Pacific Ocean - South	Humpback whale	Green Island, Smoky Cape	-30.911944, 153.087222	0	0	0	0	0	0	0	0	0	0	0	1	Yes	-	LX	-	PR/C/1011 | S. Crocetti (as above)
PR/R/16671	2019	Pacific Ocean - South	Humpback whale	Queensland	-	-	-	-	-	-	-	-	-	-	-	-	4	Yes	Crab/lobster	FPO	Dilly	PR/C/187 | Queensland Department of Agriculture, Fisheries and Forestry
PR/R/18309	2019	Southern Ocean	Sei whale	Bridport	-41.0041, 147.4323	1	-	-	-	-	-	-	-	-	-	-	-	Yes	-	MIS	Rope	PR/C/1155 | K. Carlyon *Kris.Carlyon@dpipwe.tas.gov.au*
PR/R/18666	2019	Indian Ocean	Humpback whale	Western Australia	-24.28703, 111.35742	-	-	-	-	-	-	-	-	-	-	-	2	Yes	Octopus	FPO	-	PR/C/1182 | A. Mutton *fauna@dbca.wa.gov.au*

ID	Data year	Large Area	Species	Local area	Local area (Long/Lat)	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Individual data available from the contact	Targeted fishery species	Fishing gear	Other fishing gear	Contacts
Australia cont.																						
PR/R/18669	2019	Indian Ocean	Humpback whale	Western Australia	-31.80289, 113.81836	-	-	-	-	-	-	-	-	-	-	-	6	Yes	W coast rock lobster managed fishery	FPO	-	PR/C/1182 | A. Mutton (as above)
PR/R/18672	2019	Indian Ocean	Humpback whale	Busselton, Western Australia	-33.6, 115.3	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Western rock lobster - recreational	FPO	-	PR/C/1182 | A. Mutton (as above)
PR/R/18675	2019	Indian Ocean	Humpback whale	Varanus Island, Western Australia	-20.65, 115.6	-	-	-	-	-	-	-	-	-	-	-	1	Yes		Unknown	Mooring line	PR/C/1182 | A. Mutton (as above)
PR/R/18678	2019	Indian Ocean	Humpback whale	Western Australia	-30.86451, 114.56543	-	-	-	-	-	-	-	-	-	-	-	6	Yes	Unknown	NK	Rope	PR/C/1182 | A. Mutton (as above)
PR/R/18681	2019	Indian Ocean	Humpback whale	Western Australia	-30.2, 114.9	-	-	-	-	-	-	-	-	-	-	-	7	Yes	Unknown	Unknown	Ropes and floats	PR/C/1182 | A. Mutton (as above)
PR/R/18684	2019	Indian Ocean	Humpback whale	Two Rocks, Western Australia	-31.49748, 115.57755	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	NK	-	PR/C/1182 | A. Mutton (as above)
PR/R/18687	2019	Indian Ocean	Southern right whale	Two Rocks, Western Australia	-31.50012, 115.56656	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	NK	-	PR/C/1182 | A. Mutton (as above)

Australia – notes

ID (see table above)	Explanation
PR/R/14748	1 April 2019. Did not strand. First seen entangled with craypot lines on 1 April 2019. Monitored on 2 April, then successfully released by DEW staff on 3 April 2019. Fisheries confirmed the pot was set at the location.
PR/R/14751	9 April 2019. Did not strand. Seen entangled with craypot line on 9 April 2019. DEW staff went to investigate on 11 April but could not locate the animal.
PR/R/14754	30 August 2019. Did not strand. Cow/calf pair. A rope was wrapped around calf's rostrum, which appears to be agitated and thrashing around. DEW staff went out to confirm the sighting but no disentanglement attempt made because of the remote location. Whales travelling W at S of Casuarina Island when last sighted.
PR/R/14757	4 September 2019. Did not strand. Heavy rope was wrapped around the body three times, one of them partially embedded into the body. DEW staff organised disentanglement on 15 September but could not locate the whale. Last seen 14:10-15:30 hrs on 14 September 2019.
PR/R/14760	18 November 2019. Did not strand? Whale cut free from rock lobster pot which was snagged and tethered to sea floor but lines, wrapping its pectoral fins tightly against body, could not be removed. Whale not moving when last seen but no resight since then. Photo shows some barnacles attached to the body behind its blowholes, indicating it had been in poor health for a while at least.
PR/R/15006	Whale monitored for several hours. Could not mount rescue until following day due to unsafe weather conditions. Whale disappeared overnight and could not be located despite extensive aerial search.
PR/R/15009	Response mounted but whale not located. Gear found floating at reported location. Whale assumed to have freed itself as all gear retrieved.
PR/R/15012	-
PR/R/15015	The sea mammal became tangled in lines used for lobster farming in the waters around Barwon Heads, and while it is still able to swim, the ropes place it in serious danger. DELWP Incident Controller Tim Gazzard said specialist staff have returned to the scene to try to find the whale, and attempt a rescue operation if weather permits. Dallas D'Silvia from Fisheries Victoria said the rope came from a deep-water lobster pot that was tied to a buoy. Ref: *https://www.theage.com.au/national/victoria/humpback-whale-remains-trapped-in-rope-off-barwon-heads-20190524-p51qwp.html.* A young whale entangled in waters off Barwon Heads has likely continued to migrate east, with rescuers losing sight of it. Based on the time of year, it is expected the whale will continue migrating up the east coast of Australia and is likely to be outside of Victorian waters by the time the weather abates. Ref: *https://www.bayfmgeelong.com.au/news/local-news/105334-barwon-heads-whale-rescue-called-off.*
PR/R/15018	Original observer was MoP on the beach near Cronulla SLSC, reported incident to local clubbies, who save a photo off the view screen of the observers camera, and relayed to ORRCA, then to NPWS.
PR/R/15030	Whale could not be located despite extensive aerial search.
PR/R/15039	Due to timing of reports, this whale was mistaken for the Cronulla animal (same day) but separation distance and description of entangled gear was different. Attempted rescue performed by 'good Samaritan' fishers, removed floats and significant amount of trailing line, removed all weight burden, but about 2-3m still lodged on pectoral fin in crease in pec insertion, whale swam off at about 6-7kts, hopeful that without weight it may dislodge (advised 'good Samaritan' of safety risks of what they did, but thanked them for their care).
PR/R/15042	Whale first reported off Boomerang Beach, witnesses (including surfers who paddled out to the whale) indicated it had rope wrapped over the body in front of the dorsal fin (maybe suggesting pectoral wraps), however by the time the LWD crew intercepted 4 days later, the tangle was just a handful of wraps on the peduncle only, and the release process took only a few cuts and a half hour to achieve.
PR/R/15045	Whale first sighted off southern break wall at mouth of Richmond River, Ballina by member of public, reported swimming into river, and then was monitored and photographed by MR and DPI staff, and NPWS, while waiting for confirmation a LWD Team from SE Qld was *en route*, images show a pair of smaller red and maybe black painted torpedo buoys trailing maybe 10m behind the tail, no further detail of the tangle was recorded (partial float numbers obtained).

ID (see table above)	Explanation
PR/R/15048	Single float trailing about 30m behind whale, rope looked to be entangled on right pectoral flipper, and possibly also left pectoral as there was no evidence of movement from available footage (stills and video by drone) - partial number details visible on trap.
PR/R/15051	Reported by member of public, animal seemed to have a single loop of trap rope over the front right side of the rostrum, possibly partially embedded, and rest of line trailing out the right side. (stills and video footage from drone).
PR/R/15072	-
PR/R/15114	4 unsexed in nets, 1 female in net; 1 unsexed on drumline; all 6 released alive.
PR/R/15144	Reported by member of public, animal seemed to have a single loop of trap rope over the front right side of the rostrum, possibly partially embedded, and rest of line trailing out the right side. (stills and video footage from drone).
PR/R/15147	Reported by member of public, from small recreational fishing vessel, animal appeared to be trailing a buoy about 20-30m behind.
PR/R/15150	Initial sighting called in to ORRCA by 'member of public' around 10:30am, sighted 200m offshore from Blue Pool Lookout, Bermagui, swimming north, species identification not certain, but likely to be either Humpback Whale or Southern Right Whale, accuracy of whale size estimation is dubious, but impression was possibly a smaller animal gear was described as 1 red float and 1 blue float, and rope trailing behind the whale, last seen still travelling north about 400m NNE of lookout.
PR/R/15153	Adult whale sighted from shore around midday, NP staff observers watched whale in same locality for over 1.5hrs, and were confident there was something wrapped on it, sighted via surveyors theodolite scope, so confidence level high, organised SWR Dive Centre vessel to investigate, but animal had disappeared and not sighted since.
PR/R/15156	-
PR/R/15159	Approx. 4:30pm, ORCCA received reports of an entangled Whale, about 50 to 100 meters offshore near Maroubra (Mistral Point, Mahon's Pool area), with orange or red buoy observed. Elements ID MAR20181956 (Mistral Pt or Maroubra).
PR/R/15162	Similar dorsal fin profile to NSW18-Golf from Forster on 23 July (note NSW18-Golf was partially disentangled by Seaworld off Stradbroke Island, 26 July).
PR/R/15165	Whale washed ashore dead on Long Beach, entangled in trap rope and floats, right pectoral flipper partially amputated, and evidence of severe rope abrasions on flanks around pectoral. Elements ID MAR20181962 (Ben Boyd – Long Beach) for details on the fishing gear recorded.
PR/R/15168	MOP at Sapphire Beach (observing from shore) reported a possible entangled whale. She reported that it was potentially dragging 3 round, dark coloured objects behind it. She last saw it at 08:30 but could no longer see it by the time she reported to NPWS around 09:00. Initial response was to contact Coffs Harbour Marine Rescue who put out an 'All Ships' radio message. Surf Life Saving at Park Beach confirmed the whale is entangled in a net (incorrect as it was trap ropes), by 10:00 was approaching Muttonbird Island moving south at around 5km/h. The *Pacific Explorer* (Leigh) was with the whale by 10:30 and turned to swim north obtained photos of the whale showing the entanglement forwarded to NPWS. By time LWD Team responded, sea conditions had deteriorated and observer contact with whale was lost.
PR/R/15171	Very unclear at what point this animal moved into NSW, but anecdotal information via ORRCA was that this animal was observed moving south, potentially off Tweed coast. Details unable to be confirmed. Needs verification via DPI Qld if possible. NB - On 31 July DPI Qld report a whale strike occurred at the Harbour Beach net at Mackay, Qld. Approximately 18m of mesh and 9m of the bottom rope is missing presumed attached to the whale. Unclear if this is the whale and net reported.
PR/R/15174	Member of community reported seeing another humpback collide with a shark mesh net at this location and reported via social media. NB - On 31 July DPI Qld report a whale strike occurred at the Harbour Beach net at Mackay, Qld. Approximately 18m of mesh and 9m of the bottom rope is missing presumed attached to the whale. Unclear if this is the whale and net reported.
PR/R/15177	Info from a commercial fisher that at approx. 11am he observed a group of 6 whales between Malabar and Botany Heads (heading south). One of the whales appeared to have a shark net attached to it. The fisher said that it appeared to be an old net and it was not impeding the whale's movement at all. DPI have had no reports of any missing shark nets from any contractors and all SMP nets were inspected today. NB - On 31 July DPI Qld report a whale strike occurred at the Harbour Beach net at Mackay, Qld. Approximately 18m of mesh and 9m of the bottom rope is missing presumed attached to the whale. Unclear if this is the whale and net reported.
PR/R/15180	Wespac Rescue Helicopter sighted the animal not far offshore and obtained photos which were supplied to NPWS. The tangle looks to be trap gear, attached on the left pectoral flipper or left mandible maybe, and trailing behind. The tailflukes are not engaged at the time of photography. The lines from the gear are trailing maybe 40m to 50m behind the whale, with a number of what look to be styrene floats about 20m back, and a loose end trailing another 20m to 30m beyond the floats (presumably the trap end of the line). Floats look to be white, maybe 2 or 3. Middle of the day, a crew managed to place a satellite telemetry buoy on the whale, in the hope that a trained Victorian LWD Team could intercept tomorrow or next few days. Animals last recorded position was just NE of Montague Island (based on satellite data).
PR/R/15183	Unknown, based on 3rd hand public report, may just have been a whale 'playing' close to shore?
PR/R/15186	Initial reports from 2 separate shore-based observers at Crescent Head, verified by shore based NPWS observer, but wind conditions deteriorated and ongoing sighting lost before LWD Team could deploy. Gear described as ropes and multiple floats trailing.
PR/R/15189	Panel of Qld shark mesh net, likely from Coolongatta on Sunday night 31st Sept (3 days). Based on estimated time gear was lost animal was swimming at between 2 to 2.5 knots.
PR/R/15192	SMP contractor advised that the net at Garie had significant whale damage and on retrieval of the net, it was noted that approx. 5m of rope and mesh is missing (also two small floats).
PR/R/15204	Details sketchy, but seems like reports bare a similarity to NSW18-November, in that there are multiple floats of at least orange and possibly black involved. Tangle reported to be ropes. Report from Maroubra SLSC (whale passed close inshore off SLSC) staff saw two floats, 1 orange and 1 black resembling 20L drums. Animal sighted inside Botany Bay late in the day, but not resighted overnight or next day.
PR/R/15207	Anchored in panel of shark mesh net, DPI Qld conducted rescue.
PR/R/15210	Reported around 6pm through ORRCA, as 'whale with rope and buoys 10m behind, heading towards Forster Beach'. ORRCA alerted members for shore-based surveillance, alerted Sydney LWD Team for 24-48hr intercepts if sighted.
PR/R/15213	Spotted by beach walkers early morning, calf entangled with mother not entangled close by, Sea World crew responded and freed by mid-morning, attendant mother non-aggressive. Tangle was simple drape of net over head, but up close to float line at surface, rescuers simply cut a hole in the net and calf swam through and free of other net material.
PR/R/15774	-
PR/R/15777	-
PR/R/15780	-
PR/R/15783	-
PR/R/15786	-

ID (see table above)	Explanation
PR/R/15789	-
PR/R/15792	-
PR/R/15795	-
PR/R/15801	-
PR/R/15804	-
PR/R/15807	-
PR/R/15810	-
PR/R/15813	-
PR/R/15816	DPI SMART Drumline contractors working Ballina area noted one set of gear missing. Gear was still transmitting and noted it was moving east consistent with a whale entanglement part of the gear was recovered, but the transmission unit (GPS locator) was still missing, but not transmitting. May still be attached to the whale and either under water or damaged.
PR/R/15819	Whale was first seen at Woolgoolga Headland by a member of the public Penny Eddy (ph 0417485209). Entanglement of humpback travelling south in a pair with one whale body wrapped in rope and trailing an orange float (basketball size). Due to the unavailability of LWD crew due to fires, deteriorating weather conditions and smoke and dust visibility a response is not possible.
PR/R/15822	Out of Blue whale watching in Byron reported at 10:30am today a very thin and lethargic humpback whale off Cape Byron. ORRCA reported to Susan Crocetti at 2pm. Leigh Mansfield reported from ORRCA. Reported to be 8m in length and barely moving. No lice observed but skin was reported to be very wrinkled and white between the folds.
PR/R/15840	Peter Eden is on marine rescue boat trying to locate the whale; 1 whale, 2 x white buoys and 1 blue rope entangled.
PR/R/15843	Report was reliable from NPWS staff working at Smoky Cape (shore based observer); observed in same general locality for over 1.5hrs. Observer too distant to see clear detail of entangled gear, but suspected numerous wraps over back of animal, and reflective object suspected to be float behind dorsal. Requested assistance from SWR Dive Centre vessel in vicinity, to confirm exact details of entanglement and photograph. Just prior to SWR dive vessel arriving, whale was lost from sight. Whale not re-sighted.
PR/R/15846	Member of public acted as good Samaritan and removed trailing ropes and floats, leaving a section of about 2m on either side of attachment on pectoral, hopeful that this would pull free without load of other trailing ropes.
PR/R/15849	UPDATED SIGHTING (Susan Crocetti) 11/07/2019. Redhead Beach Newcastle. Wayne Reynolds from ORRCA rang WDI on the HCCB DO number. ORRCA have received over 45 calls about whale and a significant crowd is growing as of 3pm. Whale is 50-150m offshore and not moving rapidly. Police are in attendance already. Polair has been seen thought likely associated with another emergency. Weather conditions deteriorating and time of day both preventing response at this stage. Prepare for potential stranding of whale and monitoring to determine if response possible for 12/07/2019/. Initial sighting called in to ORRCA by 'member of public' around 11:30am; - sighted 200m offshore from Blue Pool Lookout, Bermagui, swimming north. Species identification not certain, but likely to be either humpback whale or southern right whale. Accuracy of whale size estimation is dubious, but impression was possibly a smaller animal. Gear was described as 1 red float and 1 blue float, and rope trailing behind the whale. Last seen still travelling north about 400m NNE of lookout.
PR/R/15852	LWDT *en route* to meet with Forster Marine Rescue for briefing and induction. Monitor weather/sea conditions to ensure crew safety and operational plan is safe to proceed. No confirmed sighting since 09:30, 13/07/19.
PR/R/15855	Humpback whale reported by fisherman offshore from Green Island, Smoky Cape around 07:30hrs. Whale in company with one other, travelling north at around 4-5 knots. Tangle described as 'two orange faded buoys and ropes' hanging off it, but detail of tangle dynamics not clear. Seems likely based on description of tangled gear and speed to be same animal as Harrington/Crowdy ('NSW19-Quebec'. Elements MAR20192092). Sea conditions - 15kt SSW wind, swell 1.5m to 2m, choppy close to shore but OK further out.
PR/R/16671	4 humpback whales released alive. Reported by fishers via SOCI (*https://www.data.qld.gov.au/dataset/total-number-of-species-of-conservation-interest-interactions-with-released-conditions*).
PR/R/18309	Subadult stranded alive on 23 October 2019, died soon after discovery. Emaciated. Cause of death: long-term entanglement of rope around rostrum, starvation.
PR/R/18666	Broome: tracked from Broome until entangled in Cygnet Bay pearl farm where it was disentangled; Ledge Point: sighted by fisher with DBCA and DPIRD attending on dusk but long dive times and poor light prevented tag attachment.
PR/R/18669	Greenough: initially tethered, it broke free, entanglement removed with one cut; Seabird: sighted by recreational fishers off seabird, evaded DBCA next day. Augusta: spotted by whale watching boat in Flinders Bay, tagged, relocated the next day and disentangled. Guilderton: spotted and freed by recreational diver. Dawesville: tracked overnight and disentangled. Albany: initial partial disentanglement but resighted in Flinders Bay (whale watching vessel) with complete disentanglement.
PR/R/18672	Sighted then lost after adding extra buoys.
PR/R/18675	Tracked for approx. 1 week before tracker detached.
PR/R/18678	Leeman: unknown gear, not seen after initial sighting. Albany: rescue attempt the following day could not relocate the whale but discovered another entangled whale in the same region. Karratha: unable to respond given time, staffing and no satellite tag. Flinders Bay: single sighting in Flinders Bay. Dunsborough/Meelup: Meelup drone footage revealed entanglement upon footage review. Hillarys/Rottnest: breaching whale with trailing rope.
PR/R/18681	Green Head: reported late in the day, presumed to have moved on by time of report. Kalbarri: one sighting by member of public walking along the cliff, no further information. Busselton: DBCA deployed but no further sighting. Coral Bay: reported by spotter plane, due to the nature of the entanglement and speed of the whale, a tag could not be attached. Eagle Bay: sighting vessel lost it but DBCA deployed, no further sightings so left to attend Flinders Bay whale. Two Rocks Marina: entangled calf with mother in attendance, swimming strongly. Cockburn Sound: entangled calf possibly Two Rocks whale.
PR/R/18684	Whale sighted without tail, but no gear present.
PR/R/18687	Self-released.

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Denmark																					
PR/R/16458	2019	Atlantic Ocean – North	Humpback whale	Paamiut, W Greenland	-	-	-	-	1	-	-	-	-	-	-	-	Yes	Snow crab	FIX	Fisher-man	1 9m humpback whale female, Paamiut, W Greenland entangled in rope from crab gear, dead, Nov. 2019.
PR/R/16461	2019	Atlantic Ocean – North	Humpback whale	Sermiligaaq, Tasiilaq, E Greenland	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Cod	GN	Fisher-man	1 humpback whale unknown sex, Sermiligaaq, Tasiilaq, East Greenland (unknown length) observed swimming entangled in fishing gear, gillnets for cod. Not observed again, status unknown. October 2019.
PR/R/16464	2019	Atlantic Ocean – North	Humpback whale	Aasiaat, W Greenland	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Not specified	Unk	Fisher-man	1 humpback whale unknown sex, Aasiaat, W Green-land (unknown length) entangled in rope and fishing net, not specified further, euthanised, July 2019.
PR/R/16467	2019	Atlantic Ocean – North	Humpback whale	South Greenland	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Cod	FPN	Fisher-man	1 humpback whale unknown sex, South Greenland, (unknown length) entangled in fishing gear from pond net, disentangled by itself, June 2019.
PR/R/16470	2019	Atlantic Ocean – North	Humpback whale	Ikerasaarsuk-Kangaatsiaq, W Greenland	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Cod	FPN	-	1 humpback whale unknown sex, Ikerasaarsuk-Kangaatsiaq, West Greenland, (8-9m) entangled in fishing gear from pond net, dead, May 2019.

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Korea																						
PR/R/18468	2019	2020	Pacific Ocean – North	Common minke whale	East Sea	36.00000, 129.50000	1	-	-	-	8	-	-	-	-	-	-	-	Yes	GN	Fisherman, observer or inspector	PR/C/652 | H.W. Kim *forestu2@gmail.com*
PR/R/18471	2019	2020	Pacific Ocean – North	Common minke whale	East Sea	36.00000, 129.50000	11	-	-	-	15	-	-	-	2	-	-	-	Yes	FIX; FPN	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18474	2019	2020	Pacific Ocean – North	Common minke whale	East Sea	36.00000, 129.50000	5	-	-	-	10	-	-	-	-	-	-	-	Yes	FPO	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18477	2019	2020	Pacific Ocean – North	Common minke whale	East China Sea	34.00000, 127.50000	1	-	-	-	-	-	-	-	-	-	-	-	Yes	GN	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18480	2019	2020	Pacific Ocean – North	Common minke whale	East China Sea	34.00000, 127.50000	1	-	-	-	2	-	-	-	-	-	-	-	Yes	FIX; FPN	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18483	2019	2020	Pacific Ocean – North	Common minke whale	Yellow Sea	36.50000, 126.00000	2	-	-	-	-	-	-	-	-	-	-	-	Yes	GN	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18486	2019	2020	Pacific Ocean – North	Common minke whale	Yellow Sea	36.03160, 126.02000	1	-	-	-	-	-	-	-	-	-	-	-	Yes	FSN	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18489	2019	2020	Pacific Ocean – North	Bryde's whale	East China Sea	34.12700, 127.37600	1	-	-	-	-	-	-	-	-	-	-	-	Yes	FPO	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18492	2019	2020	Pacific Ocean – North	Humpback whale	East Sea	37.04100, 129.31600	1	-	-	-	-	-	-	-	-	-	-	-	Yes	GN	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)

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New Zealand																								
PR/R/18693	2019	2020	Pacific Ocean - South	Fin whale	-	-37.4, 178.38333	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Bigeye tuna	LLD	Fisherman	PR/C/1188 | Fisheries New Zealand	23/03/2019
PR/R/18696	2019	2020	Pacific Ocean - South	Southern right whale	Southland	-	-	-	-	-	-	-	-	-	-	-	-	2	Yes	Unknown	Unknown	Fisherman	PR/C/895 | Fisheries New Zealand	Reported as released alive un-injured; 07/11/19
PR/R/18897	2019	2020	Pacific Ocean - South	Humpback whale	Off Kaikoura Peninsula	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Rock lobster	FPO	Public	PR/C/537 | H. Hendriks *hhendriks@doc.govt.nz*	02/02/19 - Entangled in cray pot rope; self-released
PR/R/18900	2019	2020	Pacific Ocean - South	Unid. large baleen whale	-	-35.7392, 175.2931	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Rock lobster	FPO	Public	PR/C/537 | H. Hendriks (as above)	26/01/19; released alive uninjured
PR/R/18903	2019	2020	Pacific Ocean - South	Humpback whale	-	-42.4334, 173.7147	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Rock lobster	FPO	Fisherman	PR/C/537 | H. Hendriks (as above)	07/10/19; self-released

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Panama																									
PR/R/18651	2019	2020	Pacific Ocean - North	Hump-back whale	Salida del Puerto Mensabé, Los Santos	Ballena jorobada	7.71099, -80.50781	-	-	-	-	-	-	-	-	-	-	-	1	Yes	NK	Scientist	PR/C/794 | L.T. Trejos Lasso *ltrejos@miambiente.gob.pa*	PR/B/733 | Update to stranding in Pacific site of Panama. Trejos, L., *et al.* (unpublished)	COD1 | Animal agotado, con red de pesca en su cuerpo. Partes de la aleta doral y caudal, se logró liberación parcial, quedando sólo red en la aleta caudal.

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South Africa																							
PR/R/17067	2019	2020	Indian Ocean	Unid. large whale	-34.00, 25.00	0	0	0	0	0	0	0	0	0	0	0	1	-	Yes	Rock lobster	NK	-	PR/C/1209 | M. Meyer *Michaelmeyer0@gmail.com*
PR/R/17070	2019	2020	Indian Ocean	Southern right whale	-34.00, 18.00	0	0	0	0	0	0	0	0	0	0	0	1	-	Yes	Octopus; rock lobster	NK; LL	-	PR/C/1209 | M. Meyer (as above)
PR/R/17073	2019	2020	Indian Ocean	Humpback whale	-34.00, 18.00	1	0	0	0	1	0	0	0	0	0	0	2	-	Yes	Octopus; rock lobster; unknown	NK; LL	Thin fishing line	PR/C/1209 | M. Meyer (as above)
PR/R/17076	2019	2020	Indian Ocean	Bryde's whale	-34.00, 23.00	1	0	0	0	1	0	0	0	1	0	0	1	-	Yes	Octopus; unknown	LL; PS	Aquaculture	PR/C/1209 | M. Meyer (as above)
PR/R/19161	2019	2020	Indian Ocean	Humpback whale	-33.00, 27.00	1	0	0	0	0	0	0	0	0	0	0	3	-	Yes	-	NSC; NK; LL	Cargo net, ALDFG	PR/C/1209 | M. Meyer (as above)

ID	Data year	Year sub-mitted	Large Area	Species	Local taxonomy	Local area (Long/Lat)	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Individual data are available from the contact	Fishing gear	Contacts	References
Spain																						
PR/R/16314	2019	2020	Atlantic Ocean - North	Common minke whale	Balea alibranca	43.3194111 111111; -8.6041388 8888889	1	-	-	-	-	-	-	-	-	-	-	-	Yes	FPO	PR/C/683 | DXPN (Serv Conservación Biodiversidade) Xunta de Galicia *elisa.gago.moldes @xunta.gal*	PR/B/810 | Convenio de Colaboración Entre la Consellería de Medio Ambiente, Territorio y Vivienda de la Xunta de Galicia y la Asociación 'Coordinadora Para el Estudio de los Mamíferos Marinos - CEMMA', Para la Asitencia, Recuperación y Estudio de los Reptiles (Tortugas) y Mamíferos Marinos Varados en el Litoral de la Comunidad Autonoma de Galicia. 2019. Consellería de Medio Ambiente, Territorio y Vivienda y CEMMA (unpublished).

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UK																							
PR/R/18888	2019	2020	Atlantic Ocean - North	Humpback whale	UK	-	0	0	0	0	3	0	0	0	0	0	0	0	Yes	NK; FPO	PR/C/247 | R. Deaville *rob.deaville@ioz.ac.uk*PR/C/248 | A. Brownlow *andrew .brownlow@sac.co.uk*	PR/B/873 | CSIP Annual Report to UK Government for 2019. Deaville, R. (compiler) (unpublished)	Diagnosed from necropsy within UK stranding programme. Report of entanglements at sea and observations on stranded carcass.

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USA - 2018																							
PR/R/17991	2018	2020	Pacific Ocean - North	Gray whale	Washington; Pacific County	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Dungeness crab	FPO	Pot fishery (Washington)	Scientist	PR/C/501 | J. Greenman; *justin.greenman @noaa.gov*
PR/R/17994	2018	2020	Pacific Ocean - North	Gray whale	Washington; Snohomish County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Dungeness crab	FPO	Pot fishery (Washington)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/17997	2018	2020	Pacific Ocean - North	Gray whale	Washington; Clallam County	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Dungeness Crab	FPO	Pot fishery (Washington)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18000	2018	2020	Pacific Ocean - North	Gray whale	Washington; Pacific County	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Unknown	FIX	Unid. pot/trap fishery	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18003	2018	2020	Pacific Ocean - North	Humpback whale	Washington; Grays Harbor County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Dungeness Crab	FPO	Pot fishery (Washington)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18087	2018	2020	Pacific Ocean - North	Humpback whale	Washington; Grays Harbor County	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Dungeness Crab	FPO	Pot fishery (Wa-Tribal)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18090	2018	2020	Pacific Ocean - North	Humpback whale	Washington; Grays Harbor County	-	-	-	-	-	-	-	-	1	1	-	-	Yes	Unknown	FPO	Unid.pot/trap fishery	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18093	2018	2020	Pacific Ocean - North	Humpback whale	Washington; Clallam County	-	-	-	-	-	-	-	-	1	1	-	-	Yes	Unknown	GN	Gillnet fishery (Tribal)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18096	2018	2020	Pacific Ocean - North	Humpback whale	Washington; Clallam County	-	-	-	-	-	-	-	-	-	1	1	-	Yes	Unknown	GN	-	Scientist	PR/C/501 | J. Greenman (as above)

ID	Data year	Year submitted	Large Area	Species	Local area	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Individual data are available from the contact	Targeted fishery species	Fishing gear	Other fishing gear	How observed	Contacts
USA - 2018 cont.																							
PR/R/18099	2018	2020	Pacific Ocean - North	Humpback whale	Washington; Clallam County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	FPO	Unid. pot/trap fishery	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18102	2018	2020	Pacific Ocean - North	Gray whale	Oregon; Lincoln County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Dungeness Crab	FPO	Pot fishery (Washington)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18105	2018	2020	Pacific Ocean - North	Gray whale	Oregon; Curry County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	FPO	Unid. pot/trap fishery	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18108	2018	2020	Pacific Ocean - North	Humpback whale	Oregon; Douglas County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	Unknown	Unid. fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18111	2018	2020	Pacific Ocean - North	Humpback whale	Oregon; Curry County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	FPO	Unid. pot/trap fishery	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18114	2018	2020	Pacific Ocean - North	Humpback whale	Oregon; Clatsop County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	Unknown	Unid. fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18117	2018	2020	Pacific Ocean - North	Unidentified large whale	Oregon; Curry County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	Unknown	Unid. fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18120	2018	2020	Pacific Ocean - North	Blue whale	California; Sonoma County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	Unknown	Unid. fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18123	2018	2020	Pacific Ocean - North	Fin whale	California; Santa Barbara County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	Unknown	Unid. fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18126	2018	2020	Pacific Ocean - North	Gray whale	California Offshore	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Swordfish	GN	Drift gillnet fishery (CA)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18129	2018	2020	Pacific Ocean - North	Gray whale	California; Orange County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	Unknown	Unid. fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18132	2018	2020	Pacific Ocean - North	Gray whale	California; Monterey County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	Unknown	Unid. fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18135	2018	2020	Pacific Ocean - North	Gray whale	California; Ventura County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	GN	-	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18138	2018	2020	Pacific Ocean - North	Gray whale	California; Marin County	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Unknown	-	Fishery related marine debris	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18141	2018	2020	Pacific Ocean - North	Gray whale	California; San Diego County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	GN	-	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18144	2018	2020	Pacific Ocean - North	Gray whale	California; Orange County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	GN	-	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18147	2018	2020	Pacific Ocean - North	Gray whale	California; San Luis Obispo County	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Dungeness Crab	[FPO] TRAPS - Pots	Pot fishery (California)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18150	2018	2020	Pacific Ocean - North	Gray whale	California; Marin County	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Unknown	Unknown	Unid. fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18153	2018	2020	Pacific Ocean - North	Humpback whale	California; Monterey County	-	-	-	-	-	-	-	-	-	2	-	-	Yes	Unknown	Unknown	Unid. fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18156	2018	2020	Pacific Ocean - North	Humpback whale	California; Monterey County	-	-	-	-	-	-	-	-	-	1	1	-	Yes	Dungeness crab	FPO	Pot fishery (California)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18159	2018	2020	Pacific Ocean - North	Humpback whale	California; Monterey County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Dungeness crab	FPO	Pot fishery (commercial)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18162	2018	2020	Pacific Ocean - North	Humpback whale	California; Monterey County	-	-	-	-	-	-	-	-	-	2	-	-	Yes	Dungeness crab	FPO	Pot fishery (Washington)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18165	2018	2020	Pacific Ocean - North	Humpback whale	California; Monterey County	-	-	-	-	-	-	-	-	-	-	1	-	Yes	Spot prawn	FPO	Trap/pot fishery (recreational)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18168	2018	2020	Pacific Ocean - North	Humpback whale	California; Monterey County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Spot prawn	FPO	Trap fishery (California)	Scientist	PR/C/501 | J. Greenman (as above)

ID	Data year	Year submitted	Large Area	Species	Local area	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Individual data are available from the contact	Targeted fishery species	Fishing gear	Other fishing gear	How observed	Contacts
USA - 2018 cont.																							
PR/R/18171	2018	2020	Pacific Ocean - North	Humpback whale	California; Monterey County	-	-	-	-	-	-	-	-	-	-	1	-	Yes	Unknown	FPO	Unid. pot/trap fishery	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18174	2018	2020	Pacific Ocean - North	Humpback whale	California; San Diego County	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Dungeness crab	FPO	Pot fishery (California)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18177	2018	2020	Pacific Ocean - North	Humpback whale	California; San Diego County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	FPO	Unid. pot/trap fishery	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18180	2018	2020	Pacific Ocean - North	Humpback whale	California; San Diego County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	Unknown	Unid. fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18183	2018	2020	Pacific Ocean - North	Humpback whale	California; San Mateo County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Dungeness crab	FPO	Pot fishery (Oregon)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18186	2018	2020	Pacific Ocean - North	Humpback whale	California; San Mateo County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	FPO	Unid.pot/trap fishery	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18189	2018	2020	Pacific Ocean - North	Humpback whale	California; Los Angeles County	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Unknown	GN	-	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18192	2018	2020	Pacific Ocean - North	Humpback whale	California; Mendocino County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	Unknown	Unid. fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18195	2018	2020	Pacific Ocean - North	Humpback whale	California; Mendocino County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	FPO	Unid. pot/trap fishery	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18198	2018	2020	Pacific Ocean - North	Humpback whale	California; Humboldt County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Dungeness crab	FPO	Pot fishery (California)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18201	2018	2020	Pacific Ocean - North	Humpback whale	California; San Francisco County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	Unknown	Unid. fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18204	2018	2020	Pacific Ocean - North	Humpback whale	California; San Francisco County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	FPO	Unid. pot/trap fishery	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18207	2018	2020	Pacific Ocean - North	Humpback whale	California; San Luis Obispo County	-	-	-	-	-	-	-	-	-	2	-	-	Yes	Unknown	Unknown	Unid. fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18210	2018	2020	Pacific Ocean - North	Humpback whale	California; San Luis Obispo County	-	-	-	-	-	-	-	-	-	2	-	-	Yes	Unknown	FPO	Unid. pot/trap fishery	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18213	2018	2020	Pacific Ocean - North	Humpback whale	California; Marin County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Dungeness crab	FPO	Pot fishery (California)	Scientist	PR/C/501 | J. Greenman (as above)
PR/R/18216	2018	2020	Pacific Ocean - North	Unidentified large whale	California; Ventura County	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	Unknown	Unid. fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)

ID	Data year	Year submitted	Large Area	Species	Local area (Long/Lat)	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Individual data are available from the contact	Fishing gear	How observed	Contacts	References
USA - 2017																						
PR/R/16638	2017	2020	Atlantic Ocean - North	North Atlantic right whale	42.29356, -67.76367	-	-	-	-	-	-	-	-	4	2	0	0	Yes	NK; FPO	-	PR/C/836 | A. Henry *allison.henry@noaa.gov*	PR/B/822 | Serious Injury and Mortality Determinations for Baleen Whale Stocks along the Gulf of Mexico, United States East Coast, and Atlantic Canadian Provinces, 2013-2017 | Henry, A.G., T.V.N. Cole, L. Hall, W. Ledwell, D. Morin and A. Reid (unpublished).
PR/R/18021	2017	2020	Atlantic Ocean - North	Humpback whale	39.90974, -77.34375	-	-	-	-	-	-	-	-	3	0	5	-	Yes	NK; FPO; GN	Observer or inspector, public	PR/C/836 | A. Henry (as above)	PR/B/822 as above

ID	Data year	Year submitted	Large Area	Species	Local area (Long/Lat)	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Individual data are available from the contact	Fishing gear	How observed	Contacts	References
USA - 2017 cont.																						
PR/R/18024	2017	2020	Atlantic Ocean - North	Common minke whale	-	-	-	-	-	-	-	-	-	12	0	2	-	Yes	NK; FPO	Scientist, fisherman, observer or inspector, public	PR/C/836 | A. Henry (as above)	PR/B/822 as above
PR/R/18027	2017	2020	Atlantic Ocean - North	Fin whale	-	-	-	-	-	-	-	-	-	1	0	0	-	Yes	FPO	Fisherman	PR/C/836 | A. Henry (as above)	PR/B/822 as above
PR/R/18030	2017	2020	Atlantic Ocean - North	Sei whale	-	-	-	-	-	-	-	-	-	-	1	-	-	Yes	NK	Scientist, fisherman, observer or inspector, public	PR/C/836 | A. Henry (as above)	PR/B/822 as above

FAO Fishery gear codes

[FIX] TRAPS - Traps (not specified)	[LX] HOOKS AND LINES - Hooks and lines (not specified)
[FPN] TRAPS – Stationary uncovered pounds nets	[MIS] MISCELLANEOUS GEAR
[FPO] TRAPS - Pots	[NK] GEAR NOT KNOWN OR NOT SPECIFIED
[FSN] TRAPS – Stow nets	[NSC] SHARK CONTROL NETS
[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)	[PS] SURROUNDING NETS - With purse lines
[LL] HOOKS AND LINES - Longlines (not specified)	[RG] RECREATIONAL FISHING GEAR
[LLD] HOOKS AND LINES - Drifting longlines	

B. Vessel strikes

ID	Data year	Year sub-mitted	Large Area	Species	Local area	Local area (Long/Lat)	Total individuals: Dead	Total individuals: Seriously Injured	Total individuals: Injured	Total individuals: Unknown	Individuals data are available	Submitted to National Ship Strike Database	Submit-ted to IWC	Explanation
Australia														
PR/R/15066	2019	2020	Southern Ocean	Southern right whale	Fowlers Bay (PO), 6.5km NE, Fowlers Bay, Great Australian Bight	31 56 39 S; 132 27 07 E	1	-	-	-	Yes	No	Yes	28/08/19. Found dead. Collected for post-mortem by SA Museum. Prob. boat strike.
PR/R/15111	2019	2020	Pacific Ocean - South	Humpback whale	Fraser Island	-24.78794°S; 153.12689°E	-	-	-	2	No	No	No	-
PR/R/16566	2019	2020	Southern Ocean	Pygmy right whale	Port Lincoln (PO), 7.3km SSW, Spencer Gulf	34 46 35 S; 135 48 56 E	1	-	-	-	Yes	No	Yes	27/03/19. Found floating in bay. Collected for post-mortem by SA Museum. Probable boat strike - severe blunt trauma.

ID	Data year	Year submitted	Large Area	Species	Local area	Local area (Long/Lat)	Total individuals: Dead	Total individuals: Seriously Injured	Total individuals: Injured	Total individuals: Unknown	Individuals data are available	Submitted to National Ship Strike Database	Submitted to IWC	Explanation
Italy														
PR/R/16215	2019	2020	Atlantic Ocean - North	Fin whale	Tyrrhenian Sea (Mediterranean Sea)	35.46067; 4.21875	1	-	-	-	Yes	Unknown	Yes	Newborn; Female; estimated total length: 500cm; empty stomach. The animal showed equally-spaced linear cuts (i.e. propeller injury), on the back (30cm deep), affecting skin, subcutaneus and deep muscular tissues. Clot in abdomen. Presence of abundant intarpulmonary meconium detected microscopically. The impact is considered related with severe respiratory failure due to aspiration of a significant amount of meconium (neonatal/perinatal pathology).

ID	Data year	Year sub-mitted	Large Area	Species	Local area	Local taxonomy	Local area (Long/Lat)	Total individuals: Dead	Total individuals: Seriously Injured	Total individuals: Injured	Total individuals: Unknown	Individuals data are available	Submitted to National Ship Strike Database	Submitted to IWC	Explanation
Netherlands															
PR/R/16938	2019	2020	Atlantic Ocean - North	Fin whale	Vlissingen	Gewone vinvis	-	1	-	-	-	Yes	No	No	The animal was brought into the Sloehaven on the bow of a vessel. Due to the impact with the vessel most organs were absent. Without organs weight approx. 18 tons, length 15.7m. It was a male fin whale.

ID	Data year	Year submitted	Large Area	Species	Local area	Local taxonomy	Total individuals: Dead	Total individuals: Seriously Injured	Total individuals: Injured	Total individuals: Unknown	Individuals data are available	Submitted to National Ship Strike Database	Submitted to IWC	Contacts	Explanation
Spain															
PR/R/17832	2019	2020	Atlantic Ocean - North	Sperm whale	Canary Islands	Cachalote	3	-	-	-	Yes	No	No	PR/C/663 | A. Fernández *antonio.fernandez@ulpgc.es*; PR/C/664 | M. Arbelo *manuel.arbelo@ulpgc.es*	Reference: Speed talk at the World Marine Mammal Conference, December 9-12, 2019.
PR/R/17850	2019	2020	Atlantic Ocean - North	Bryde's whale	Canary Islands	Rorcual tropical	1	-	-	-	Yes	No	No	PR/C/663; PR/C/664 (as above)	As above

ID	Data year	Year sub-mitted	Large Area	Species	Local area	Total individuals: Dead	Total individuals: Seriously Injured	Total individuals: Injured	Total individuals: Unknown	Individuals data are available?	National Ship Strike Database	Submitted to IWC	Contacts	References	Explanation
UK															
PR/R/18876	2019	2020	Atlantic Ocean - North	Common dolphin	UK	1	0	0	0	-	Unknown	Unknown	PR/C/247 | R. Deaville *rob.deaville@ioz.ac.uk*	PR/B/873 | CSIP Annual Report to UK Government for 2019. Deaville, R. (compiler) (unpublished).	Diagnosed from necropsy within UK strandings programme.

ID	Data year	Year submitted	Large Area	Species	Local area	Local area (Long/Lat)	Total individuals: Dead	Total individuals: Seriously Injured	Total individuals: Injured	Total individuals: Unknown	Individuals data are available	Submitted to National Ship Strike Database	Submitted to IWC
USA - 2018													
PR/R/16833	2019	2020	Pacific Ocean - North	Gray whale	Washington	Jefferson County	1	0	0	0	No	No	Unknown
PR/R/16845	2019	2020	Pacific Ocean - North	Humpback whale	King County	-	0	0	0	1	No	No	Unknown
PR/R/16848	2019	2020	Pacific Ocean - North	Gray whale	Marin County	-	1	0	0	0	No	No	Unknown
PR/R/16854	2019	2020	Pacific Ocean - North	Humpback whale	Marin County	-	1	0	0	1	No	No	Unknown
PR/R/16857	2019	2020	Pacific Ocean - North	Gray whale	Contra Costa County	-	1	0	0	0	No	No	Unknown
PR/R/16860	2019	2020	Pacific Ocean - North	Gray whale	San Francisco county	-	1	0	0	0	No	No	Unknown
PR/R/16863	2019	2020	Pacific Ocean - North	Gray whale	San Mateo County	-	2	0	0	0	No	No	Unknown
PR/R/16866	2019	2020	Pacific Ocean - North	Gray whale	Ventura County	-	1	0	0	0	No	No	Unknown
PR/R/16869	2019	2020	Pacific Ocean - North	Gray whale	Los Angeles County	-	1	0	0	1	No	No	Unknown
PR/R/16872	2019	2020	Pacific Ocean - North	Blue whale	Los Angeles County	-	1	0	0	0	No	No	Unknown
PR/R/16875	2019	2020	Pacific Ocean - North	Sei whale	Orange County	-	1	0	0	0	No	No	Unknown

ID	Data year	Year submitted	Large Area	Species	Local area	Local area (Long/Lat)	Total individuals: Dead	Total individuals: Seriously Injured	Total individuals: Injured	Total individuals: Unknown	Individuals data are available	Submitted to National Ship Strike Database	Submitted to IWC
USA - 2017													
PR/R/16626	2017	2020	Atlantic Ocean - North	North Atlantic right whale	-	-	5	0	0	0	Yes	Unknown	Unknown
PR/R/16629	2017	2020	Atlantic Ocean - North	Humpback whale	-	-	8	1	-	-	Yes	Unknown	Unknown
PR/R/16632	2017	2020	Atlantic Ocean - North	Fin whale	-	-	1	-	-	-	Yes	Unknown	Unknown
PR/R/16635	2017	2020	Atlantic Ocean - North	Common minke whale	-	-	2	0	0	0	Yes	Unknown	Unknown

Annex H

State of the Cetacean Environment Report (SOCER) 2020

Editors: M. Stachowitsch[1], N.A. Rose[2] and E.C.M. Parsons[3]

INTRODUCTION

Several resolutions of the International Whaling Commission, including Resolutions 1997-7 (IWC, 1998) and 1998-5 (IWC, 1999), directed the Scientific Committee to provide regular updates on environmental matters that affect cetaceans. Resolution 2000-7 (IWC, 2001) welcomed the concept of the State of the Cetacean Environment Report (SOCER) and requested the annual submission of this report to the Commission. The first full SOCER (Stachowitsch *et al.*, 2003) was 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 2020 SOCER features the **Atlantic Ocean**, summarising key papers and articles published from *ca*. 2018 through 2020 to date. This year's regional SOCER represents the initial year of the next cycle (see first SOCER five-year compendium at *https://iwc.int/socer-report*), which will be combined in a second five-year compendium (2020: Atlantic Ocean through 2024: Mediterranean and Black Seas) to present to the Commissioners at IWC/70.

ATLANTIC OCEAN

General

Comprehensive Overview of Marine Pollution in the Caribbean

The Caribbean is home to six species of baleen whales and 24 species of toothed whales and for many of these species, waters of the region serve as primary habitat for critical activities such as feeding, mating and calving. In five chapters, seven annexes and dozens of figures, tables and boxes, this overview of the marine pollution problems facing the Wider Caribbean Region deals with a full range of issues, from oil pollution to marine debris and invasive species. It emphasises assessment, marine pollution policy frameworks, and the impacts and threats to the blue economy. Notably, 15 Caribbean countries have now banned plastic bags and Styrofoam. With 37 distinct geopolitical entities, this region has the potential to serve as a case study for addressing the major difficulties in controlling pollution in seas bordered by multiple countries.

(SOURCE: Diez, S.M., Patil, P.G., Morton, J., Rodriguez, D.J., Vanzella, A., Robin, D.V., Maes, T. and Corbin, C. 2019. Marine Pollution in the Caribbean: Not a Minute to Waste. Washington, D.C., World Bank Group, 100pp. https://www.researchgate.net/publication/333237096).

Cruise Ship Waste and Seismic Noise in the Caribbean

Beyond the marine pollution problems facing the Wider Caribbean Region (WCR) outlined in Diez *et al.* (2019), other publications have noted that this region has, for example, one of the highest numbers of cruise routes and cruise ship ports worldwide. The number of vessels and the amount of waste produced have increased substantially over the last two decades (e.g. a middle-sized ship produces an estimated 8 tons of solid waste within a week). Most port facilities do not have sufficient capacity to receive garbage, and while discharging of solid waste at sea is prohibited through MARPOL, enforcement is often lacking. With regard to noise, 12 marine areas in Latin America are under exploration for oil and gas reserves and therefore subject to seismic surveys: 11 such blocks are located in the Caribbean. As an example for scale, this is equivalent to approximately 34 million ha or 10% of the Colombian seascape. Increasing energy demands are expected to intensify the use of seismic surveying, and this activity is currently poorly regulated. The authors provide detailed lists of appropriate mitigation standards that should be adopted and implemented.

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[2]Animal Welfare Institute, Washington, DC, USA.
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(SOURCES: Acosta, A., Niño-Rodríguez, N., Yepes, M. C. and Boisseau, O. 2017. Mitigation provisions to be implemented for marine seismic surveying in Latin America: A review based on fish and cetaceans. Aquat. Biol. 26: 199-216; Dowling, R. and Weeden, C. (ed). 2017. Cruise Ship Tourism. 2nd Edition. University of Brighton, U.K.; Sanches, V.M.L., Aguiar, M.R.d.C.M., de Freitas, M.A.V. and Pacheco, E.B.A.V. 2020. Management of cruise ship-generated solid waste: A review. Mar. Pollut. Bull. 151: 110785. https://doi.org/10.1016/j.marpolbul.2019.110785).

Habitat degradation

Fisheries interactions

Proactive Conservation is Needed and Effective for the North Atlantic Right Whale

Of 17 documented North Atlantic right whales killed in 2017, 12 died in the Gulf of St Lawrence, Canada, and five in the USA, extending south to the state of Virginia (*https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2020-north-atlantic-right-whale-unusual-mortality-event*). Nine died from entanglement in fishing gear (*n*=4) or ship strike (*n*=5); the others died of unknown causes. These mortalities were deemed an unusual mortality event (UME). Three more carcasses were found in US waters in 2018 - all died from entanglement (Sharp *et al.*, 2019). Davies and Brillant (2019) maintain that the UME in Canada was the result of relative inaction by government agencies nominally working to protect this species from these threats. The tendency to protect economic sectors at the expense of conservation efforts can lead, as it did here, to a crisis where emergency action could be more damaging to economic interests than measured proactive responses. The authors believe that '[m]onitoring…and proportionate action in response to evidence in years prior to 2017 almost certainly would have lessened the mass mortality of right whales'. They conclude that conservation '[a]ctions must be done proportionate to the evidence, and based on science, but also be adaptive and precautionary'. Importantly, strict federal regulations in Canada in 2018, enacted in response to the UME, led to zero whale deaths attributable to entanglement in Canadian waters, while allowing a successful fishery in areas of high whale density. Thus acting *before* a crisis can be effective in reducing wildlife losses. The authors thus advocate for proactive plans, with strong follow-through, to allow consistent right whale recovery. Right whale deaths in Canada resumed in 2019, with the primary cause of death attributable to ship strikes in at least three of the nine documented cases (see URL above). Final causes of death are still pending for the remaining cases. Two additional right whale deaths occurred in the USA as well, one each in 2019 and 2020.

Partly in response to the UME, a consortium of researchers, fishing industry representatives, manufacturers, conservationists and regulators is working to develop 'ropeless' fishing gear (Myers *et al.*, 2019). Fishing traps on the seafloor connected to buoys at the surface by vertical ropes are commonly used in right whale habitat, who become entangled easily as they skim feed at the surface. They then may drag the gear for weeks or months before succumbing to infection or injury as the rope cuts into the flesh and blubber. The development of ropeless traps would be an important innovation, directly relevant to the goal of avoiding future UMEs. This gear is not yet ready to be used widely, but is the type of 'adaptive' gear innovation recommended by Davies and Brillant (2019). The consortium notes that '[r]opeless fishing needs to advance quickly to help avert the existing [North Atlantic right whale] entanglement crisis and address the immediate need to reduce wildlife entanglements off the U.S. West Coast while keeping the fishing industry viable'.

(SOURCES: Davies, K.T.A. and Sean W. Brillant, S.W. 2019. Mass human-caused mortality spurs federal action to protect endangered North Atlantic right whales in Canada. Mar. Pol. 104: 157-162; Sharp, S.M., McLellan, W.A., Rotstein, D.S., Costidis, A.M., Barco, S.G., Durham, K., Pitchford, T.D., Jackson, K.A. et al. 2019. Gross and histopathologic diagnoses from North Atlantic right whale Eubalaena glacialis mortalities between 2003 and 2018. Dis. Aquat. Org. 135: 1-31, https://doi.org/10.3354/dao03376; Myers, H.J., Moore, M.J., Baumgartner, M.F., Brillant, S.W., Katona, S.K., Knowlton, A.R., Morissette, L., Pettis, H.M. et al. 2019. Ropeless fishing to prevent large whale entanglements: Ropeless Consortium report. Mar. Pol. 107: 103587, https://doi.org/10.1016/j.marpol.2019.103587).

Bycatch of Harbour Porpoises Exceeds Sustainable Anthropogenic Removal Levels

Bycatch in fisheries is one of the major threats to marine mammal populations worldwide. The number of bycaught harbour porpoises, one of the most common cetaceans in northern Europe, in gillnet fishing operations is high. An observer programme in the Swedish Skagerrak and Kattegat Seas recorded a total of 21 porpoises bycaught during 10,174 km*h of fishing effort. This is 2.6% of the population abundance, i.e. above the maximum sustainable total anthropogenic removal (1.7%). Net soak time, string length and water depth were positively related to bycatch occurrence. Such results provide guidance for bycatch mitigation measures in terms of adjusting fishing operations (restricting soak time and string length), improving gear, and establishing separate management units for area-specific conservation measures.

(SOURCE: Nui, J. 2019. Factors Affecting Harbour Porpoise Bycatch Occurrence in the Swedish Skagerrak and Kattegat Seas. MSc Thesis, Uppsala University, 1-40. http://www.diva-portal.org/smash/get/diva2:1367052/FULLTEXT01.pdf).

Drift of Stranded Bycaught Dolphins in High NE Atlantic may help Identify Fisheries involved

A new method (reverse drift modelling) calculated that 3690 common dolphins died in fishing gear within the Bay of Biscay in 2017, based on 793 stranded cetaceans (84% of which were common dolphins) along the French Atlantic coasts during two months in that year. There was a positive correlation between the origin of stranded bycaught dolphins and the fishing effort distribution of French midwater pair trawlers, Spanish otter bottom trawlers and French Danish seiners. The common feature of these fisheries is that they target predatory fishes (sea bass and hake) in winter and use high vertical opening gear. The authors call for continued monitoring of strandings to help explain the unusual stranding events recorded in the Bay of Biscay since the late 1980s.

(SOURCE: Peltier, H., Authier, M., Dabin, W., Dars, C., Demaret, F., Doremus, G., Van Canneyt, O., Laran, S. et al. 2020. Can modelling the drift of bycaught dolphin stranded carcasses help identify involved fisheries? An exploratory study. Global Ecol. Conserv. 21: e00843. https://doi.org/10.1016/j.gecco.2019.e00843).

Marine debris

Deep-feeding Pygmy Sperm Whales Ingest Marine Debris

A pygmy sperm whale stranded on the coast of Brazil showed evidence of interaction with fishing nets. Its stomach also contained four plastic items (packaging and bags) measuring 70×92cm; 47×31cm; 30×45cm; and 30×45cm; these occupied a considerable proportion of the stomach. These findings supported earlier reports that this species ingests plastics, and the fact that it feeds at depths between 600 and 1,200m underlines that even deep-feeding cetaceans are threatened by marine debris. As experts do not yet agree on an explanation for such ingestion, the authors call for further monitoring of stranded marine mammals to detect it.

(SOURCE: Brentano, R. and Petry, M.V. 2020. Marine debris ingestion and human impacts on the Pygmy sperm whale (Kogia breviceps) in southern Brazil. Mar. Pollut. Bull. 150: 110595. https://doi.org/10.1016/j.marpolbul.2019.110595).

Interactions Between Marine Litter and Megafauna

Charismatic megafauna can serve as flagship species for marine conservation. In addition to sea turtles, sea birds, seals and certain large fish species, this paper presented case studies on interactions between litter and eight cetacean species in the Atlantic Ocean. All these case studies reveal the need to improve guidelines and protocols, as well as standardise monitoring efforts regarding entanglement and ingestion. The improved information would better highlight the diversity and scale of impacts being felt by marine species. This goes beyond marine debris to include other anthropogenic pressures (e.g. bycatch, ship strikes). As charismatic megafauna, cetaceans can help communicate the health of ecosystems, an important step in developing management plans for the conservation of ecosystems and biodiversity.

(SOURCE: Claro, F., Fossi, M.C., Ioakeimidis, C., Baini, M., Lusher, A.L., Mc Fee, W., McIntosh, R.R., Pelamatti, T. et al. 2019. Tools and constraints in monitoring interactions between marine litter and megafauna: Insights from case studies around the world. Mar. Pollut. Bull. 141: 147-160. https://doi.org/10.1016/j.marpolbul.2019.01.018).

Microplastics may be Omnipresent in Atlantic Small Cetaceans

Although microplastics are a major topic in recent marine debris literature, researchers have only recently begun to examine their presence in the digestive tract of cetaceans. One study examined the stomach contents of 35 stranded common dolphins in northwest Spain. Microplastics were identified in all the samples, with an average of 12 items per stomach (mostly fibres). The authors consider the fact that all stomachs analysed contained microplastics to be a cause for concern. A second study in the waters of the Republic of Ireland supported these results and conclusions. It examined four species of stranded and bycaught small cetaceans (common bottlenose dolphin, striped dolphin, harbour porpoise, common dolphin) and reported that, of the 21 individuals assessed using a novel method for identifying microplastics, all contained this material (84% fibres, 16% fragments).

(SOURCES: Hernandez-Gonzalez, A., Saavedra, C., Gago, J., Covelo, P., Santos, M.B. and Pierce, G.J. 2018. Microplastics in the stomach contents of common dolphin (Delphinus delphis) stranded on the Galician coasts (NW Spain, 2005-2010). Mar. Pollut. Bull. 137: 526-532. https://doi.org/10.1016/j.marpolbul.2018.10.026; Lusher, A.L., Hernandez-Milian, G., Berrow, S., Rogan, E. and O'Connor, I. 2018. Incidence of marine debris in cetaceans stranded and bycaught in Ireland: recent findings and a review of historical knowledge. Environ. Pollut. 232: 467-476. https://doi.org/10.1016/j.envpol.2017.09.070).

The UK's 'Fishing For Litter' Scheme - A Promising Approach to Reducing Marine Debris?

A voluntary clean-up scheme, Fishing for Litter (FFL), in which marine debris is collected as part of routine fishing operations, may be a promising approach to addressing this problem. A survey of fishers and stakeholders showed an overall positive evaluation. FFL fishers showed less environmentally harmful waste management behaviours, both out at sea and in other contexts, than did non-FFL fishers. Thus, as well as directly helping to remove litter, this clean-up scheme indirectly helps address the underlying causes of marine pollution. The authors conclude that FFL is an exemplary scheme that makes use of people in the right place at the right time, builds on best practise and social norms, and empowers fishers to do something about a problem that directly affects them.

(SOURCE: Wyles, K.J., Pahl. S., Carroll, L. and Thompson, R.C. 2019. An evaluation of the Fishing For Litter (FFL) scheme in the UK in terms of attitudes, behavior, barriers and opportunities. Mar. Pollut. Bull. 144: 48-60. https://doi.org/10.1016/j.marpolbul.2019.04.035).

Ship strikes

Whales Struck by Ships Present Fat Emboli in Lung Tissue

An estimated 60% of sperm whale deaths in the Canary Islands are due to ship strikes. When carcasses are relatively fresh, injuries providing evidence that strikes occurred before death (i.e. ante mortem) (rather than a ship striking a floating carcass) are easy to detect, but this is more difficult in decomposed carcasses. A study on 35 sperm whale carcasses (collected between 2000 and 2017) sought to identify diagnostic signs of ante mortem ship strikes. Lung samples were taken from 24 whales; 16 had evidence of ship strikes. Seventy percent of samples were autolysed (i.e. in a state of decomposition). Of these, 83% presented fat emboli in blood vessels. Emboli were found in only 25% of the lung samples from whales not struck by ships. Bone fractures were also significantly more common in ship struck animals. Moreover, sperm whale calves (62%) were significantly more likely to be struck by ships; only 12.5% of ship-struck whales were adults. The study concluded that 81% of the sperm whales with signs of ship strike were alive at the moment of being struck and died subsequently. Fat emboli may be a good diagnostic tool to identify ship strike mortality cases, even in heavily decomposed carcasses.

(SOURCE: Arregui, M., Bernaldo de Quirós, Y., Saavedra, P., Sierra, E., Suárez-Santana, C.M., Arbelo, M., Díaz-Delgado, J., Puig-Lozano et al. 2019. Fat embolism and sperm whale ship strikes. Front. Mar. Sci. 6: 379. https://doi.org/10.3389/fmars.2019.00379).

High Ship Strike Risk for Humpback Whales in Chesapeake Bay

In winter, humpback whales forage in the mouth of Chesapeake Bay, USA. In addition to hosting a naval base, this area has substantial recreational and fishing boat traffic and has the nation's sixth busiest container port. From December 2015 to February 2017, 35 whales were tagged; nearly all were found in, or next to, shipping channels during the study. In addition, of 106 photo-identified humpback whales, 8.5% displayed injury suggestive of propeller strikes. One tagged whale was later found dead from a ship strike. This region therefore poses a relatively high risk of ship strike injury and mortality to humpbacks.

(SOURCE: Aschettino, J.M., Engelhaupmt D.T., Engelhaupt, A.G., DiMatteo, A., Pusser, T., Richlen, M.F. and Bell, J.T. 2020 Satellite telemetry reveals spatial overlap between vessel high-traffic areas and humpback whales (Megaptera novaeangliae) near the mouth of the Chesapeake Bay. Front. Mar. Sci. 7: 121. https://doi.org/10.3389/fmars.2020.00121).

High Ship Strike Risk for Humpback Whales in the New York Bight

The New York Bight, including New York Harbour, is an area with a high density of shipping traffic, but it is also frequented by increasing numbers of humpback whales. Opportunistic sightings from 2011 to 2016 were analysed and compared to shipping data (collected via AIS vessel position data). By 2016, 95% of humpback whale sightings were located within 100m of the path of at least one vessel. Passenger vessels showed the highest likelihood of encounters with whales (81%), followed closely by tug or towing vessels (76%). There is therefore a high, and increasing, threat of vessel collision with whales in this region.

(SOURCE: Brown, D., Sieswerda, P.L. and Parsons, E.C.M. 2019. Potential encounters between humpback whales (Megaptera novaeangliae) and vessels in the apex of the New York Bight, USA. Mar. Pol. 107: art. 103527 (1-8)).

Modelling Exercise Implies Speed Restriction Reduces Right Whale Mortality

A modelling framework based on encounter theory was used to estimate the risk of North Atlantic right whale ship strikes. Ship locations were obtained using AIS data and spatial changes in right whale abundance from surveys, with adjustments to account for the likelihood of whale sightings being missed. These data were then used to compare potential mortality before and after the implementation of a vessel speed rule on the south Atlantic US coast. After the rule was implemented, the expected seasonal mortality rate decreased by 22% on average. Unsurprisingly, risk of ship strikes was greatest when both whale and ship densities were simultaneously high, and the speed restriction had greatest effect at these times and areas. This analysis took account of several factors incorporated in other studies, i.e. the effects of vessel size, speed, transit distance, as well as whale abundance and behaviour when encountering ships. This method could possibly be used to model other anthropogenic risks, such as offshore wind farms. This study did not ascertain the ship strike risk from vessels that are less than 20 m in length, nor military or other government vessels, which are not subject to the speed restriction.

(SOURCE: Crum, N., Gowan, T., Krzystan, A. and Martin, J. 2019. Quantifying risk of whale-vessel collisions across space, time, and management policies. Ecosphere 10: e02713 (1-15)).

Ship Strikes on Humpback Whales in the Gulf of Maine may be Underreported

Although there are regulations protecting humpback whales from whale-watching traffic, there are no regulations for other types of shipping. To gauge the extent of shipping interactions, 210,733 photographs of 624 individuals taken between 2004 and 2013 in the southern Gulf of Maine were analysed by multiple reviewers for five types of ship-strike related injury. This review showed 14.7% had injuries consistent with one or more vessel strikes. It was noted that this analysis would not detect internal blunt force trauma injuries. The authors conclude that 'vessel strikes are underreported' and they call for a management strategy to minimise ship strikes in the region.

(SOURCE: Hill, A.N., Karniski, C., Robbins, J., Pitchford, T., Todd, S. and Asmutis-Silvia, R. 2017. Vessel collision injuries on live humpback whales, Megaptera novaeangliae, in the southern Gulf of Maine. Mar. Mamm. Sci. 33: 558-573).

High Numbers of Ship Strikes for Large Whales on the French Coast

Stranding records of large whales in French waters between 1972 and 2017 were reviewed, with 51 ship strike incidents identified. Seven instances were reported in the first decade of this period, increasing to 22 animals in the last dozen years. One in five whales stranded on the Mediterranean coast showed evidence of ship strike. The authors note that this high number of ship strikes may prevent France from meeting its obligations within the European Marine Strategy Framework Directive.

(SOURCE: Peltier, H., Beaufils, A., Cesarini, C., Dabin, W., Dars, C., Demaret, F., Dhermain, F., Doremus, G. et al. 2019. Monitoring of marine mammal strandings along French coasts reveals the importance of ship strikes on large cetaceans: A challenge for the European Marine Strategy Framework Directive. Front. Mar. Sci. 6: 486. https://doi.org/10.3389/fmars.2019.00486).

Impacts of Shipping on Bottlenose Dolphin Behaviour

Land-based observations of common bottlenose dolphin behaviour were made with a digital theodolite in the Galveston Ship Channel, in Texas, USA. This constrained waterway has a high level of dolphin-watching, fishing and commercial shipping traffic. Dolphins regularly used the channel to forage (57% of their time) and socialise (27%) and rarely used the channel to travel to other sites (5%). When boats were present, the proportion of time dolphins spent socialising and foraging was significantly lower. Swimming speed significantly increased in the presence of small recreational boats, dolphin-watching vessels and shrimp trawlers. Direction changes also increased significantly in the presence of tourism boats and shrimp trawlers. Because of the impact on foraging, and the likely resulting energetic cost this poses to dolphins, the author warns of 'potential long-term consequences to health and survivorship' of the dolphin population.

(SOURCE: Piwetz, S. 2019 Common bottlenose dolphin (Tursiops truncatus) behavior in an active narrow seaport. PLoS ONE 14: e0211971 (1-23)).

Chemical pollution

Moderate to High Hg Levels in Colombian Delphinids

The La Guajira region in the northern portion of the Colombian Caribbean is a transit zone for dolphins and could be an important feeding area, due to upwelling events and productive local marine ecosystems. The region is affected by local ports and coal mining, leading to potential heavy metal pollution. Measurements of skin Hg content for four delphinid species show that all were influenced by Hg contamination, with moderate to high values. The mean THg ranged from 2,481ng/g for common dolphins to 16,817ng/g for rough-toothed dolphins. These values are similar or higher than reported in skin samples of delphinid species in Europe.

(SOURCE: Barragán-Barrera, D. C., Farías-Curtidor, N., Luna-Acosta, A., Bustamante, P., Ayala, R. and Caballero, S. 2019. Evidence of mercury bioaccumulation in skin samples of wild delphinids in La Guajira, Colombian Caribbean. Poster presented at SETAC Latin America 13th Biennial Meeting. September 15-18, 2019. Cartagena, Colombia).

Potential Health Risk from Hg in Endangered Panamanian Bottlenose Dolphin Population

Hg levels were generally low in the small and genetically isolated common bottlenose dolphin population that resides year-round in the Bocas del Toro Archipelago along the northwest Caribbean coast of Panama, as well as in 11 of its prey species. Nonetheless, biomagnification revealed a marginal health risk for adult dolphins, and a potential major health threat to calves. This is important in light of other threats facing this endangered population, such as overfishing, pollution, sedimentation and, above all, significant pressure due to boat traffic. The authors call for monitoring the exposure of these dolphins, in particular the transfer of pollutants from mother to calf, and argue for monitoring the temporal trends in Hg concentrations in sentinel species as a proxy for ecosystem health.

(Concentration range on dry weight basis: 113-4,627ng/g for THg).

(SOURCE: Barragán-Barrera, D.C., Luna-Acosta, A., May-Collado, L.J., Polo-Silvag, C.J., Riet-Sapriza, F.G., Bustamante, P., Hernández-Ávila, M.P., Vélez, N. et al. 2019. Foraging habits and levels of mercury in a resident population of bottlenose dolphins (Tursiops truncatus) in Bocas del Toro Archipelago, Caribbean Sea, Panama. Mar. Pollut. Bull. 145: 325-333. https://doi.org/10.1016/j.marpolbul.2019.05.076).

Lead Levels Decreasing in St Lawrence Beluga Whales

Analysis of liver and kidney samples from male (*n*=3) and female (*n*=7) beluga whales stranded along the St Lawrence River in 2006 and 2007 showed Pb levels had decreased from levels reported in the 1980s. Comparative data such as this can be used to help establish timelines of how long heavy metals take to make their way through ecosystems into the tissues of top predators such as cetaceans, and to demonstrate the impacts of environmental protective measures on persistent pollutants.

(SOURCE: Belanger, M. and Wittnich, C. 2018. Evidence of stabilizing lead concentrations in livers and kidneys of St. Lawrence beluga (Delphinapterus leucas) from 1982 to 2007. J. Mar. Anim. Ecol. 10: 6-10).

Unusual Heavy Metal in South Atlantic False Killer Whales

The concentrations of Ag, a biologically non-essential metal, in the liver and kidney of five mass-stranded false killer whales in the Strait of Magellan, Chile, exceeded the cetacean toxic thresholds proposed as 'unhealthy concentrations' and 'critically dangerous'. The main exposure route for Ag is likely through ingestion of contaminated prey items. In general, values were higher than those reported in odontocetes from other marine areas of South America, and concentrations varied within the ranges measured in species worldwide (aside from the high values in beluga whales). Importantly, however, the values exceeded the new proposed toxicological levels in odontocetes for hepatic, renal, muscle and lung tissues. In view of the numerous stressors that this species faces, which may lead to stranding events, the authors call for continuously monitoring these animals: toxic metal levels can help to determine the degree of overall species contamination and inform future conservation plans.

(Concentration ranges on dry weight basis: 6.62-10.78µg/g in liver; 0.008-7.41µg/g in spleen; 0.004-5.71µg/g in testis; 0.757-1.69µg/g in kidney; 0.011-0.078µg/g in lung; <0.01-0.038µg/g in muscle).

(SOURCE: Cáceres-Saez, I., Haro, D., Blank, O., Aguayo-Lobo, A., Dougnac, C., Arredondo, C., Luis Cappozzo, H. and Ribeiro Guevara, S. 2019. Stranded false killer whales, Pseudorca crassidens, in Southern South America reveal potentially dangerous silver concentrations. Mar. Pollut. Bull. 145: 325-333. https://doi.org/10.1016/j.marpolbul.2019.05.045).

Long-banned Organochlorine Insecticide Still Present in Caribbean Cetaceans

The insecticide chlordecone can induce a wide range of pathologies in birds and mammals (e.g. reproductive impairment, neurotoxicity). It is carcinogenic, causing hepatic tumours in laboratory rats and mice and prostate cancer in humans. Despite having been banned since 1993 in the French West Indies and prohibited by the Stockholm Convention in 2009, chlordecone was found in the blubber of four cetacean species (Fraser's dolphin, Pantropical spotted dolphin, sperm whale, false killer whale) in Guadeloupe. Although the values were low, this underlines: (1) the long-term presence of persistent toxic chemicals that show biomagnification and bioaccumulation; and (2) that such compounds have reached deep-sea food webs in areas with deep waters close to shore.

(Concentration range on lipid weight basis: 1-329ng/g).

(SOURCE: Méndez-Fernandez, P., Kiszka, J.J., Heithaus, M.R., Beal, A., Vandersarren, G., Caurant, F., Spitz, J., Taniguchi, S. et al. 2018. From banana fields to the deep blue: Assessment of chlordecone contamination of oceanic cetaceans in the eastern Caribbean. Mar. Pollut. Bull. 137: 56-60. https://doi.org/10.1016/j.marpolbul.2018.10.012).

High Concentrations of POPs in Stranded Killer Whales in Ireland

The concentrations of 16 PCBs, 7 PBDEs, 1 PBB and 19 OCs were measured in blubber samples from four killer whales stranded in Ireland between 2010 and 2017. The levels of these POPs were high, with the value in one female exceeding the suggested toxicity threshold of 17mg/kg. This confirms that bioaccumulation continues to be a major concern for marine apex predators such as killer whales.

(Concentration ranges on lipid weight basis: 1.5-49.3mg/kg and 0.04-1.2mg/kg for Σ16PCBs and Σ7PBDEs respectively. Concentrations in one male killer whale on lipid weight basis: 49.4mg/kg for Σ19OCs)

(SOURCE: Schlingermann, M., Berrow, S., Craig, D., McHugh, B., Marrinan, M., O'Brien, J., O'Connor, I., Mudzatsi, E. et al. 2020. High concentrations of persistent organic pollutants in adult killer whales (Orcinus orca) and a foetus stranded in Ireland. Mar. Pollut. Bull. 151: 110699. https://doi.org/10.1016/j.marpolbul.2019.110699).

Organohalogens May Impact Several Biological Functions in Beluga and Minke Whales

Concentrations of POPs and emerging HFRs are elevated in the tissues of beluga whales in the St Lawrence Estuary (Canada), as well as of minke whales visiting that feeding area. This study examined the linkages between blubber concentrations of these compounds and the transcription of genes involved in regulating thyroid and steroid function in belugas: concentrations of PCBs, OCs and HBB were positively correlated with the transcription of thyroid- and/or steroid-related genes, while Dec-604 CB concentrations were negatively associated with the transcription of glucocorticoid and thyroid genes. In minke whales, PBDE concentrations changed positively with Esrβ transcript levels and HBB concentrations negatively with Nr3c1 transcripts. Nonetheless, demonstrating cause-effect linkages between organohalogen exposure and endocrine disruption will require more closely examining other potentially confounding variables (e.g. age, nutritional status, other unmeasured contaminants), other markers (e.g. hormone titres) and degradation products of certain POPs - efforts hampered by difficulties in collecting sufficient tissue to conduct the required multiple analyses. This beluga population - at risk of extinction under the Canadian Species at Risk Act - has been declining approximately 1% per year since the year 2000, from contaminant and noise exposure, disturbance, algal toxins, food scarcity and climate change.

(SOURCE: Simond, A.E., Houde, M., Lesage, V., Michaud, R., Zbinden, D. and Verreault, J. 2019. Associations between organohalogen exposure and thyroid- and steroid-related gene responses in St. Lawrence Estuary belugas and minke whales. Mar. Pollut. Bull. 145: 174-184. https://doi.org/10.1016/j.marpolbul.2019.05.029).

Disease and mortality events

Disease

Morbillivirus May Have Spread via Coastal Bottlenose Populations

An outbreak of dolphin morbillivirus in the western North Atlantic (2013-2015) resulted in the stranding of over 1,600 common bottlenose dolphins. A study was conducted to investigate the spread of this outbreak between the five coastal and 10 bay/estuarine bottlenose dolphin stocks along the Atlantic coast of the USA via a combination of antibody testing and satellite tagging. Antibody rates were higher in coastal dolphins (from the South Carolina-Georgia stock) than in bay/estuarine dolphins (southern Georgia estuarine system), i.e. the spread and occurrence may have been primarily via coastal dolphins. It was noted, however, that the small sizes of bay/estuarine stocks, in addition to possible pollutant impacts, may make these populations more vulnerable to disease, especially morbillivirus outbreaks.

(SOURCE: Balmer, B., Zolman, E., Rowles, T., Smith, C., Townsend, F., Fauquier, D., George, C., Goldstein, T. et al. 2018. Ranging patterns, spatial overlap, and association with dolphin morbillivirus exposure in common bottlenose dolphins (Tursiops truncatus) along the Georgia, USA coast. Ecol. Evol. 8: 12,890-12,904).

Anthropogenic Mortalities in Cetaceans from the Canary Islands

Of 234 stranded cetaceans in the Canary Islands, 34% were in a good nutritional state and 23.5% were in a poor nutritional state. Anthropogenic causes of death included vessel collisions (11.5%), fishery interactions (4.8%) and foreign body ingestion (2.4%). Natural causes of death included probable aggression and injury by, within or between cetaceans (17.8%) and likely birth complications (6.2%). In total, 19% of mortalities had an identified anthropogenic cause.

(SOURCE: Diaz-Delgado, J., Fernandez, A., Sierra, E., Sacchini, S. andrada, M., Vela, A.I., Quesada-Canales, O., Paz, Y. et al. 2018. Pathologic findings and causes of death in stranded cetaceans in the Canary Islands (2006-2012). PLoS One 13: e0204444 (1-33)).

Mass Mortality of Guiana Dolphins from Morbillivirus in Brazil

From November 2017 to March 2018, a cetacean morbillivirus outbreak caused an unprecedented mass mortality among Guiana dolphins; at least 263 individuals died in Sepetiba and Grande Bays, from a total population of 739-2,196). Boat surveys were undertaken to observe the behaviour and clinical signs presented by diseased dolphins. At least five dolphins were observed having difficulties maintaining their course, orientation and buoyancy, and three pf these were assumed to have died (one stranded). A further 40 dolphins were observed emaciated, and 10 photo-identified dolphins had skin lesions (including orange patches and ulcerated lesions). Dolphins were also heard with laboured breathing, suggestive of pneumonia. High levels of organochlorine contaminants have been found in this species, which may have been an exacerbating factor. The authors conclude that anthropogenic pressures, with the simultaneous threat posed by morbillivirus infection, 'is of concern for the survival of the Guiana dolphin population' in Sepetiba Bay, Brazil.

(SOURCE; Flach, L., Alonso, M.B., Marinho, T., Van Waerebeek, K. and Van Bressem, M.F. 2019. Clinical signs in free-ranging Guiana dolphins Sotalia guianensis during a morbillivirus epidemic: case study in Sepetiba Bay, Brazil. Dis. Aquat. Org. 133: 175-180).

High Level of *Toxoplasma* Infection in St Lawrence Estuary Beluga Whales

Samples from 34 stranded belugas in the St Lawrence Estuary, Quebec, Canada, were analysed for the protozoan parasite *Toxoplasma gondii*, using PCR for *Toxoplasma* DNA. Forty-four percent were positive, with more neonates and juveniles being infected than adults, and males having a higher level of infection than females. However, while there was a high prevalence of *T. gondii* infection, very few deaths have been attributed to toxoplasmosis (the disease resulting from the parasite). This population of belugas is listed as 'endangered' under the Canadian Species at Risk Act and the high prevalence of *T. gondii* infection is another issue to monitor for the health of this population.

(SOURCE: Iqbal, A., Measures, L., Lair, S. and Dixon, B. 2018. Toxoplasma gondii infection in stranded St. Lawrence Estuary beluga Delphinapterus leucas in Quebec, Canada. Dis. Aquat. Org. 130: 165-175).

The Spread of Morbillivirus

There have been multiple morbillivirus outbreaks in cetaceans and pinnipeds, leading to mass mortality events. To investigate the nature of morbillivirus, wild viruses were sequenced from cetacean tissues from multiple species and locations. Closely related strains of the virus found in the Gulf of Mexico, the Mediterranean Sea, both coasts of the North Atlantic Ocean and the North Sea demonstrated the wide trans-ocean pattern of the virus spread. One strain was more basal and likely diverged from the other cetacean morbillivirus strains a few hundred years ago. Moreover, the virus strain in the Mediterranean outbreak in 1990-1992 was more basal to strains that have emerged in subsequent years, including the outbreak in 2006-2008, suggesting rapid divergence and spread. However, the virus was likely endemic in an as-yet-unidentified cetacean species in the North Atlantic from the 1970s, because a strain more basal than the 1990-1992 Mediterranean strain was found in North Sea Atlantic white-sided dolphins. The authors suggest pilot whales and melon-headed whales might be vectors spreading the virus between populations. The virus appears to need little change, if any, to jump between cetacean species, which means that the virus is a particular threat to endangered cetacean populations, as it could be readily contracted from other more robust cetacean species.

(SOURCE: Jo, W.K., Kruppa, J., Habierski, A., van de Bild, M., Mazzariol, S., Di Guardo, G., Siebert, U., Kuiken, T. et al. 2018. Evolutionary evidence for multi-host transmission of cetacean morbillivirus. Emerg. Microbes Infect. 7: 1-15).

High Prevalence of Pneumonia in Riverine Cetaceans

Lung tissue examined in Amazon River dolphins (*n*=24) and tucuxi (*n*=28) were found to have an extremely high prevalence of pneumonia (85%). Of these cases, one quarter were the result of the nematode worm *Halocercus brasiliensis* (a lungworm) and one quarter were bacterial pneumonia. This high prevalence of lung infection could potentially have population-level effects on these riverine cetaceans.

(SOURCE: Rodrigues, T.C.S., Díaz-Delgado, J., Catão-Dias, J.L., da Luz Carvalho, J. and Marmontel, M. 2018. Retrospective pathological survey of pulmonary disease in free-ranging Amazon River dolphin Inia geoffrensis and tucuxi Sotalia fluviatilis. Dis. Aquat. Org. 131: 1-11).

High Prevalence of Brucella Infection in By-caught and Stranded Small Cetaceans in Brazil

One hundred twenty-four stranded or by-caught cetaceans from Brazil were tested for the pathogen *Brucella*; there was 'a relatively high occurrence of Brucella-positivity' (10.1%). Animals infected included pygmy killer whale (*n*=1); short-finned pilot whales (*n*=3); melon-headed whales (*n*=2); franciscana (*n*=1); Guiana dolphin (*n*=1); Clymene dolphins (*n*=3); spinner dolphin (*n*=1); and common bottlenose dolphin (*n*=1). Two of the *Brucella*-infected cetaceans were also infected with cetacean morbillivirus; *Edwardsiella tarda* (see Lee *et al.* [2018] below) and *Proteus mirabilis* were also detected. Lesions observed in infected animals included chronic meningoencephalitis and meningitis, chronic gastritis and enterocolitis, hepatitis, pneumonia, lymphoid hyperplasia and lymphoid depletion. Three of the animals were newborns, suggesting that infection may have occurred *in utero.* This is the first record of *Brucella* infection in the franciscana, Guiana dolphin and spinner dolphin.

(SOURCE; Sánchez-Sarmiento, A.M., Carvalho, V.L., Díaz-Delgado, J., Ressio, R.A., Fernandes, N.C., Guerra, J.M., Sacristán, C., Groch, K.R. et al. 2019. Molecular, serological, pathological, immunohistochemical and microbiological investigation of Brucella spp. in marine mammals of Brazil reveals new cetacean hosts. Transbound Emerg. Dis. 66: 1674-1692).

Harmful Algal Blooms (HABs)

Alzheimer-like Changes Seen in the Brains of Dolphins Exposed to HAB Toxin

Dolphins stranding in Florida and Massachusetts, USA, were examined to determine whether cyanobacteria toxins (i.e. from a HAB) could be identified; specifically, the bioaccumulating and biomagnifying neurotoxin BMAA. High levels of BMAA (20-748µg/g) were found in the brains of 13 of 14 dolphins examined. Microscopic examination of these brains showed abnormal, Alzheimer-like nerve cell changes. The presence of BMAA suggests that dolphins provide an excellent sentinel species for such toxin exposure in the marine environment and may have long-term implications for cetacean health.

(SOURCE: Davis, D.A., Mondo, K., Stern, E., Annor, A.K., Murch, S.J., Coyne, T.M., Brand, L.E., Niemeyer, M.E. et al. 2019 Cyanobacterial neurotoxin BMAA and brain pathology in stranded dolphins. PLoS ONE 14: e0213346 (1-18). https://doi.org/10.1371/journal.pone. 0213346).

Oil spills

Oil Spill in Southern Atlantic Threatens Coastal Marine Biodiversity

Since late August/early September 2019, nearly 400 localities spanning approximately 3000km of the northern and southeast Brazilian coast (> 980 beaches) have been exposed to hundreds of tons of crude oil from an as yet undetected source. Magris and Giarrizzo (2020) identify three most-affected habitats (estuaries, mangroves, seagrass meadows) and 27 potentially most-affected threatened coastal species, including the Guiana dolphin. These authors expect the mysterious oil slicks to have significant and long-lasting socioeconomic impacts, in particular for local tourism and small-scale fisheries. de Oliviera Soares *et al*. (2020) consider this oil spill to be the most extensive and severe environmental disaster ever recorded in Brazilian history, in the South Atlantic basin and in tropical coastal regions worldwide.

(SOURCES: Magris, R.A. and Giarrizzo, T. 2020. Mysterious oil spill in the Atlantic Ocean threatens marine biodiversity and local people in Brazil. Mar. Pollut. Bull. 153: 110961. https://doi.org/10.1016/j.marpolbul.2020.110961; de Oliveira Soares, M., Teixeira, C.E.P., Bezerra, L.E.A., Paiva, S.V., Tavares, T.C.L., Garcia, Z.M., de Araújo, J.T., Campos, C.C. et al. 2020. Oil spill in South Atlantic (Brazil): Environmental and governmental disaster. Mar. Pol. 115: 103879. https://doi.org/10.1016/j.marpol.2020.103879).

Ten Years After the Deepwater Horizon Oil Spill

The Deepwater Horizon oil spill occurred on 20 April 2010, spilling an estimated 210 million gallons of oil into the Gulf of Mexico. Ten years later, 55% of common bottlenose dolphins in affected areas have worsening lung disease, 43% exhibit abnormal stress responses, 25% are underweight and 19% anaemic. Successful birth rates are less than a quarter of normal levels for the species. However, dolphins born after the spill do not exhibit symptoms of as many maladies as those that were exposed to the spill. An estimated 17% of the Gulf's unique population of Bryde's whales died as a result of the spill, and reproductive failures are predicted for surviving individuals. Despite increased legislation on oil platform safety, the US Coast Guard reports that an additional 13,187 oil spills have occurred in the Gulf of Mexico in the past decade. In addition, other marine megafaunal species, such as turtles, and fish stocks suffered impacts. In a separate analysis, a model assessed the impacts of the oil spill on the growth and mortality rates of fish stocks and fisheries closures. The model estimated that biomass of large reef fish decreased by 25-50% in areas most affected by the spill and of large demersal fish by 40-70%. The model also showed that, while high-turnover populations of fish have mostly recovered in the 10 years since the oil spill, some slower-growing fish populations could take more than 30 years to recover from exposure.

(SOURCES: National Wildlife Federation. 2020. 10 Species, 10 Years Later: A Look at Gulf Restoration after the Deepwater Horizon Disaster, https://restorethegulf.nwf.org/?_ga=2.48848998.116792924.1587758800-395230847.1587758800; Ainsworth, C.H., Paris C.B., Perlin, N., Dornberger, L.N., Patterson, W.F., Chancellor, E., Murawski, S., Hollander, D. et al. 2018. Impacts of the Deepwater Horizon oil spill evaluated using an end-to-end ecosystem model. PLoS ONE 13: e0190840 (1-21). https://doi.org/10.1371/journal.pone.0190840).

Climate change

Prey Species of North Atlantic Baleen Whales Responding to Ecosystems Altered by Climate Change

Oceanographically, three sectors in the North Atlantic present contrasting habitats to baleen whales: (i) a broad-deep-strait and deep-shelf inflow system in the Northeast Atlantic; (ii) a combination of inflow and outflow systems north of Iceland in the central North Atlantic; and (iii) an outflow shelf and basin in the Northwest Atlantic. Sea ice loss, ocean warming and regional increases in primary productivity are causing rapid transformation, with effects across the entire food chain. Humpback, fin, common minke, sei and blue whales occupy the diverse habitats here. These species all exhibit flexible diets, mostly krill and forage fishes (e.g. capelin, herring, sand eel), which are now responding to ecosystems altered by climate change. Baleen whale distribution, phenology, body condition and diet can provide data for ecosystem models, underlining the potential sentinel capability these cetaceans offer to improve our understanding of ocean habitats.

(SOURCE: Moore, S.E., Haug, T., Víkingsson, G.A. and Stenson, G.B. 2019. Baleen whale ecology in arctic and subarctic seas in an era of rapid habitat alteration. Prog. Oceanography 176: 102188. https://doi.org/10.1016/j.pocean.2019.05.010).

Noise impacts

Acoustic Deterrent Devices Have Potential Adverse Effects on Both Target and Non-target Species

Acoustic deterrent devices (ADDs) are designed to, for example, reduce pinniped depredation on finfish aquaculture sites by emitting loud and pervasive noise. This study shows that ADD detections have steadily increased from 2006 to 2016 on the Scottish west coast (mainly in relation to Atlantic salmon facilities). This represents a significant and chronic source of underwater noise here. This has potential adverse impacts on target (pinniped) and non-target (e.g. cetacean) species. The authors call for further study and improved monitoring and regulatory strategies to assess the wider environmental impact of the aquaculture industry.

(SOURCE: Findlay, C.R., Ripple H.D., Coomber F., Froud, K., Harries, O., van Geel, N.C.F., Calderan, S.V., Benjamins, S. et al. 2018. Mapping widespread and increasing underwater noise pollution from acoustic deterrent devices. Mar. Pollut. Bull. 135: 1,042-1,050. https://doi.org/10.1016/j.marpolbul.2018.08.042).

Guiana Dolphin Acoustic Behavior Affected by Underwater Noise

An investigation of the effects of underwater noise (0.43-35.8 kHz) on the Guiana dolphin in Pipa, Brazil, found that recreational tourism motorboats caused a significant alteration in several dolphin whistle and call patterns. The sound of an underwater water pump was associated with a significant decrease in dolphin click duration. It was suggested that the changes were the result of dolphins trying to compensate for the anthropogenic noise. The Guiana dolphin in northeast Brazil has already demonstrated a decrease in residence time and reduced number of individuals occurring when recreational vessels were present; therefore, the authors suggest that regulations to manage boat traffic need to be put in place, alongside an outreach program to boat operators, tourists, and the general public.

(SOURCE: Leão Martins, D.T., Rossi-Santos, M.R. and de Lima Silva, F.J. 2018. Effects of anthropogenic noise on the acoustic behaviour of Sotalia guianensis (Van Bénéden, 1864) in Pipa, North-eastern Brazil. J. Mar. Biol. Assoc. UK 98: 215-222).

Underwater Noise Pollution in the Northeast Atlantic

Impulsive noise activity (e.g. explosions, seismic air guns, percussive pile driving) in the Northeast Atlantic was reported from 2015-2017 to the first international impulsive noise register (INR), established in 2016 under the OSPAR Convention. Seismic air gun surveys were the dominant noise source (67%-83% of annual activity) and declined by 38% during the study period. Reported pile driving activity increased 46%. Explosions and sonar/acoustic deterrent devices showed overall increases in activity. Such noise can affect marine fauna through mortality, physical injury, auditory damage, physiological stress, acoustic masking and behavioural responses. The authors argue for using and improving noise registries to develop 'noise budgets' within regional seas, which, if exceeded, would necessitate measures to limit noise emissions at sensitive times and locations, and/or require the application of noise abatement measures.

(SOURCE: Merchant, N.D., Andersson, M.H., Box, T., Le Courtois, F., Cronin, D., Holdsworth, N., Kinneging, N., Mendes, S. et al. 2020. Impulsive noise pollution in the Northeast Atlantic: Reported activity during 2015-2017. Mar. Pollut. Bull. 152: 110951. https://doi.org/10.1016/j.marpolbul.2020.110951).

GLOBAL

General

Sex Ratios of Migrating Whales: A Novel Indicator of Ecosystem Health

Based on a 1:1 birth ratio, the relative migratory sex ratios of southern humpback whales could serve as an indirect measure of relative, inter-annual whale fecundity. Accordingly, the lower the female component of the migration, the lower their reproductive health: females that have been unable to accumulate sufficient energy reserves do not participate in the migration. As an example, the migrating population was more highly male skewed in years with poor feeding conditions (e.g. extreme La Niña event). This is also reflected in the adiposity (blubber thickness) of the population as a whole. The authors argue for including such sex ratios as a new non-lethal tool for the study of population health, which in turn is a function of ecosystem productivity and reflects ecosystem health.

(SOURCE: Druskat, A., Ghosh, R., Castrillon, J. and Bengtson Nash, S.M. 2019. Sex ratios of migrating southern hemisphere humpback whales: A new sentinel parameter of ecosystem health. Mar. Environ. Res. 151: 104749. https://doi.org/10.1016/j.marenvres.2019.104749).

Rebuilding the World's Marine Ecosystems by 2050

In a review of successful conservation interventions, it was suggested that 'substantial recovery of the abundance, structure and function of marine life could be achieved by 2050'. There have been some gains in marine conservation over the past 20 years. For example, levels of many marine pollutants (such as DDTs) have declined. The proportion of marine species threatened with extinction was 18% in 2000, and had declined to 11.4% by 2019. For marine mammals, 47% of the 124 well-assessed populations showed a significant increase in population size over the past 20 years, with only 13% decreasing, with the recovery of humpback whale populations being a particular success story. In 2000, only 0.9% of the ocean was protected; today, fully implemented MPAs now encompass 5.3% of the ocean. However, greater protection is required for substantial recovery. In addition to greater action on mitigating the effects of climate change, the proportion of the oceans that would need protection would have to be increased by approximately 50%. This would cost US$10-20 billion per year to achieve, although it is also estimated that the economic dividends will eventually outweigh the expenditure by a factor of 10. The authors conclude that 'meeting this challenge requires immediate action to reduce relevant pressures, including climate change, safeguarding places of remaining abundance, and recovering depleted populations, habitats and ecosystems elsewhere. This will require sustained perseverance and substantial commitment of financial resources', but they note that if this is done, the economic benefits could be immense.

(SOURCE: Duarte, C.M., Agusti, S., Barbier, E., Britten, G.L., Castilla, J.C., Gattuso, J.P., Fulweiler, R.W., Hughes, T.P. et al. 2020. Rebuilding marine life. Nature 580: 39-51).

Habitat degradation

General

New Potential Impact of Offshore Wind Farms

Wind farms have been identified as potential threats to cetaceans as physical barriers and as sources of noise and vibrations related to construction, operation, servicing and decommissioning. Another potential threat comes from impacts due to corrosion protection systems, i.e. the leaching of toxic metals, organic and other compounds from protective paints, coatings and galvanic anodes. As of 2017, Europe had 4,149 grid-connected wind turbines in 92 offshore wind farms across 11 countries. Based on the observed effects of anti-fouling paints on boat hulls and other structures, and on the expected future increase of wind farms here and elsewhere, the authors argue for collecting more information as part of efforts to reduce the environmental footprint of such facilities.

(SOURCE: Kirchgeorg, T., Weinberg, I., Hörnig, M., Baier, R., Schmid, M.J. and Brockmeyer, B. 2018. Emissions from corrosion protection systems of offshore wind farms: Evaluation of the potential impact on the marine environment. Mar. Pollut. Bull. 136: 257-268. https://doi.org/10.1016/j.marpolbul.2018.08.058).

Fisheries interactions

Prospects for Critically Endangered Small Cetaceans Grim Unless Bycatch Problem is Resolved

The conservation status of small cetaceans has significantly worsened since the 1980s. Thirteen species, subspecies, or populations (units-to-conserve or units) of small cetaceans are listed as Critically Endangered (IUCN Red List). Bycatch is the main threat to 11 of these units. The long-term solution is the development of efficient, inexpensive, alternative fishing gear that can replace gillnets. Good fisheries governance and the direct involvement of fishing communities are essential to the successful conservation of most threatened populations of small cetaceans. Among others, the authors highlight the Baltic harbour porpoise, the Yangtze finless porpoise, and the Atlantic humpback dolphin. Adequately sized conservation zones (gillnet use forbidden) will have to be coupled with strict enforcement.

(SOURCE: Brownell Jr., R.L., Reeves, R.R., Read, A.J., Smith, B.D., Thomas, P.O., Ralls, K., Amano, M., Berggren, P. et al. 2019. Bycatch in gillnet fisheries threatens Critically Endangered small cetaceans and other aquatic megafauna. Endang. Spec. Res. 40: 285-296. https://doi.org/10.3354/esr00994).

Seeking Global Trends in, and Solutions to, Ghost Fishing Gear

Abandoned, lost or discarded fishing gear (ALDFG) comprises a significant amount of global marine debris, with diverse impacts to marine environments, wildlife (including cetaceans) and the fishing industry. This paper summarises a technical session of ALDFG leaders. The Global Ghost Gear Initiative (GGGI) calls for raising awareness of and developing solutions for ALDFG. In this pursuit, the authors highlight: (1) case studies that feature innovative approaches to ALDFG data collection and retrieval; (2) examples of opportunities to fill data gaps and improve our understanding of wildlife ingestion and entanglement; and (3) awareness-raising by developing a publicly accessible global ALDFG database.

(SOURCE: Richardson, K., Asmutis-Silvia, R., Drinkwin, J., Gilardi, K.V.K., Giskes, I., Jones, G., O'Brien, K., Pragnell-Raasch, H. et al. 2019. Building evidence around ghost gear: Global trends and analysis for sustainable solutions at scale. Mar. Pollut. Bull. 138: 222-229. https://doi.org/10.1016/j.marpolbul.2018.11.031).

Electrofishing A Threat to Freshwater Cetaceans

Electrofishing has been banned in most countries due to its damaging impacts on fish stocks and non-target species, including several endangered and threatened cetacean species (e.g. Yangtze river dolphin, Yangtze finless porpoise, Irrawaddy dolphins). Due to the potential for death and injury of threatened freshwater cetaceans, there is a need to identify lesions and injuries caused by electrofishing, the range of impacts caused by this fishing method, and the extent and scale of the practise. The threats that this fishing method poses to endangered cetaceans (and ecosystems) lead the authors to suggest that 'high priority should be given to enforcing electrofishing bans in the freshwater habitat of dolphins and finless porpoises'.

(SOURCE: Thomas, P.O., Gulland, F.M.D., Reeves, R.R., Kreb, D., Wang, D., Smith, W.B., Malik, M.I., Ryan, G.E. et al. 2019. Electrofishing as a potential threat to freshwater cetaceans. Endang. Spec. Res. 39: 207-220).

Marine debris

Global Impact of Marine Plastic Encompasses Marine Mammals

A literature review of 1191 data points examined the global ecological, social and economic impacts of marine plastic pollution and determined that there is global evidence of impact with medium to high frequency on all the major marine groups and social factors, with a medium to high degree of irreversibility. In the case of marine mammals, on a score range from +9 (positive effect) to -9 (lethal or sublethal effect that is global, highly irreversible and occurring at a high frequency), the score was poor: -7 regarding entanglement and -7 regarding ingestion. The authors conclude that, overall, this is accompanied by a reduction in ecosystem services with implications for human health and wellbeing, linked particularly to fisheries, charismatic species, and recreation.

(SOURCE: Beaumont, N.J., Aanesen, M., Austen, M.C., Börger, T., Clark, J.R., Cole, M., Hooper, T., Lindeque, P.K. et al. 2019. Global ecological, social and economic impacts of marine plastic. Mar. Pollut. Bull. 14: 189-195. https://doi.org/10.1016/j.marpolbul.2019.03.022).

Microplastics Gain Relevance for Cetaceans

Beyond the entanglement and direct ingestion threat posed by larger marine debris, researchers are increasingly examining the potential impact of microplastics on cetaceans. The uptake for two large whale species was inferred by determining their prey species and examining the latter species' microplastics load. High levels of microplastic contamination were reported for fish from the family Scombridae in the Atlantic (a prey of sei whales) and anchovy in the northwest Pacific (a prey of minke whales). Other fish species and invertebrates (e.g. copepods) had lower values. Species-specific prey preferences and feeding strategies (minke whales are 'gulpers', whereas sei whales are 'surface skimmers') imply that different cetaceans have varied potential for diet-related microplastics ingestion, even if they feed in similar geographic areas. Importantly, the authors stress that microplastics may also be ingested incidentally and directly from the water; for example, while grazing for copepods. Unravelling the effects of microplastics on cetaceans is imperative because the influx of plastics into the oceans is expected to increase, and 29% of the 89 cetacean species are currently listed as critically endangered, endangered, vulnerable or near threatened.

(SOURCE: Burkhardt-Holm, P. and N'Guyen, A. 2019. Ingestion of microplastics by fish and other prey organisms of cetaceans, exemplified for two large baleen whale species. Mar. Pollut. Bull. 145: 224-234. https://doi.org/10.1016/j.marpolbul.2019.04.068).

Pervasive Ingestion of Marine Debris by Marine Megafauna

In a summary of 747 studies with marine debris entanglement and ingestion records for marine birds, mammals, turtles, fish and invertebrate species, 914 species were found entangled in, and/or had ingested, marine debris. Ingestion was recorded for 701 species, entanglement for 354 species. Less than 30% of individual seabirds, 4.4% of mammals and 32% of turtles had debris in their stomachs. Cetacean species overall seemed to suffer more from marine debris ingestion (60.5% of species) than entanglement (25.6%). Within species, a substantial proportion of individual baleen whales (16.7%) were found to have ingested marine debris; for toothed whales, it was 9.4%, a strong difference between these taxa. Amongst toothed whale taxa, while less than 10% of dolphins and porpoises ingested marine debris, approximately a quarter of all beaked, pygmy and dwarf sperm, and sperm whales, as well as the franciscana, did so. The actual occurrence of marine debris ingestion is probably underestimated in many studies due to methodological differences. In harbour porpoises, for example, one study showed that using a plastic-dedicated protocol increased the detection of affected individuals from 6% to 15%. The authors conclude that ingestion rates are reason for serious concern for certain species and call for using standardised methods in future studies to generate datasets that allow higher-level ecosystem analyses.

(SOURCES: Kühn, S. and van Franeker, J.A. 2020. Quantitative overview of marine debris ingested by marine megafauna. Mar. Pollut. Bull. 151: 110858. https://doi.org/10.1016/j.marpolbul.2019.110858; Van Franeker, J.A., Bravo Rebolledo, E.L., Hesse, E., IJsseldijk, L.L., Kühn, S., Leopold, M. and Mielke, L. 2018. Plastic ingestion by harbour porpoises Phocoena phocoena in the Netherlands: Establishing a standardised method. Ambio 47: 387-397. https://doi.org/10.1007/s13280-017-1002-y).

Feeding Strategy Probably More Important Than Position in Water Column for Marine Debris Ingestion

One approach to understanding the effect of marine debris on cetaceans and other larger organisms is to determine the factors that govern ingestion. One hypothesis (tested on four fish and two dolphin species) involves whether the position of predators in the water column affects the probability of ingestion. Accordingly, those species living closer to the bottom (demersal) should be more exposed (because debris availability is high and associated mainly with the seabed at this study site). The hypothesis was not supported: while the 'pelagic demersal' feeding franciscana showed the highest frequency of debris ingestion, the values for the boto (pelagic) and the fish species (both pelagic and demersal representatives) were lower and similar. The authors conclude that prey-capture strategies (or feeding behaviour) rather than preferred feeding site (depth) determine the probability of ingestion, regardless of debris availability (a conclusion also supported by Burkhardt-Holm and N'Guyen (2019), above).

(SOURCE: Madeira Di Beneditto, A.P. and da Silva Oliveira, A. 2019. Debris ingestion by carnivorous consumers: Does the position in the water column truly matter? Mar. Pollut. Bull. 145: 134-139. https://doi.org/10.1016/j.marpolbul.2019.04.074).

What Happens with Collected Marine Debris?

Beyond the direct impact of entanglement and ingestion, marine debris poses multiple other threats to marine species and their environment. This has prompted numerous schemes to collect this material, but there is little or no information about how this waste is treated or used post-collection. A review of 103 studies and 29 projects outside academia on collection efforts found over 250,000 tons of litter have already been removed, but much is from wealthy countries that do not primarily contribute to the problem. Given this is only a tiny fraction of the amount entering the world's oceans every year, and that little information is available on waste treatment of collected material, the authors call for boosting collection efforts and a 'full system quantitative assessment from the impact of litter collections on the marine environment all the way to reuse and recycling options … to help policy makers and waste treatment companies identify the collection and treatment pathways of marine litter that are most environmentally friendly and minimize undesired side effects'.

(SOURCE: Schneider, F., Parsons, S., Clift, S., Stolte, A. and McManus, M.C. 2018. Collected marine litter - A growing waste challenge. Mar. Pollut. Bull. 128: 162174. https://doi.org/10.1016/j.marpolbul.2018.01.011).

Ship strikes

Mitigation Should Account for Night-time Whale Locations, When Ship Strike Risk is Highest

Blue, fin, and humpback whales are known to feed in areas of high ship traffic along the US west coast. Tagging research indicated that, while dive profiles varied, all three species spent a high proportion of their time closer to the surface at night, when they might be more vulnerable to ship strikes. In particular, night time vulnerability of blue whales to ship strike was twice as high as in daytime. In addition, due to the whales following prey, there were different patterns of overlap with shipping lanes during the night versus the day. As risk for whales from shipping is assessed using daytime visual survey data, this difference is critical. The authors state that '[ship strike mitigation] methods based on visual sightings of whales or other approaches requiring daylight would not be very effective since they would not address the primary period of whale vulnerability'.

(SOURCE: Calambokidis, J., Fahlbusch, J.A., Szesciorka, A.R., Southall, B.L., Cade, D.E., Friedlaender, A.S. and Goldbogen, J.A. 2019. Differential vulnerability to ship strikes between day and night for blue, fin, and humpback whales based on dive and movement data from medium duration archival tags. Front. Mar. Sci. 6: 543. https://doi.org/10.3389/fmars.2019.00543).

A 'Road Ecology' Approach to Mitigating Shipping Impacts

A 'road ecology' framework (similar to methods used in terrestrial species, treating shipping lanes as marine roads) was used to review the threat to cetaceans and other megafauna from ship strikes. Large body size, long migrations and time spent at the surface makes cetaceans especially vulnerable to ship strike. Shipping also causes chemical and noise pollution and fragments habitats. In addition to shifting shipping lanes to avoid high concentrations of cetaceans, the authors recommend 'transition zones' (i.e. buffer areas around shipping lanes where the impacts of threats, such as noise, diminish) to mitigate impacts. Minimising the creation of new shipping channels and having 'no go' zones where shipping traffic is prohibited (e.g. in the Arctic) may also help to mitigate shipping impacts. New technologies (e.g. advanced methods for tracking whales) may identify possible collisions before they occur and prevent them from happening. The authors conclude that '[r]oad ecology indicates that the expansion of marine roads has potential risks that may be unforeseen through existing approaches'.

(SOURCE; Pirotta, V., Grech, A., Jonsen, I.D., Laurance, W.F. and Harcourt, R.G. 2019. Consequences of global shipping traffic for marine giants. Front. Ecol. Environ. 17: 39-47).

Chemical pollution

Hg Contamination Trends in Cetaceans

A review on Hg contamination in cetaceans found there was no trend in levels between 1975 and 2010. However, despite a decline in global emissions of Hg, levels continued to bioaccumulate in cetaceans. Of all monitored cetacean populations, Mediterranean species displayed the highest levels (in liver tissues). Toxic effects resulting from Hg contamination in cetaceans have been reported for neurological systems, immune systems, and kidney and liver tissues. The element Se is often found in conjunction with Hg and may play a detoxifying effect in cetacean tissues. The authors recommend that Se levels in tissues should also be determined when trying to estimate the impacts of Hg contamination in cetaceans. The population-level effects of Hg contamination are still unknown and the authors state that 'Estimating direct and indirect risk thresholds of mercury exposure is a priority'.

(SOURCE: Kershaw, J.L. and Hall, A. 2019. Mercury in cetaceans: Exposure, bioaccumulation and toxicity. Sci. Total Environ. 694. https://doi.org/10.1016/j.scitotenv.2019.133683).

Silver Nanoparticles Impact Cetacean Immune Systems

Ag nanoparticles (AgNPs) are raising increasing concern as a widespread marine contaminant (they are used in numerous products for their anti-microbial properties). A study investigated the impact of these nanoparticles on cetacean immune systems, specifically on white blood cells *in vitro*. At high concentrations of 20nm AgNPs (10 and 50µg/ml), cell death occurred in cetacean leukocytes, lymphocytes and monocytes. Lower doses (0.1 and 1µg/ml) negatively affect the ability of these types of white blood cells to perform their functions of engulfing or killing pathogens infecting an organism. The authors conclude that their results 'suggest that the immune function of cetaceans may have been compromised by AgNPs and/or Ag, and the immunotoxic effects of AgNPs in marine mammals should not be overlooked'. See also Cáceres-Saez *et al.* (2019) above.

(SOURCE: Li, W.T., Chang, H.W., Yang, W.C., Lo, C., Wang, L.Y., Pang, V.P., Chen, M.H. and Jeng, C.R. 2018. Immunotoxicity of silver nanoparticles (AgNPs) on the leukocytes of common bottlenose dolphins (Tursiops truncatus). Sci. Rep. 8: 5593 (1-12). https://doi.org/10.1038/s41598-018-23737-0).

Disease and mortality events

Disease

Genetic Analysis of Morbillivirus Susceptibility

Cetacean morbillivirus is highly contagious and has caused the death of tens of thousands of cetaceans in several locations around the world, including the northwest Atlantic. A genetic analysis of non-survivors and living animals (putative survivors) from the most infected population (n=38) sought to identify genes associated with morbillivirus resistance and susceptibility. There were significant differences in the genetic make-up of victims and survivors, in particular five candidate genes associated with stress, pain and immune responses. The authors note that 'These results could also possibly aid in the advancement of vaccines against morbilliviruses', as well as help to genetically identify susceptible populations.

(SOURCE: Batley, K.C., Sandoval-Castillo, J., Kemper, C.M., Attard, C.R.M., Zanardo, N., Tomo, I., Beheregaray, L.B. and Möller, L.M. 2019. Genome-wide association study of an unusual dolphin mortality event reveals candidate genes for susceptibility and resistance to cetacean morbillivirus. Evolut. Applic. 12: 718-732).

Virulence and Genome of the Pathogen *Edwardsiella tarda*

The bacterial pathogen *Edwardsiella tarda* has been reported in several marine mammal species and is one of the main causes of septicaemia in captive marine mammals. The genome of an *E. tarda* strain isolated from a false killer whale by-caught in South Korea was similar to strains that are pathogenic in humans, and distinct from other *Edwardsiella* species. Several virulence-related genes (genes that increase the ability for a pathogen to infect or injure a host) were present in the genome, although some genes that are responsible for virulence in other *Edwardsiella* species were not. The authors conclude that 'These results provide important insights into the *E. tarda* infecting marine mammals and give valuable information on potential virulence factors in this pathogen'. Moreover, the analysis determined that this cetacean *E. tarda* strain is a 'potentially virulent strain' that could spread quickly through cetacean populations and possibly cause zoonotic infections (infections that pass from animals to humans) if encountered during stranding events or if consumed (i.e. through eating cetacean meat).

(SOURCE: Lee, K., Kim, H.K., Park, S-Y., Sohn, H., Cho, Y., Choi, Y.-M., Jeong, D.G. and Kim, D.G. 2018. First report of the occurrence and whole genome characterization of Edwardsiella tarda in the false killer whale (Pseudorca crassidens). J. Vet. Med. Sci. 80: 1,041-1,046).

Harmful Algal Blooms (HABs)

Expansion in Range and Frequency of HABs in Response to Climate Change and Other Factors

The impacts of HABs have increased in recent decades and, in coastal waters, are associated with other threats. This trend is attributed partly to the effects of ocean warming, marine heatwaves, oxygen loss, eutrophication and pollution. This highlights the combined effects of perturbations in the marine environment. The authors report that the United Nations' Intergovernmental Panel on Climate Change's (IPCC) Special Report (approved September 2019) on the Ocean and Cryosphere in a Changing Climate was the first IPCC report to directly link HABs to climate change. Two other threats - acidification and deoxygenation - are also noted as being related to progressive warming. Non-climatic drivers such as increased nutrient input from rivers, which leads to eutrophication, also promote HABs. Eutrophication also promotes the oxygen crises that can lead to mass mortalities of organisms and collapses of entire marine ecosystems ('dead zones'). The authors call for addressing the gaps in our understanding of HABs as a climate change co-stressor in order to develop management plans that adequately protect fisheries, aquaculture, aquatic ecosystems and human health.

(SOURCES: Griffith, A.W. and Gobler, C.J. 2019. Harmful algal blooms: A climate change co-stressor in marine and freshwater ecosystems. Harmful Algae 91: 101590. https://doi.org/10.1016/j.hal.2019.03.008; Gobler, C.J. 2020. Climate change and harmful algal blooms: Insights and perspective. Harmful Algae 91: 101731. https://doi.org/10.1016/j.hal.2019.101731).

Oil spills

Oil Readily Washes off of Baleen Plates

There has been concern that baleen whales encountering oil might undergo clogging of the baleen plates as they filter-feed in oil-contaminated waters. An investigation of the effects of oil on bowhead, fin, humpback and North Atlantic right whale baleen demonstrated that it was hydrophilic (water-attracting) and oleophobic (oil-repelling). Six petroleum-based oils and two fish oils were tested. There was no difference amongst oil types or species; baleen readily repelled oil, and oil easily rinsed off of the baleen plates. Thus, coating of baleen plates by these types of oil is not a threat. However, the potential risks of ingestion of oil by the whales remains.

(SOURCE: Werth, A.J., Blakeney, S.M. and Cothren, A.I. 2019. Oil adsorption does not structurally or functionally alter whale baleen. R. Soc. Open Sci. 6: 182194. http://dx.doi.org/10.1098/rsos.182194).

Climate change

Predicting Marine Mammal Vulnerability to Climate Change

A trait-based approach to assess the vulnerability of marine mammals to climate change used 15 traits in five categories (feeding, habitat, reproduction, social behaviour and biology) for 123 marine mammal species. Traits that made species vulnerable (e.g. restricted range) or might allow species to adapt to a changing climate were especially noted. Vulnerability to climate change was then ranked on a 4-point scale. This was compared to the predicted change in temperature for the respective habitats under a high and low greenhouse gas emission scenario for the middle and end of the 21st century. The results showed that the North Pacific Ocean, the Greenland Sea and the Barents Sea had species that were most vulnerable to global warming. The most vulnerable included some that are currently quite abundant, such as the Pacific white-sided dolphin, or data deficient (e.g. northern bottlenose whale and Stejneger's beaked whale), but several currently threatened marine mammals were also amongst the most vulnerable, such as the North Pacific right whale and narrow-ridged finless porpoise.

(SOURCE: Albouy, C., Delattre, V., Donati, G., Frölicher, T.L., Albouy-Boyer, S., Rufino, M., Pellissier, L., Mouillot, D.F. et al. 2020. Global vulnerability of marine mammals to global warming. Sci.Rep. 10: 548. https://doi.org/10.1038/s41598-019-57280-3).

Modelling the Effects of Increasing Ocean Temperatures on Cetacean Distribution

Sightings and environmental data from 1991-2009 were modelled for eight cetacean species found in the California Current system. These models were then used to predict cetacean abundance and distribution in 2014, a year with unusually warm ocean temperatures (average sea surface temperature was 18.4°C, versus the average of 16.7°C over the previous period). The predicted cetacean distributions matched well with the observed distributions for that year, indicating an effective model. As water warmed, cool water species such as northern right whale dolphins, Pacific white-sided dolphins and Dall's porpoises generally shifted northward into cooler waters, or their range contracted. Warm water species such as short-beaked common and striped dolphins also moved northward as these waters warmed. In warm conditions, blue whale abundance decreased (except in offshore areas of Monterey Bay and the coast of the Southern California Bight), while fin and humpback whale abundance increased. The model accurately predicted particular humpback increases in the Monterey Bay and San Francisco area. This exercise showed that climate models can accurately predict cetacean distributions as ocean temperatures rise.

(SOURCE: Becker, E.A., Forney, K.A., Redfern, J.V., Barlow, J., Jacox, M.G., Roberts, J.J. and Palacios, D.M. 2019. Predicting cetacean abundance and distribution in a changing climate. Divers. Distrib. 25: 626-643).

Dire Predictions for Whale Populations When Climate Change Factored into Model

A model linking whale and krill population dynamics with changes in ocean temperatures, primary productivity and sea ice coverage predicted negative impacts on whale populations and their prey species from climate change. The model predicted population declines and even extirpation for Pacific populations of blue, fin and southern right whales, and Atlantic and Indian Ocean fin and humpback whales. Whale populations that fed in mid-latitudes appeared to suffer more negative impacts by prey changes than whale populations in the Southern Ocean and southern Atlantic/Pacific. If whales could adapt their migratory routes to account for changes in Antarctic sea ice, the model predicted that some of the impacts might be mitigated for Antarctic minke and blue whales with feeding habitats associated with the ice edge. The model showed a much lower rate of population increase, post-whaling, than other population models that do not consider climate change (a third of the rate of some models). It also predicted population crashes not predicted by whale population models not factoring in climate change. In short, accounting for climate change led to more pessimistic predictions for whale population growth. Greenhouse gas emissions are currently matching scenarios with higher warming effects and there is a predicted expansion of krill fisheries. Therefore, dramatic reductions in greenhouse gas emissions, coupled with major decreases in whale mortality (e.g. from bycatch and ship strikes), may be needed to prevent extirpation of whale populations, even of those currently recovering.

(SOURCE: Tulloch, V.J.D., Plagányi, É.E., Brown, C., Richardson, A.J. and Matear, R. 2019. Future recovery of baleen whales is imperilled by climate change. Glob. Change Biol. 25: 1,263-1,281).

Noise impacts

Social Interactions Between Humpback Whales More Affected by Noise Than Previously Recognised

In an examination of the responses (reduced likelihood of socially interacting) of migrating humpback whales to vessels towing seismic air gun arrays, whale groups were significantly less likely to interact in the presence of a vessel, regardless of whether or not the air guns were active. Thus, potentially detrimental behavioural changes occur at much greater ranges, and much lower received sound levels, than previously thought or are being used for current mitigation recommendations. Accordingly, while current regulations and practices are likely to prevent direct hearing impacts of seismic surveys (for a small number of individuals very close to the air guns), they do not prevent all impacts such as changes in behaviour, which affects a much larger number of whales.

(SOURCE: Dunlop, R.A., McCauley, R.D. and Noad, M.J. 2020. Ships and air guns reduce social interactions in humpback whales at greater ranges than other behavioral impacts. Mar. Pollut. Bull. 154: 1110721072. https://doi.org/10.1016/j.marpolbul.2020.111072).

Airplane Noise Identified as Potential Threat to Marine Mammals

Airplane noise may be more audible underwater than commonly expected, especially when runways are built near a coast, on reclaimed land, or extend into the ocean. The coastal underwater soundscape caused by commercial passenger airplanes at two locations (Indonesia and Australia) exhibited broadband received levels of 84-132 dB re 1µPa rms. The levels were similar to those of cargo and container ships transiting at ranges of 1-3 km, although the airplane noise passed much faster. Power spectral density levels of airplane noise underwater exceeded ambient levels between 12 Hz and 2 or 10 kHz by up to 36 dB. While most of the acoustic energy was below 300 Hz, other frequencies are relevant to marine mammals such as pinnipeds, sirenians, baleen whales, and odontocetes. With many of the world's airports lying close to the coast, airplane noise may affect at-risk species in small, confined habitats. In this respect the authors also point to cetaceans near Hong Kong, belugas in Cook Inlet, southern resident killer whales, western grey whales and bottlenose dolphins.

(SOURCE: Erbe, C., Williams, R., Parsons, M., Parsons, S.K., Hendrawan, I.G. and Dewantama, I.M.I. 2018. Underwater noise from airplanes: An overlooked source of ocean noise. Mar. Pollut. Bull. 137: 656-661. https://doi.org/10.1016/j.marpolbul.2018.10.064).

Noise Levels Alone do not Determine Impact on Cetaceans

A review of 370 papers on the effects of noise on cetaceans in the wild found that the severity of the behavioural response was better explained by the sound source type (e.g. continuous, sonar, seismic/explosion) and functional hearing group (different species have different sensitivities), rather than the received level of sound that the cetacean encountered (i.e. more severe responses were not necessarily caused by higher received levels of sound). Continuous sources (such as shipping) elicited less severe behavioural responses from odontocetes with best hearing in mid-frequencies, whereas seismic or explosive sound sources elicited substantially greater behavioural responses in mysticetes with best hearing at low frequencies. Behavioural responses were reported at RL from 110 dB re 1 µPa, but a severe behavioural response was just as likely as a low or moderate one at this RL. The authors warn that monitoring and regulation of noise-producing activities should not be based on generic RL thresholds for multiple species. Regulations based primarily on RLs are unlikely to effectively mitigate the impacts of underwater noise. Accordingly, the absence of a behavioural response to a sound source does not necessarily mean there was no impact, and a severe behavioural response does not necessarily mean a severe population-level impact. Finally, the authors suggest that monitoring the impact of noise upon cetaceans should be based on variables associated with biologically important behaviours - such as foraging, socialising, reproduction and/ or survival - rather than simply degree of behavioural response.

(SOURCE; Gomez, C., Lawson, J.W., Wright, A.J., Buren, A.D., Tollit, D. and Lesage, V. 2016. A systematic review on the behavioural responses of wild marine mammals to noise: the disparity between science and policy. Can. J. Zool. 94: 801-819).

Response of Beaked Whales to Military Sonar

Seven tagged Blainville's beaked whales were monitored for their response to exposure to mid-frequency naval sonar (at 3-8 kHz) in the Bahamas. Five of the seven whales were displaced from 28 to 68km by this exposure, returning 2 to 4 days after the sonar-using exercise had ended. The RL of sound was initially 145-172 dB re 1 µPa, dropping to 70-150 dB re 1µPa after the whales moved away. Although the whales took dives that were assumed to be for foraging, the length of these dives was reduced by the sonar exposure. These 'lost' foraging dives may translate to a loss of energy for the whales, which should be considered, in addition to the displacement from habitat, in terms of population-level impacts.

(SOURCE: Joyce, T.W., Durban, J.W., Claridge, D.E., Dunn, C.A., Hickmott, L.S., Fearnbach, H., Dolan, K. and Moretti, D. 2020. Behavioral responses of satellite tracked Blainville's beaked whales (Mesoplodon densirostris) to mid-frequency active sonar. Mar. Mamm. Sci. 36: 29-46).

Harbour Porpoises Show Significant Behavioural Changes When Exposed to Naval Sonar

Two harbour porpoises were exposed to mid-frequency naval sonar in a 12×8×2 m pool with background ambient noise equivalent to Beaufort 6 weather conditions. At a source SPL of 117 dB re 1 µPa, there was no noticeable response; however, both porpoises demonstrated a significant change in behaviour (i.e. surfacing rates) at 122 dB re 1 µPa. The decibel scale is logarithmic, meaning the latter SPL is multiple times louder.

(SOURCE: Kastelein, R.A., Ainslie, M.A. and van Kester, R. 2019. Behavioral responses of harbor porpoises (Phocoena phocoena) to U.S. Navy 53C sonar signals in noise. Aquat. Mamm. 45: 359-366).

Mass Strandings of Beaked Whales During Naval Sonar Exercises in the Marianas Islands

Two Cuvier's beaked whales stranded on the northern Marianas Islands (western Pacific) on 22-23 August 2011, after mid-frequency active sonar was detected from hydrophones. Subsequently, patterns of beaked whales standing were compared to naval exercises. Between June 2006 and January 2019, eight stranding events (with 1-3 animals) occurred, with half happening within six days of a US naval exercise (a statistically significant relationship). The authors note that due to the difficulties of observing beaked whales at sea, passive acoustic monitoring for beaked whales is especially important as a mitigation measure.

(SOURCE: Simonis, A.E., Brownell Jr, R.L., Thayre, B.J., Trickey, J.S., Oleson, E.M., Huntington, R. and Baumann-Pickering. S. 2020. Co-occurrence of beaked whale standings and naval sonar in the Mariana Islands, Western Pacific. Proc. Roy. Soc. B 287: 20200070 (1-10).

Responses of Blue Whales to Military Sonar Exposure

The behavioural responses of 42 tagged blue whales when exposed to mid-frequency active sonar (3-8 kHz; maximum SL 210 dB re 1µPa @ 1m) was recorded off the California coast. The animals included both shallow feeding (<30m; *n*=7) and deep water feeding whales (>50m; *n*=21), as well as non-feeding whales (*n*=5). Observers subjectively graded responses to sonar exposure on a severity scale of 0 to 9. More than 50% of the deep feeding blue whales responded to the sonar exposure (scores ranging from 3-7 at RLs of 97-155 dB re 1µPa^2), but no responses were observed in shallow feeding whales. Two of the non-feeding whales scored a 7 in their response at RLs of 108-123 dB re 1µPa^2. The authors conclude that '[w]ith increased energetic demands and needs for high-density prey, even the cessation of feeding for a short time could have consequences for the fitness of these large animals…If [these consequences] are chronic, they could manifest as population level effects'.

(SOURCE: Southall, B.L., DeRuiter, S.L., Friedlaender, A., Stimpert, A.K., Goldbogen, J.A., Hazen, E., Casey, C., Fregosi, S. et al. 2019. Behavioral responses of individual blue whales (Balaenoptera musculus) to mid-frequency military sonar. J. Exp. Biol. 222: jeb190637, 1-15. https://doi.org/10.1242/jeb.190637).

Passing Ship Caused Humpback Whales to Stop Singing

Humpback whales ceased singing when a twin propeller passenger-cargo liner (57×12m; 453 tons), producing noise at a SL of 157 dB rms re 1µPa at 54 Hz, approached and passed by. The primary vocal frequency range of the humpback whales in this study was 100-800 Hz. One whale ceased singing when the ship was approaching and 235m away, whereas other whales stopped singing when the boat had passed the whales, and was at a distance of 500-1,200m. The estimated RL of shipping sound at the whales that ceased singing was 95-105 dB rms re 1µPa. Nine of 12 whales stopped singing and did not restart singing until at least 30 minutes after the liner had passed by the test area (and was approximately 17-20km away).

(SOURCE: Tsujii, K., Akamatsu, T., Okamoto, R., Mori, K., Mitani, Y. and Umeda, N. 2018. Change in singing behavior of humpback whales caused by shipping noise. PLoS ONE 13: e0204112).

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Appendix 1

GLOSSARY

Glossary of terms

ADD: Acoustic deterrent device, typically used to keep predators away from mariculture facilities.

AIS: Automatic identification system, for logging the location of ships.

Bioaccumulation: Increase in concentration of a pollutant within an organism compared to background levels in its diet. Pollutant levels are highest in older individuals.

Biomagnification: Increase in concentration of a contaminant from one link in a food chain to another. Pollutant levels are highest in top predators.

BMAA: β-methylamino-L-alanine, a neurotoxin associated with some harmful algal blooms.

Brucella: Various species of bacteria that cause the disease brucellosis.

Chlordecone (also known as Kepone or CLD): An organochlorine insecticide once used worldwide to control banana weevil infestations in banana plantations.

dB: Decibel - a logarithmic measure of sound pressure level.

DDT: The organochlorine pesticide dichlorodiphenyltrichloroethane, which tends to accumulate in the ecosystem and in the blubber and certain internal organs of cetaceans.

Dec-604 CB: Dechlorane 604 Component B, a halogenated flame retardant.

Demersal: Living in the water body just above the sea floor (see also pelagic).

Ecosystem services: The many and varied direct and indirect benefits to human well-being provided by the natural environment and its inhabitants.

Edwardsiella tarda: Anaerobic bacterium that causes the disease Edwardsiella septicaemia in marine animals.

Emboli: Plural of embolus, a clot (of blood or other material) in a blood vessel leading to circulation blockage.

Endocrine disruption: When an outside substance (chemical) interferes with an organism's endocrine system, a system of ductless glands producing hormones that control and moderate metabolic processes in the body.

Esrβ: Estrogen [oestrogen] receptor B gene.

Eutrophication: Input of nutrients into an aquatic system, typically associated with excessive plant growth and oxygen depletion.

Fecundity: The potential reproductive capacity of an organism or population.

Glucocorticoid: A type of natural, corticosteroid hormone that is very effective at reducing inflammation and suppressing the immune system.

ha: Hectare.

HBB: Hexabromobenzene, a halogenated flame retardant.

Hz: Hertz, a measure of sound frequency (pitch), in wave cycles per second (kHz=1,000 Hz).
HFRs: Halogenated flame retardants.
Immunotoxic: Toxic to the immune system of an organism.
In vitro: Latin for ‘in glass’, meaning outside a living organism/in a laboratory.
IUCN: International Union for Conservation of Nature.
Km*h: Kilometres of fishing net multiplied by hours of soak time
µg: Microgram, one thousandths of a gram.
µPa: Micropascal, a unit of pressure.
Microplastics: Plastic particles 0.3-5mm in diameter, often the result of larger plastic pieces breaking down over time.
MPA: Marine protected area.
ng: Nanogram, one billionth of a gram.
nm: Nanometre, one billionth of a metre.
Nr3c1: Nuclear receptor subfamily 3 group C member 1, a glucocorticoid receptor gene.
OC: Organochlorine compound.
OSPAR: Convention for the Protection of the Marine Environment of the North-East Atlantic.
PBB: Polybrominated biphenyl.
PBDE: Polybrominated diphenyl ether.
PCB: Polychlorinated biphenyl.
PCR: Polymerase chain reaction, a method for making many copies of small sections of genetic material.
Pelagic: Living in the open water (see also demersal).
Phenology: The study of cyclic and seasonal natural phenomena, especially in relation to climate and plant and animal life.
POPs: Persistent organic pollutants, organic compounds that are resistant to degradation and thus persist in the environment.
Proteus mirabilis: Anaerobic bacterium that causes urinary tract infections.
RL: Received level of a sound.
rms: Root-mean-square, a measurement of sound pressure.
Septicaemia: Fatal blood poisoning.
SL: Source level of a sound.
SPL: Sound pressure level.
Stockholm Convention: International environmental convention on Persistent Organic Pollutants, signed in 2001 and effective from May 2004, designed to help eliminate or restrict the production and use of persistent organic pollutants.
THg: Total mercury.
Toxoplasma gondii: A parasitic one-celled organism that causes the disease toxoplasmosis.
Transcript: In the context of genetics, a transcript is the first product of gene expression, usually a strand of RNA made from a strand of DNA.
Water column: A conceptual column of water extending from the sea surface down to the seafloor.

Species glossary

Amazon River dolphin or boto	*Inia geoffrensis*
Antarctic minke whale	*Balaenoptera bonaerensis*
Atlantic humpback dolphin	*Souza teuszii*
Atlantic white-sided dolphin	*Lagenorhynchus acutus*
Beluga whale	*Delphinapterus leucas*
Blainville's beaked whale	*Mesoplodon densirostris*
Blue whale	*Balaenoptera musculus*
Bowhead whale	*Balaena mysticetus*
Bryde's whale (Gulf of Mexico)	*Balaenoptera edeni*
Common bottlenose dolphin	*Tursiops truncatus*
Common dolphin (short-beaked)	*Delphinus delphis*
Common minke whale	*Balaenoptera acutorostrata*
Cuvier's beaked whale	*Ziphius cavirostris*
Dall's porpoise	*Phocoenoides dalli*
Fin whale	*Balaenoptera physalus*
False killer whale	*Pseudorca crassidens*
Franciscana	*Pontoporia blainvillei*
Fraser's dolphin	*Lagenodelphis hosei*
Grey whale	*Eschrichtius robustus*
Guiana dolphin or costero	*Sotalia guianensis*
Harbour porpoise	*Phocoena phocoena*
Humpback whale	*Megaptera novaeangliae*
Indo-Pacific bottlenose dolphin	*Tursiops aduncus*
Irrawaddy dolphin	*Orcaella brevirostris*
Killer whale	*Orcinus orca*
Melon-headed whale	*Peponocephala electra*
Narrow-ridged finless porpoise	*Neophocaena asiaeorientalis*
North Atlantic right whale	*Eubalaena glacialis*
North Pacific right whale	*Eubalaena japonica*
Northern bottlenose whale	*Hyperoodon ampullatus*
Northern right whale dolphin	*Lissodelphis borealis*
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*
Pantropical spotted dolphin	*Stenella attenuata*
Pygmy killer whale	*Feresa attenuata*
Pygmy sperm whale	*Kogia breviceps*
Rough-toothed dolphin	*Steno bredanensis*
Sei whale	*Balaenoptera borealis*
Short-finned pilot whale	*Globicephala macrorhynchus*
Southern right whale	*Eubalaena australis*
Sperm whale	*Physeter macrocephalus*
Spinner dolphin	*Stenella longirostris*
Stejneger's beaked whale	*Mesoplodon stejnegeri*
Striped dolphin	*Stenella coeruleoalba*
Tucuxi	*Sotalia fluviatilis*
Yangtze finless porpoise	*Neophocaena asiaeorientalis asiaeorientalis*
Yangtze river dolphin	*Lipotes vexillifer*
Anchovy	Family *Engraulidae*
Atlantic salmon	*Salmo salar*
Capelin	*Malotus villosus*
Hake (European)	*Merluccius* spp.
Herring	*Clupea haerengus*
Mackerels, tunas, bonitos	Family *Scombridae*
Sand eel	*Ammodytes* spp.
Sea bass (European)	*Dicentrarchus* spp.
Krill	Family *Euphausiidae* (euphausiids)
Heavy metals	
Ag	Silver
Hg	Mercury
Pb	Lead
Se	Selenium

Annex I

Fishery Bycatch of Small Cetaceans Entered into the Progress Report Database in 2020

Complied by Marion Hughes, IWC Secretariat

(F = female, M = male, US = unknown sex, D = dead, SI = seriously injured, I= injured, FU = Fate Unknown)

ID	Data year	Year sub-mitted	Large Area	Species	Local area	Local taxonomy	Local area (Long/Lat)	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Targeted fishery species	Fishing gear	Other fishing gear	How observed	Contacts
Australia																								
PR/R/14736	2019	2020	Pacific Ocean - South	Indo-Pacific bottlenose dolphin	Newcastle	-	-32.931887, 151.786385	1	-	-	-	-	-	-	-	-	-	-	-	-	NSC	-	Scientist	PR/C/209 | J. Hall *jhall@zoo.nsw.gov.au*
PR/R/14739	2019	2020	Pacific Ocean - South	Common dolphin	Narrabeen	-	-33.70492, 151.30460	-	-	-	-	1	-	-	-	-	-	-	-	-	NSC	-	Scientist	PR/C/209 | J. Hall (as above)
PR/R/14742	2019	2020	Pacific Ocean - South	Common dolphin	Cronulla	-	-34.05391, 151.15416	-	-	-	-	1	-	-	-	-	-	-	-	-	NSC	-	Scientist	PR/C/209 | J. Hall (as above)
PR/R/14745	2019	2020	Pacific Ocean - South	Indo-Pacific bottlenose dolphin	Bilgola	-	-33.63995, 151.30539	-	-	-	-	1	-	-	-	-	-	-	-	-	NSC	-	Scientist	PR/C/209 | J. Hall (as above)
PR/R/14763	2019	2020	Southern Ocean	Common dolphin	South Australia	Short-beaked common dolphin	-	4	-	-	-	-	-	-	-	1	-	-	-	SA sardine fishery and others	SPR	-	Scientist, fisherman	PR/C/573 | C. Kemper (South Australian Museum) *Catherine.Kemper@samuseum.sa.gov.au*
PR/R/14769	2019	2020	Southern Ocean	Indo-Pacific bottlenose dolphin	Gulf St Vincent	-	-35.01800, 138.03223	1	-	-	1	-	-	-	1	-	-	-	-	-	RG	-	Scientist, observer or inspector, public	PR/C/573 | C. Kemper (as above)
PR/R/14772	2019	2020	Southern Ocean	Unid. dolphin	O'Sullivan Beach (township), (S of O'Sullivan Beach boat ramp), Gulf St Vincent		-35.12094, 138.46241	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Bucket or cage	Public	PR/C/573 | C. Kemper (as above)
PR/R/15117	2019	2020	Pacific Ocean - South	Common bottlenose dolphin	Queensland	*Tursiops* sp. (unid. bottlenose dolphin)	Sunshine Coast to Gold Coast	3	-	-	-	1	-	-	-	-	-	-	-	White, tiger and bull shark	NSC	-	Fisherman	PR/C/493 | Queensland Department of Agriculture and Fisheries; PR/C/718 | J. Meager *justin.meager@des.qld.gov.au*
PR/R/15120	2019	2020	Pacific Ocean - South	Common dolphin	Queensland	-	Rainbow Beach to the Gold Coast	6	-	-	1	1	-	-	-	-	-	-	-	White, bull and tiger sharks	NSC; LX	-	Fisherman	PR/C/187 | Queensland Department of Agriculture, Fisheries and Forestry; PR/C/718 | J. Meager (as above)
PR/R/15123	2019	2020	Pacific Ocean - South	Indo-Pacific bottlenose dolphin	Queensland	-	Moreton Bay	-	-	-	-	-	-	-	-	-	-	-	1	Fin fish	RG	-	Scientist	PR/C/718 | J. Meager (as above)
PR/R/15129	2019	2020	Pacific Ocean - South	Indo-Pacific humpback dolphin	Queensland	Australian humpback dolphin	-	-	-	-	-	-	-	-	-	-	-	-	1	-	GNS	-	Fisherman	PR/C/187 | Queensland Department of Agriculture, Fisheries and Forestry
PR/R/15132	2019	2020	Pacific Ocean - South	False killer whale	Queensland	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	GNS	-	Fisherman	PR/C/493 | Queensland Department of Agriculture and Fisheries
PR/R/15861	2019	2020	Pacific Ocean - South	Common bottlenose dolphin	Nelson Bay	-	-32.718889, 152.145556	0	0	0	0	0	0	0	0	0	0	0	1	-	LX	-	-	PR/C/1011 | S. Crocetti *susan.crocetti@environment.nsw.gov.au*

ID	Data year	Year sub-mitted	Large Area	Species	Local area	Local taxonomy	Local area (Long/Lat)	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Targeted fishery species	Fishing gear	Other fishing gear	How observed	Contacts
Australia cont.																								
PR/R/16575	2019	2020	Pacific Ocean - South	Killer whale	-	-	-41.1, 148.7	-	-	-	-	-	-	-	-	-	-	-	2	-	LL	Drop line	Fisherman	PR/C/1083 | C. van der Geest *claire.vandergeest@afma.gov.au*
PR/R/16578	2019	2020	Pacific Ocean - South	False killer whale	-	-	-23.2,155.7	-	-	-	-	-	-	-	-	-	-	-	4	-	LLD	-	Fisherman	PR/C/1083 | C. van der Geest (as above)
PR/R/16581	2019	2020	Pacific Ocean - South	Common dolphin	-	-	-40.6, 148.6	-	-	-	-	-	-	-	-	4	-	-	-	-	TBB	Bottom otter trawls	Fisherman	PR/C/1083 | C. van der Geest (as above)
PR/R/16584	2019	2020	Pacific Ocean - South	Common dolphin	-	-	-27.1, 156.6	-	-	-	-	-	-	-	-	1	-	-	2	-	LLD	-	Fisherman	PR/C/1083 | C. van der Geest (as above)
PR/R/16587	2019	2020	Pacific Ocean - South	Common dolphin	-	-	-35.7, 150.1	-	-	-	-	-	-	-	-	13	-	-	2	-	OT	-	Fisherman	PR/C/1083 | C. van der Geest (as above)
PR/R/16590	2019	2020	Pacific Ocean - South	Common dolphin	-	-	-38, 143	-	-	-	-	-	-	-	-	16	-	-	-	-	GNS	-	Fisherman	PR/C/1083 | C. van der Geest (as above)
PR/R/16593	2019	2020	Pacific Ocean - South	Common bottlenose dolphin	-	-	-26.48333, 157.28333	-	-	-	-	-	-	-	-	-	-	-	1	-	LLD	-	Fisherman	PR/C/1083 | C. van der Geest (as above)
PR/R/16596	2019	2020	Pacific Ocean - South	Common bottlenose dolphin	-	-	-35.60017, 150.65783	-	-	-	-	-	-	-	-	1	-	-	-	-	TM	-	Fisherman	PR/C/1083 | C. van der Geest (as above)
PR/R/16599	2019	2020	Pacific Ocean - South	Common bottlenose dolphin	-	-	-39.8, 146.4	-	-	-	-	-	-	-	-	7	-	-	-	-	GNS	-	Fisherman	PR/C/1083 | C. van der Geest (as above)
PR/R/16602	2019	2020	Indian Ocean	Short-finned pilot whale	-	-	-33.36667 ,114.01667	-	-	-	-	-	-	-	-	-	-	-	1	-	LLD	-	Fisherman	PR/C/1083 | C. van der Geest (as above)
PR/R/16605	2019	2020	Pacific Ocean - South	Short-finned pilot whale	-	-	-26.9, 154.7	-	-	-	-	-	-	-	-	-	-	-	5	-	LLD	-	Fisherman	PR/C/1083 | C. van der Geest (as above)
PR/R/16608	2019	2020	Pacific Ocean - South	Unid. dolphin	-	-	-32.4, 152.9	-	-	-	-	-	-	-	-	5	-	-	2	-	LLD	-	Fisherman	PR/C/1083 | C. van der Geest (as above)
PR/R/16611	2019	2020	Pacific Ocean - South	Unid. dolphin	-	-	-39.8, 145.8	-	-	-	-	-	-	-	-	17	-	-	-	-	GNS	-	Fisherman	PR/C/1083 | C. van der Geest (as above)
PR/R/16614	2019	2020	Pacific Ocean - South	Unid. dolphin	-	-	-36.5, 149.8	-	-	-	-	-	-	-	-	4	-	-	-	-	TBB	Bottom otter trawl	Fisherman	PR/C/1083 | C. van der Geest (as above)
PR/R/16686	2019	2020	Pacific Ocean - South	Common bottlenose dolphin	Queensland	Unid. bottlenose dolphin	Moreton Bay	-	-	-	-	-	-	-	-	-	-	-	1	-	RG	-	Fisherman	PR/C/718 | J. Meager (as above)

Australia - Notes

ID	Explanation
PR/R/14736	Australian Registry of Wildlife Health case numbers 13047.1.
PR/R/14739	Australian Registry of Wildlife Health case number 13048.1.
PR/R/14742	Australian Registry of Wildlife Health case number 13049.1.
PR/R/14745	Australian Registry of Wildlife Health case number 13050.1.
PR/R/14763	5 separate stranding events with 1 individual each.
PR/R/14769	2 separate stranding incidents with 3 individuals. 1 died, and a mother and calf successfully disentangled.
PR/R/14772	11 December 2019. Did not strand. Seen entangled with a cage or burley bucket on its tail. Sighting is not confirmed by the DEW staff.
PR/R/15117	-
PR/R/15120	1 female released alive in good condition from a drumline. 7 dead in nets.
PR/R/15123	-
PR/R/15129	1 dolphin released alive. Reported by fisher via SOCI (*https://www.data.qld.gov.au/dataset/total-number-of-species-of-conservation-interest-interactions-with-released-conditions*).
PR/R/15132	Reported by fisher via SOCI (*https://www.data.qld.gov.au/dataset/total-number-of-species-of-conservation-interest-interactions-with-released-conditions*).

ID	Explanation
PR/R/15861	Dolphin calf (swimming with adult) observed by local commercial operators with rope around its peduncle, and trailing behind it with seaweed attached. Commercial operators notified local NPWS office. NPWS staff went out on boat and observed/took footage of calf with entanglement. 09 Nov 2019 - (Duan March) After some searching for the entangled calf in Nelson Bay on Friday, the mother and calf were located in the shallow Jet ski area opposite Little Beach. The animals spent time in both the sandy area adjacent the channel which was less than 2m deep and the channel. According to Dolphin Watch operator MoonShadow this is a normal location for them. The mum and calf were not with other animals and both were freely swimming. Positive ID is relatively easy as there is about a 1½ line trailing with some weed attached. At one point the animals swum beneath the boat and a manual attempt was made to catch the calf which failed. Following this, the animals were boat shy. From observations it looks like the animal will be a candidate for immediate release following removal of the line. I think the best chance of catching the animal is to wait a few days for it to become less boat shy and monitor its movements. Hopefully the mum and calf are routinely using the shallow jet ski area. If they are, given the shallow depth and uniform bottom, I think a net would be the best option. 24 Jan 2020 - Jim Lawson (RMS Boating Safety Officer) reported a 'sighting' on Friday 24 Jan 2020. He thought that he saw the entangled dolphin in Shoal Bay.
PR/R/16575	Australian Fisheries Management Authority data - all recorded as alive. Individual locations: -41.18333 148.65; -41.03333 148.71667.
PR/R/16578	Australian Fisheries Management Authority data - all recorded as alive. Individual locations: -27.43333 157.45; -19.38333 153.13333; -18.73333 152.73333; -27.38333 159.38333.
PR/R/16581	Australian Fisheries Management Authority data. Individual locations: -41.243 148.62217; -41.08917 148.632; -41.219 148.61567; -41.33033 148.60967; -38.26167 148.49333.
PR/R/16584	Australian Fisheries Management Authority data. Individual locations: -29.38333 157.78333 dolphin (dead) had been hooked in the mouth and tail wrapped. -23.36667 154.31667 dolphin was tail wrapped in mainline, line was cut and removed dolphin swam away. -28.58333 157.66667 small animal hooked around tail.
PR/R/16587	Australian Fisheries Management Authority data. Individual locations and details: -35.86667 150.49333 Dead and flexible; -35.55 150.65 Dolphin caught in the excluder on the codend. -35.86683 150.50283 dolphin was caught by nose in the hood of excluder as if it was trying to get into excluder to get fish out; -35.35233 150.607 Common dolphin meshed in excluder due to the length of time it took to retrieve the trawl due to mechanical failure. -35.50167 150.73167 Caught its tail in the small netting while hauling. Released outside of the vessel. -36.05967 150.42917 1 had tail caught in big mesh in trawl, 4 were in excluder with 2 sunfish they had no way to escape. -35.45383 150.7705 Dead. -35.95667 150.49667 Bust out of the mid-section of the net at the surface. -35.61333 150.66333 Caught in the excluder. -35.81833 150.54667 Dead. -35.64167 150.65833 caught in the excluder.
PR/R/16590	Australian Fisheries Management Authority data. Individual data: -37.93333 148.38333 tail wrapped in floatline. -36.65 138.33333 dolphin was tangled bottom of net, was dead we had trouble setting nets for that night we cut the net there was no sinker only a float. -37.833 149.206 shot into tied by mistake. -36.61667 138.46667 meshed in green mesh. -39.949 145.486 dead and damaged. -38.7 144.1 dead. -39.636 148.121 dead. -36.81667 139.25 tail wrapped. -39.606 146.119 dead. -36.71667 138.56667 in middle of gear, tail wrapped in green mesh. -36.55 138.18333 20m from end of gear. -38.53767 141.26033 dead and damaged.
PR/R/16593	Australian Fisheries Management Authority data; dolphin alive and vigorous.
PR/R/16596	Australian Fisheries Management Authority data; bottlenose dolphin meshed just below hood and excluder exit hole like was trying to get out but got nose caught.
PR/R/16599	Australian Fisheries Management Authority data; individual locations: -40.6 146.48333 dead. -38.25383 147.58217 bottlenose dolphin was dead hooked by the nose no tag. -40.95 148.48333 dead. -40.76667 146.43333 dead. -38.835 144.961 dead. -38.65 142.55 dead and flexible. -40.75 148.53333 dead.
PR/R/16602	Australian Fisheries Management Authority data; Cut free due to crew safety concerns.
PR/R/16605	Australian Fisheries Management Authority data; individual data: -29.53333 154.18333 alive. -21.58333 154.41667 released unharmed cut with scessor. -28.88333 159.85 entangled in mainline. Freed with no line remaining on animal. Juvenile appx 2m in length. No other whales sighted. -19.75 153.75 unknown. -34.883 151.341 it was a little pilot whale he was jumping out of water swam off happy.
PR/R/16608	Australian Fisheries Management Authority data. Individual data: -32.75 152.73333 alive and vigorous, line cut 30cm from hook. -37.66667 150.41667 released alive and vigorous. -32.91667 152.58333 tail rapped used live cutter to cut free. -35.28333 151.08333 tangled in mainline no hook. -29.88333 154.05 dead. -32.98333 155.23333 large dolphin. -25.31667 153.95 was tail tangled. Cut away from line but don't think it survived.
PR/R/16611	Australian Fisheries Management Authority data. Individual data: -39.56667 145.86667 dead. -40.35 145.51667 dead. -39.53333 145.85 was tangled around tail fin. -42.43333 148.16667 dead. -39.53333 147.18333 dead. -38.892 147.417 dead. -43.61667 146.98333 no dolphins sighted while setting. -39.807 144.262 didn't see how it was caught, barely in net by pectoral fin. -38.612 144.314 only caught by one mesh on tail. -39.684 144.392 dead. -39.35439 147.29471 dead. -39.10191 146.64064 dead. -38.742 142.882 dead. -40.477 147.38333 was dead but not yet in rigger. Didn't see any dolphins beforehand or while setting. -38.28408 141.074 dead. -38.035 147.843 tangled with foot line.
PR/R/16614	Australian Fisheries Management Authority data. Individual data: -38.20667 148.66833 dead. -35.73333 150.38333 dead. -35.56667 150.46667 dead.
PR/R/16686	-

ID	Data year	Year submitted	Large Area	Species	Local area	Local taxonomy	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Fishing gear	How observed	Contacts	References	Explanation
Croatia																							
PR/R/11045	2018	2020	Atlantic Ocean - Adriatic Sea	Common bottlenose dolphin	Eastern Adriatic Sea	Dobri dupin	1	0	0	0	0	0	0	0	0	0	0	0	GN	Scientist	PR/C/742 | M. Đuras *martina.duras@vef.hr*	-	Entangled in gear, cut off and sank.
PR/R/16794	2019	2020	Atlantic Ocean - North	Common bottlenose dolphin	Rovinj, Eastern Adriatic Sea	Dobri dupin	-	-	-	-	1	-	-	-	-	-	-	-	-	-	PR/C/742 | M. Đuras (as above)	PR/B/834 | Gomerčić, T., Đuras, M. 2019. Analiza smrtnosti kitova u hrvatskom dijelu Jadranskoga mora u 2019. Godini. Izvješće Hrvatskoj Agenciji za okoliš i prirodu. 13 stranica. Gomerčić, T., Đuras, M. (unpublished).	Postmortem examination

ID	Data year	Year sub-mitted	Large Area	Species	Local area	Local area (Long/Lat)	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Targeted fishery species	Fishing gear	How observed	Contacts	References
France																							
PR/R/18999	2016	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	45.58329, -4.57031	-	-	-	-	-	-	-	-	1	-	-	-	Hake	GNS	Observer or inspector	PR/C/1227 | Observatoire Pelagis UMS 3462 (*pelagis@univ-lr.fr*)	PR/B/891 | 2018. Rapport annuel sur la mise en œuvre du règlement européen (CE) N812/ 2004 établissant les mesures relatives aux captures accidentelles de cétacés dans les pêcheries (année 2016). IFREMER (unpublished).
PR/R/19002	2016	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	45.70618, -2.98828	-	-	-	-	-	-	-	-	1	-	-	-	Skipjack tuna	GNS	Observer or inspector	As above	As above
PR/R/19005	2016	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	46.43786, -3.95508	-	-	-	-	-	-	-	-	2	-	-	-	Mackerel	GNS	Observer or inspector	As above	As above
PR/R/19008	2016	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	45.89001, -3.07617	-	-	-	-	-	-	-	-	7	-	-	-	Sole	GTR	Observer or inspector	As above	As above
PR/R/19011	2016	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	45.76752, -3.07617	-	-	-	-	-	-	-	-	21	-	-	-	Hake	PTM	Observer or inspector	As above	As above
PR/R/19014	2016	2020	Atlantic Ocean - North	Harbour porpoise	Bay of Biscay	45.95115, -3.86719	-	-	-	-	-	-	-	-	3	-	-	-	Monkfish	GTR	Observer or inspector	As above	As above
PR/R/19017	2016	2020	Atlantic Ocean - North	Striped dolphin	Celtic Sea	51.61802, -12.65625	-	-	-	-	-	-	-	-	1	-	-	-	Monkfish	OTT	Observer or inspector	As above	As above
PR/R/19020	2016	2020	Atlantic Ocean - North	Common dolphin	Eastern Chanel	49.89463, -2.63672	-	-	-	-	-	-	-	-	3	-	-	-	Monkfish	GTR	Observer or inspector	As above	As above
PR/R/19023	2016	2020	Atlantic Ocean - North	Harbour porpoise	Eastern Chanel	49.83798, -2.63672	-	-	-	-	-	-	-	-	1	-	-	-	Monkfish	GTR	Observer or inspector	As above	As above
PR/R/19026	2016	2020	Atlantic Ocean - North	Striped dolphin	Med. Sea - Gulf of Lion	42.90816, 3.95508	-	-	-	-	-	-	-	-	1	-	-	-	European anchovy	OTM	Observer or inspector	As above	As above
PR/R/19029	2017	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	45.58329, -3.69141	-	-	-	-	-	-	-	-	1	-	-	-	Gilthead seabream	GNS	Observer or inspector	As above	PR/B/894 | 2019. Rapport annuel sur la mise en œuvre du règlement européen (CE) N812/2004 établissant les mesures relatives aux captures accidentelles de cétacés dans les pêcheries (année 2017). IFREMER (unpublished).
PR/R/19035	2017	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	46.16461, -3.60352	-	-	-	-	-	-	-	-	32	-	-	-	European seabass	PTM	Observer or inspector	As above	As above
PR/R/19038	2017	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	46.25585, -3.99902	-	-	-	-	-	-	-	-	25	-	-	-	Hake	PTM	Observer or inspector	As above	As above
PR/R/19041	2017	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	46.22545, -3.99902	-	-	-	-	-	-	-	-	2	-	-	-	Monkfish	GTR	Observer or inspector	As above	As above
PR/R/19044	2017	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	46.19504, -3.69141	-	-	-	-	-	-	-	-	3	-	-	-	Sole	GTR	Observer or inspector	As above	As above
PR/R/19047	2017	2020	Atlantic Ocean - North	Harbour porpoise	Bay of Biscay	46.19504, -3.42773	-	-	-	-	-	-	-	-	1	-	-	-	Monkfish	OTB	Observer or inspector	As above	As above
PR/R/19050	2017	2020	Atlantic Ocean - North	Harbour porpoise	Bay of Biscay	46.24065, -3.36182	-	-	-	-	-	-	-	-	3	-	-	-	Sole	GTR	Observer or inspector	As above	As above
PR/R/19053	2017	2020	Atlantic Ocean - North	Harbour porpoise	Bay of Biscay	46.01222, -3.51563	-	-	-	-	-	-	-	-	1	-	-	-	European seabass	GTR	Observer or inspector	As above	As above
PR/R/19056	2017	2020	Atlantic Ocean - North	Long-finned pilot whale	Bay of Biscay	46.13417, -3.60352	-	-	-	-	-	-	-	-	5	-	-	-	Albacore	PTM	Observer or inspector	As above	As above
PR/R/19059	2017	2020	Atlantic Ocean - North	Harbour porpoise	Bay of Biscay	46.16461, -3.60352	-	-	-	-	-	-	-	-	1	-	-	-	European seabass	PTM	Observer or inspector	As above	As above
PR/R/19062	2017	2020	Atlantic Ocean - North	Common dolphin	Eastern Channel	49.55373, -3.25195	-	-	-	-	-	-	-	-	1	-	-	-	Codfishes	OTB	Observer or inspector	As above	As above

ID	Data year	Year sub-mitted	Large Area	Species	Local area	Local area (Long/Lat)	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Targeted fishery species	Fishing gear	How observed	Contacts	References
France cont.																							
PR/R/19065	2017	2020	Atlantic Ocean - North	Harbour porpoise	Celtic Sea	50.62507, -7.64648	-	-	-	-	-	-	-	-	1	-	-	-	Norway lobster	OTT	Observer or inspector	As above	As above
PR/R/19068	2017	2020	Atlantic Ocean - North	Common bottlenose dolphin	Med. Sea - Gulf of Lion	42.87596, 3.91113	-	-	-	-	-	-	-	-	1	-	-	-	Various fishes	OTB	Observer or inspector	As above	As above
PR/R/19071	2017	2020	Atlantic Ocean - North	Unid. small cetacean	Med. Sea - Gulf of Lion	42.90816, 3.95508	-	-	-	-	-	-	-	-	1	-	-	-	Various fishes	OTB	Observer or inspector	As above	As above
PR/R/19074	2017	2020	Atlantic Ocean - North	Striped dolphin	Med. Sea - Gulf of Lion	42.93230,3.95508	-	-	-	-	-	-	-	-	2	-	-	-	European anchovy	OTM	Observer or inspector	As above	As above
PR/R/19077	2018	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	46.13417, -3.99902	-	-	-	-	-	-	-	-	1	-	-	-	Meagre	GNS	Observer or inspector	As above	PR/B/900 | 2020. Rapport annuel sur la mise en œuvre du règlement européen (CE) N812/2004 établissant les mesures relatives aux captures accidentelles de cétacés dans les pêcheries (année 2018). IFREMER (unpublished).
PR/R/19080	2018	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	46.31658, -3.36182	-	-	-	-	-	-	-	-	6	-	-	-	Sole	GTR	Observer or inspector	As above	As above
PR/R/19083	2018	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	46.10371, -3.44971	-	-	-	-	-	-	-	-	54	-	-	-	Hake, European seabass	PTM	Fisherman	PR/C/1227 (as above); PR/C/1230 | T. Rimaud *thomas.rimaud@pecheursdebretagne.eu*	PR/B/897 | 2019. Rapport final du projet PIC. Rimaud, T., Authier, M., Mehault, S., Peltier H., Van Canneyt, O. (unpublished).
PR/R/19086	2018	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	46.01222, -3.36182	-	-	-	-	-	-	-	-	7	-	-	-	Hake, European seabass	PTM	Observer or inspector	As above	As above
PR/R/19089	2018	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	46.01222, -3.36182	-	-	-	-	-	-	-	-	1	-	-	-	Monkfish	GTR	Observer or inspector	PR/C/1227 (as above); Observatoire Pelagis UMS 3462 *pelagis@univ-lr.fr*	As above
PR/R/19092	2018	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	46.13417, -3.42773	-	-	-	-	-	-	-	-	1	-	-	-	Various fishes	OTM	Observer or inspector	As above	As above
PR/R/19095	2018	2020	Atlantic Ocean - North	Harbour porpoise	Bay of Biscay	46.16461, -3.51563	-	-	-	-	-	-	-	-	1	-	-	-	Sole	GTR	Observer or inspector	As above	As above
PR/R/19098	2018	2020	Atlantic Ocean - North	Common dolphin	Bay of Biscay	46.02748, -3.42773	-	-	-	-	-	-	-	-	1	-	-	-	Albacore	PTM	Observer or inspector	As above	As above
PR/R/19101	2018	2020	Atlantic Ocean - North	Common dolphin	Eastern Channel	49.78126, -2.15332	-	-	-	-	-	-	-	-	3	-	-	-	Codfishes	OTB	Observer or inspector	As above	As above
PR/R/19104	2018	2020	Atlantic Ocean - North	Common dolphin	Celtic Sea	50.62507, -8.96484	-	-	-	-	-	-	-	-	1	-	-	-	Monkfish	OTB	Observer or inspector	As above	As above
PR/R/19107	2018	2020	Atlantic Ocean - North	Common dolphin	Celtic Sea	50.28934, -8.61328	-	-	-	-	-	-	-	-	5	-	-	-	Codfishes	OTB	Observer or inspector	As above	As above
PR/R/19110	2018	2020	Atlantic Ocean - North	Common dolphin	Celtic Sea	49.72448, -8.61328	-	-	-	-	-	-	-	-	1	-	-	-	Norway lobster	OTT	Observer or inspector	As above	As above
PR/R/19113	2018	2020	Atlantic Ocean - North	Harbour porpoise	Eastern Channel	49.26780, -3.99902	-	-	-	-	-	-	-	-	1	-	-	-	Monkfish	OTT	Observer or inspector	As above	As above

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Germany																						
PR/R/17085	2019	2020	Atlantic Ocean - North	Harbour porpoise	Coast of Federal State of Schleswig Holstein (Baltic Sea)	1	0	0	0	3	0	0	0	0	0	0	0	Cod, mackerel, whiting	GN	Fisherman	PR/C/623 | Prof. h. c. Dr. U. Siebert (*Ursula.Siebert@tiho-hannover.de*)	4 direct by-catches handed over by fishermen.
PR/R/17088	2019	2020	Atlantic Ocean - North	Harbour porpoise	Coast of Federal State of Schleswig Holstein (Baltic Sea)	6	0	0	0	1	0	0	0	0	0	0	0	-	NK	-	PR/C/623 | U. Siebert (as above)	Animals stranded, but based on pathological investigations, 7 suspected bycatches.

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Italy																						
PR/R/16368	2019	2020	Atlantic Ocean - North	Common bottlenose dolphin	Mediterranean Sea - Mar Tirreno centrale Sardegna, Isola Rossa - Trinità d'Agultu e Vignola (SS)	Long: 8:53.021 Lat: 41:1.073	1	-	-	-	-	-	-	-	-	-	-	-	Unk	Scientist	PR/C/1035 | C. Casalone (*credima@izsto.it*); PR/C/1038 | A. Pintore (*antonio.pintore@izs-sardegna.it*)	Juvenile. Male. Total length: 121cm. The animal showed a deep wound at the level of the peduncle (caudal fin almost amputated). Fresh stomach content (5 octopus in 1 chamber). Post-mortem predation injuries (right mandibular region). Generalized autolysis.
PR/R/16371	2019	2020	Atlantic Ocean - North	Striped dolphin	Mediterranean Sea - Mar Ionio settentrionale Calabria, Praia Longa, Capo Rizzuto Island (KR)	Long: 16:59.476 Lat: 38:56.007	1	-	-	-	-	-	-	-	-	-	-	-	Unk	Scientist	PR/C/1035 | C. Casalone (as above); PR/C/1041 | G. Lucifora (*giuseppe.lucifora@cert.izsmportici.it*)	Juvenile. Male. Total length 189cm. Empty stomach. The animal showed a penetrating tip wound at head level, around the left mandible, with deep bleeding and enucleation of left eye; serum-blood effusion in the abdomen. Microscopic investigations revealed non-suppurative meningo-encephalitis (unknown origin). Fishery by-catch probable, as a result of cerebral impairment and abnormal behaviour.
PR/R/16374	2019	2020	Atlantic Ocean - North	Common bottlenose dolphin	Mediterranean Sea - Mar Adriatico meridionale Puglia, Monopoli (BA)	37.16032, 11.95313	1	-	-	-	-	-	-	-	-	-	-	-	Unk	Scientist, fisherman	PR/C/1035 | C. Casalone (as above); PR/C/1044 | A. Petrella (*antonio.petrella@izspb.it*)	Adult. Male Total length 291cm. The subject was trapped in a trawl (data reported by fisherman of the port area, where the animal had settled in the last months). Superficial abrasions. Generalized congestion. Fresh stomach content (3 sea bream in 1 chamber). Bloody foam in trachea and bronchi. Severe pulmonary edema. Meningeal hyperemia. Brain congestion, with hemorrhagic foci.

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Republic of Korea																							
PR/R/18510	2019	2020	Pacific Ocean - North	Common bottlenose dolphin	East Sea	-	-	1	-	-	-	1	-	-	-	-	-	-	-	GN	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (*forestu2@gmail.com*)
PR/R/18522	2019	2020	Pacific Ocean - North	Dall's porpoise	East Sea	dalli-type	38.300, 129.0000	-	-	-	-	-	-	-	-	1	-	-	-	GN	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18528	2019	2020	Pacific Ocean - North	Risso's dolphin	East Sea	-	-	2	-	-	-	-	-	-	-	1	-	-	-	FPO	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)

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Republic of Korea cont.																							
PR/R/18537	2019	2020	Pacific Ocean - North	Finless porpoise	East Sea	Neo-phocaena asia-eorientalis	36.00000, 129.50000	4	-	-	-	4	-	-	-	-	-	-	-	GN	-	Fisherman, observer or inspector	-
PR/R/18543	2019	2020	Pacific Ocean - North	Pacific white-sided dolphin	East Sea	-	-	31	-	-	-	23	-	-	-	15	-	-	-	GN	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18549	2019	2020	Pacific Ocean - North	Finless porpoise	East China Sea	N. asia-eorientalis	34.00000, 127.50000	-	-	-	-	-	-	-	-	1	-	-	-	FSN	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18552	2019	2020	Pacific Ocean - North	Pacific white-sided dolphin	East Sea	-	-	3	-	-	-	2	-	-	-	1	-	-	-	FIX; FPN	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18555	2019	2020	Pacific Ocean - North	Pacific white-sided dolphin	East Sea	-	-	3	-	-	-	4	-	-	-	3	-	-	-	FPO	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18558	2019	2020	Pacific Ocean - North	Finless porpoise	East China Sea	N. asia-eorientalis	34.00000, 127.50000	-	-	-	-	-	-	-	-	1	-	-	-	FPO	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18567	2019	2020	Pacific Ocean - North	Pacific white-sided dolphin	East Sea	-	-	-	-	-	-	-	-	-	-	1	-	-	-	TM	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18570	2019	2020	Pacific Ocean - North	Common dolphin	East Sea	-	-	23	-	-	-	43	-	-	-	18	-	-	-	GN	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18576	2019	2020	Pacific Ocean - North	Common dolphin	East Sea	-	-	111	-	-	-	121	-	-	-	14	-	-	-	FIX; FPN	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18579	2019	2020	Pacific Ocean - North	Finless porpoise	Yellow Sea	N. asia-eorientalis	36.50000, 126.00000	-	-	-	-	1	-	-	-	11	-	-	-	GN	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18582	2019	2020	Pacific Ocean - North	Common dolphin	East Sea	-	-	11	-	-	-	10	-	-	-	-	-	-	-	FPO	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18585	2019	2020	Pacific Ocean - North	Common dolphin	East Sea	-	-	-	-	-	-	-	-	-	-	1	-	-	-	Unk.	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18588	2019	2020	Pacific Ocean - North	Finless porpoise	Yellow Sea	N. asia-eorientalis	36.50000, 126.00000	-	-	-	-	-	-	-	-	1,173	-	-	-	FSN	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)
PR/R/18591	2019	2020	Pacific Ocean - North	Common dolphin	East Sea	-	-	1	-	-	-	-	-	-	-	-	-	-	-	LL	-	Fisherman, observer or inspector	PR/C/652 | H.W. Kim (as above)

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Mexico																						
PR/R/18006	2019	2020	Pacific Ocean - North	Long-beaked common dolphin	Upper Gulf of California	-	-	-	-	-	-	-	-	-	-	-	-	Totoaba	GEN	-	PR/C/1149 | E. Hidalgo (*science@seashepherd.org*)	Total number=9. The animals were observed during patrolling and elimination of gillnets for avoiding bycatch of vaquita for Sea Shepherd Conservation Society. More info w/contact.
PR/R/18018	2019	2020	Pacific Ocean - North	Vaquita	Upper Gulf of California	1	-	-	-	-	-	-	-	-	-	-	-	Totoaba	GEN	Observer or inspector	PR/C/1185 | O. Santillan (*oswaldo.santillan@profepa.gob.mx*)	

ID	Data year	Year sub-mitted	Large Area	Species	Local Area	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Contacts	References	Explanation
Netherlands																				
PR/R/16206	2019	2020	Atlantic Ocean - North	Harbour porpoise	North Sea	4	-	-	-	2	-	-	-	-	-	-	-	PR/C/453 | L. IJsseldijk (*L.L.IJsseldijk@uu.nl*)	PR/B/819 | Postmortaal onderzoek van bruinvissen (*Phocoena phocoena*) uit Nederlandse wateren, 2019. Biologische gegevens, gezondheidsstatus en doodsoorzaken. Wettelijke Onderzoe-kstaken Natuur; Milieu, WUR. WOt-technical report 2020 not published yet | IJsseldijk, L.L., M.J.L. Kik, van Schalkwijk, L.; A. Gröne | Unpublished	This data is not based on a targeted program to assess bycatch. This information is based on the post-mortem examination of animals. In 2019, 57 dead harbour porpoises were examined: 31 males and 26 females, 22 adults, 24 juveniles and 11 neonates. There were an additional six foetuses found. Most of the examined harbour porpoises died as a result of infectious diseases (30%) and grey seal attacks (21%), followed by bycatch (11%). The six porpoises (11%) that were considered bycatch were categorised as follows: probable bycatch: 2; highly probable bycatch: 3; certain bycatch: 1. The animals were four juveniles and two adults. Two males and four females. They were found in the months March (2), April, May, October and December.

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New Zealand																								
PR/R/18699	2019	2020	Pacific Ocean - South	Long-finned pilot whale	-	-36.15, 175.01667	-	-	-	-	-	-	-	-	1	-	-	-	SNA - snapper	TBB	Precision bottom trawl	Fisherman	PR/C/895 | Fisheries New Zealand	10/01/2019
PR/R/18702	2019	2020	Pacific Ocean - South	Common bottlenose dolphin	-	-37.25, 177.11667	-	-	-	-	-	-	-	-	-	-	1	-	BIG - bigeye tuna	LLD	Surface/mid-water long line	Fisherman	PR/C/895 | Fisheries New Zealand	31/01/2019
PR/R/18705	2019	2020	Pacific Ocean - South	Hector's dolphin	-	-43.6833, 173.2	-	-	-	-	-	-	-	-	3	-	-	-	WAR - common warehou	TBB	-	Fisherman	PR/C/895 | Fisheries New Zealand	18/02/2019
PR/R/18708	2019	2020	Pacific Ocean - South	Common dolphin	-		-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	Fisherman	PR/C/895 | Fisheries New Zealand	20/05/2019
PR/R/18711	2019	2020	Pacific Ocean - South	Common dolphin	-	-38.7535, 174.0411	-	-	-	-	-	-	-	-	1	-	-	-	WAR - common warehou	GNS	-	Fisherman	PR/C/895 | Fisheries New Zealand	20/07/2019
PR/R/18714	2019	2020	Pacific Ocean - South	Common dolphin	-	-41.4965, 174.5365	-	-	-	-	-	-	-	-	2	-	-	-	HOK - hoki	TM	-	Fisherman	PR/C/895 | Fisheries New Zealand	02/09/2019
PR/R/18717	2019	2020	Pacific Ocean - South	Common dolphin	-	-37.3378, 174.1692	-	-	-	-	-	-	-	-	3	-	-	-	JMA - jack mackerel	TM	-	Fisherman	PR/C/895 | Fisheries New Zealand	27/11/2019
PR/R/18906	2019	2020	Pacific Ocean - South	Common dolphin	-	-36.3593, 174.8177	1	-	-	-	-	-	-	-	-	-	-	-	Recreational pelagic	RG	Unknown braided line	Public	PR/C/537 | H. Hendriks (*hhendriks@doc.govt.nz*)	15/12/2019
PR/R/18909	2019	2020	Pacific Ocean - South	Killer whale	-	-36.3756, 174.8628	-	-	-	-	-	-	-	1	-	-	-	-	Rock lobster	FPO	Cray pot rope and floats	Public	PR/C/537 | H. Hendriks (as above)	14/09/19; released alive
PR/R/18912	2019	2020	Pacific Ocean - South	Common dolphin		-40.9954, 173.9628	-	-	-	-	-	-	-	-	1	-	-	-	Salmon farm	-	Fixed sea pen	Fisherman	PR/C/537 | H. Hendriks (as above)	03/07/19; dolphin entangled and drowned in salmon farm
PR/R/18915	2019	2020	Pacific Ocean - South	Killer whale	Tutukaka coast	-	-	-	-	-	-	-	-	1	-	-	-	-	Rock lobster	FPO	-	Public	PR/C/537 | H. Hendriks (as above)	23/12/2019. Reported by public and DOC dis-entanglement team responded. Partially disentangled but not seen again.

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South Africa																		
PR/R/19293	2019	2020	Indian Ocean	Indo-Pacific bottlenose dolphin	-30.00, 31.00	11	-	-	1	7	-	-	-	-	-	-	-	PR/C/1212 | M. Dicken (*matt@shark.co.za*)
PR/R/19509	2019	2020	Indian Ocean	Indian Ocean Humpback dolphin	-30.00, 31.00	2	-	-	-	-	-	-	-	-	-	-	-	PR/C/1212 | M. Dicken (as above)

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Spain																									
PR/R/16296	2019	2020	Atlantic Ocean - North	Common dolphin	-	Golfiño común	42.2776861111111, -8.82938888888889	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	PR/C/683 | DXPN (Serv Conservación Biodiversidade) Xunta de Galicia (*elisa.gago.moldes@xunta.gal*)	PR/B/810 | Footnote 1
PR/R/16299	2019	2020	Atlantic Ocean - North	Common dolphin	-	Golfiño común	42.5849388888889, -8.94966666666667	1	-	-	-	-	-	-	-	-	-	-	-	-	TX	-	-	As above	As above
PR/R/16302	2019	2020	Atlantic Ocean - North	Common dolphin	-	Golfiño común	42.568225, -8.98099166666667	-	-	-	-	1	-	-	-	-	-	-	-	-	TX	-	Pregnant female	As above	As above
PR/R/16305	2019	2020	Atlantic Ocean - North	Common dolphin	-	Golfiño común	41.9003305555556, -8.881175	-	-	-	-	1	-	-	-	-	-	-	-	-	LNS	-	-	As above	As above
PR/R/16308	2019	2020	Atlantic Ocean - North	Unid. dolphin	-	-	42.1220194444444, -8.84951944444444	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	As above	As above
PR/R/16311	2019	2020	Atlantic Ocean - North	Common dolphin	-	Golfiño común	43.7203277777778, -7.81296666666667	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	As above	As above
PR/R/17370	2019	2020	Atlantic Ocean - North	Striped dolphin	Med-iterra-nean	-	38.59702, -0.04257	-	-	-	-	1	-	-	-	-	-	-	-	Unknown	NK	Scientist	-	PR/C/141 | J.A. Raga (*toni. raga@uv.es*); PR/C/1128 | J.L. Crespo (*jlcrespo@oceanografic.org*)	-
PR/R/17376	2019	2020	Atlantic Ocean - North	Striped dolphin	Med-iterra-nean	-	38.59326, -0.03708	-	-	-	-	1	-	-	-	-	-	-	-	Unknown	NK	-	-	As above	-
PR/R/18369	2019	2020	Atlantic Ocean - North	Striped dolphin	Can-ary Isl.	Delfín listado	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	Scientist	-	PR/C/663 | A. Fernández (*antonio.fernandez@ulpgc.es*); PR/C/664 | M. Arbelo (*manuel.arbelo@ulpgc.es*)	PR/B/864 | Footnote 2
PR/R/18372	2019	2020	Atlantic Ocean - North	Common dolphin	Can-ary Isl.	Delfín común	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	Scientist	-	As above	As above

[1]Convenio De Colaboración Entre La Consellería De Medio Ambiente, Territorio Y Vivienda De La Xunta De Galicia Y La Asociación ‘Coordinadora Para El Estudio De Los Mamíferos Marinos – Cemma’, Para La Asitencia, Recuperación Y Estudio De Los Reptiles (Tortugas) Y Mamíferos Marinos Varados En El Litoral De La Comunidad Autonoma De Galicia. 2019 | Consellería de Medio Ambiente, Territorio y Vivienda + CEMMA. Unpublished.
[2]Adquisición de la información patológica y estudio de causas de muerte de los cetáceos varados en Canarias en 2019 | Centro Atlántico de Investigación de Cetáceos; Instituto Universitario de Sanidad Animal y Seguridad Alimentaria; Universidad de Las Palmas de Gran Canaria. Unpublished.

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UK																						
PR/R/18870	2019	2020	Atlantic Ocean - North	Common dolphin	UK	4	0	0	0	9	0	0	0	0	0	0	0	NK	Scientist	PR/C/247 | R. Deaville (*rob.deaville@ioz.ac.uk*)	PR/B/873 | CSIP Annual Report to UK Government for 2019 | Deaville, R. (compiler) | Unpublished	Diagnosed as bycatch from necropsies within UK strandings programme.
PR/R/18873	2019	2020	Atlantic Ocean - North	Harbour porpoise	UK	1	0	0	0	2	0	0	0	0	0	0	0	NK	Scientist	PR/C/247 | R. Deaville (as above)	PR/B/873 | As above	As above

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USA - 2018																								
PR/R/16881	2018	2020	Pacific Ocean - North	Long-beaked common dolphin	California	San Diego County	0	0	0	0	0	0	0	0	5	0	0	0	Unknown	GN	-	Scientist, observer or inspector	PR/C/501 | J. Greenman (*justin.greenman@noaa.gov*)	-
PR/R/16884	2018	2020	Pacific Ocean - North	Long-beaked common dolphin	California	Offshore	0	0	0	0	0	0	0	0	1	0	0	0	CA halibut and white seabass	GNS	-	Observer or inspector	PR/C/501 | J. Greenman (as above)	Observer gear. Set gillnet fishery
PR/R/16887	2018	2020	Pacific Ocean - North	Long-beaked common dolphin	Washington	Pacific County	0	0	0	0	0	0	0	0	1	0	0	0	Unknown	Unk.	Unidentified fishery interaction	Scientist	PR/C/501 | J. Greenman (as above)	-
PR/R/16890	2018	2020	Pacific Ocean - North	Common dolphin	California	Offshore	0	0	0	0	0	0	0	0	2	0	0	0	CA swordfish	GND	-	Observer or inspector	PR/C/501 | J. Greenman (as above)	Short-beaked common dolphin; by obser.
PR/R/16893	2018	2020	Pacific Ocean - North	Common dolphin	California	Ventura County	0	0	0	0	0	0	0	0	1	0	0	0	Unknown	GN	-	Scientist	PR/C/501 | J. Greenman (as above)	Short-beaked common dolphin
PR/R/16896	2018	2020	Pacific Ocean - North	Common dolphin	California	Orange County	0	0	0	0	0	0	0	0	0	1	0	0	Unknown	-	Marine debris	Fisherman	PR/C/501 | J. Greenman (as above)	Unid. common dolphin
PR/R/16899	2018	2020	Pacific Ocean - North	Harbour porpoise	California	Alameda County	0	0	0	0	0	0	0	0	1	0	0	0	Unknown	GN	-	Scientist	PR/C/501 | J. Greenman (as above)	-
PR/R/16902	2018	2020	Pacific Ocean - North	Harbour porpoise	Oregon	Clatsop County	0	0	0	0	0	0	0	0	2	0	0	0	Unknown	GN	-	Scientist	PR/C/501 | J. Greenman (as above)	-
PR/R/16905	2018	2020	Pacific Ocean - North	Harbour porpoise	Washington	Pacific County	0	0	0	0	0	0	0	0	1	0	0	0	Unknown	GN	-	Scientist	PR/C/501 | J. Greenman (as above)	-
PR/R/16908	2018	2020	Pacific Ocean - North	Harbour porpoise	Washington	Kitsap County	0	0	0	0	0	0	0	0	2	0	0	0	Unknown	GN	-	Scientist	PR/C/501 | J. Greenman (as above)	-
PR/R/16911	2018	2020	Pacific Ocean - North	Pacific white-sided dolphin	California	Offshore	0	0	0	0	0	0	0	0	3	0	0	0	Unknown	-	Scientific research trawl	Scientist	PR/C/501 | J. Greenman (as above)	-
PR/R/16914	2018	2020	Pacific Ocean - North	Pacific white-sided dolphin	Oregon	Offshore	0	0	0	0	0	0	0	0	2	0	0	0	Unknown	-	Scientific research trawl	Scientist	PR/C/501 | J. Greenman (as above)	-
PR/R/16917	2018	2020	Pacific Ocean - North	Unidentified dolphin	California	Offshore	0	0	0	0	0	0	0	0	1	0	0	0	CA swordfish	GND	-	Observer or inspector	PR/C/501 | J. Greenman (as above)	Observer

ID	Data year	Year submitted	Large Area	Species	Local Area (Long/Lat)	F: D	F: SI	F: I	F: FU	M: D	M: SI	M: I	M: FU	US: D	US: SI	US: I	US: FU	Fishing gear	How observed	Contacts	References
USA - 2017																					
PR/R/18348	2017	2020	Atlantic Ocean - North	Risso's dolphin	39.90974, -75.93750	-	-	-	-	-	-	-	-	5	3	-	-	LL; TBB	Observer or inspector	PR/C/1158 | E. Josephson (*elizabeth.josephson@noaa.gov*)	PR/B/825 | US Atlantic and Gulf of Mexico Marine Mammal Stock Assessment Reports 2019 | Hayes *et al.*, unpubl.
PR/R/18351	2017	2020	Atlantic Ocean - North	Long-finned pilot whale	-	-	-	-	-	-	-	-	-	-	1	-	-	LLS	Observer or inspector	PR/C/712 | L. Garrison (*lance.garrison@noaa.gov*)	As above
PR/R/18354	2017	2020	Atlantic Ocean - North	Short-finned pilot whale	-	-	-	-	-	-	-	-	-	-	14	-	-	LLS	Observer or inspector	PR/C/711 | L. Garrison (as above)	-
PR/R/18357	2017	2020	Atlantic Ocean - North	Atlantic white-sided dolphin	-	-	-	-	-	-	-	-	-	1	1	-	-	TBB	Observer or inspector	PR/C/1158 | E. Josephson (*elizabeth.josephson@noaa.gov*)	As above
PR/R/18360	2017	2020	Atlantic Ocean - North	Common dolphin	-	-	-	-	-	-	-	-	-	87	2	-	-	GNS; TBB	Observer or inspector	PR/C/1158 | E. Josephson (as above)	As above
PR/R/18363	2017	2020	Atlantic Ocean - North	Common bottlenose dolphin	-	-	-	-	-	-	-	-	-	4	-	-	-	GNS; TBB	Observer or inspector	PR/C/1158 | E. Josephson (as above)	As above
PR/R/18366	2017	2020	Atlantic Ocean - North	Harbour porpoise	-	-	-	-	-	-	-	-	-	19	1	-	-	-	Observer or inspector	PR/C/1158 | E. Josephson (as above)	As above

Fishing Gear FAO Codes

[FIX] TRAPS - Traps (not specified)
[FPN] TRAPS - Stationary uncovered pounds nets
[FPO] TRAPS - Pots
[FSN] TRAPS - Stow nets
[GEN] GILLNETS AND ENTANGLING GEAR - Gillnets and entangling gillnets (not specified)
[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
[GND] GILLNETS AND ENTANGLING GEAR - Driftnets
[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)
[GTR] GILLNETS AND ENTANGLING GEAR - Trammel nets
[LL] HOOKS AND LINES - Longlines (not specified)
[LLD] HOOKS AND LINES - Drifting longlines
[LLS] HOOKS AND LINES - Set longlines
[LNS] LIFT NETS - Shore operated stationary lift nets
[LX] HOOKS AND LINES - Hooks and lines (not specified)
[MIS] MISCELLANEOUS GEAR
[NK] GEAR NOT KNOWN OR NOT SPECIFIED
[NSC] SHARK CONTROL NETS
[OT] MIDWATER TRAWLS - Otter trawls (not specified)
[OTB] TRAWLS - Beam trawl
[OTM] MIDWATER TRAWLS - Otter trawls (side or stern)
[OTT] MIDWATER TRAWLS - Otter twin trawls
[PTM] MIDWATER TRAWLS - Pair trawls
[RG] RECREATIONAL FISHING GEAR
[SPR] SEINE NETS - Pair seines
[TBB] TRAWLS - Bottom trawls
[TM] MIDWATER TRAWLS - Midwater trawls (not specified)
[TX] MIDWATER TRAWLS - Other trawls (not specified)

Annex J

Direct Takes of Small Cetaceans in Japan by Type of Fishery and Prefecture of Departure Port, 1997-2018

Complied by Sue Burkett, IWC Secretariat

Table 1

Quotas (by season). SW=small type whaling; D=drive fishery; H=hand harpoon fishery.

		Quota													
	Prefecture	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Baird's beaked whale**		**66**	**66**	**66+1**	**66**	**67**	**66**	**66**	**66+5**	**66**	**66+4**	**66**	**66+7**	**66+3**	**66+10**
SW	Hokkaido	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SW	Miyagi/Chiba	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	Chiba	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Short-finned pilot whale (northern form)															
SW	Miyagi	36	36	36	36	36	36	36	36	36	36	36	36	36	36
Short-finned pilot whale (southern form)															**168**
SW	Chiba/Wakayama	50	36	36	36	36	36	36	36	36	36	36	36	36	33-31[$]
D	Wakayama	} 400	} 414	} 369	} 339	} 307	} 276	} 245	} 214	} 196	} 185	} 151	} 166	} 166	} 135+31[$]
H	Okinawa	}	}	}	}	}	}	}	}	}	}	}	}	}	}
Risso's dolphin															
SW	Wakayama	20	20	20	-	-	-	-	-	-	-	-	-	-	-
D	Wakayama	**} 1,280**	**} 1,280**	**} 541**	**} 532**	**} 523**	**} 514**	**} 505**	**} 496**	**} 487**	**} 478**	**} 469**	**} 460**	**} 460**	**} 460**
H	Wakayama	}	}	}	}	}	}	}	}	}	}	}	}	}	}
False killer whale															
SW	Wakayama	-	-	-	20	20	20	20	20	20	20	20	20	20	20
D	Shizuoka	}	}	}	}	}	}	}	}	}	}	}	}	}	}
D	Wakayama	} 50	} 50	} 100	} 100	} 100	} 100	} 100	} 100	} 100	} 100	} 100	} 100	} 100	} 100
H	Okinawa	}	}	}	}	}	}	}	}	}	}	}	}	}	}
Striped dolphin		**725**	**725**	**685**	**670**	**655**	**640**	**625**	**610**	**595**	**580**	**565**	**550**	**550**	**550**
D	Shizuoka	-	-	-	-	-	-	-	-	-	-	-	-	-	
D	Wakayama	-	-	-	-	-	-	-	-	-	-	-	-	-	
H	Chiba	-	-	-	-	-	-	-	-	-	-	-	-	-	
H	Wakayama	-	-	-	-	-	-	-	-	-	-	-	-	-	
Bottlenose dolphin		**1,100**	**1,100**	**1,018**	**960**	**903**	**845**	**788**	**730**	**673**	**615**	**558**	**500**	**500**	**500**
D	Shizuoka	-	-	-	-	-	-	-	-	-	-	-	-	-	
D	Wakayama	-	-	-	-	-	-	-	`	-	-	-	-	-	
H	Wakayama	-	-	-	-	-	-	-	-	-	-	-	-	-	
H	Okinawa	-	-	-	-	-	-	-	-	-	-	-	-	-	
Pantropical spotted dolphin		**950**	**950**	**879**	**835**	**788**	**742**	**697**	**651**	**606**	**560**	**515**	**470**	**470**	**470**
D	Shizuoka	-	-	-	-	-	-	-	-	-	-	-	-	-	
D	Wakayama	-	-	-	-	-	-	-	-	-	-	-	-	-	
H	Wakayama	-	-	-	-	-	-	-	-	-	-	-	-	-	
Pacific white-sided dolphin		-	-	**360^**	**360**	**360**	**360**	**360**	**360**	**360**	**360**	**360**	**360**	**360**	**360**
D	Shizuoka	-	-	-	-	-	-	-	-	-	-	-	-	-	
D	Wakayama	-	-	-	-	-	-	-	-	-	-	-	-	-	
H	Iwate	-	-	-	-	-	-	-	-	-	-	-	-	-	
H	Wakayama	-	-	-	-	-	-	-	-	-	-	-	-	-	

	Prefecture	Quota 2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Dall's porpoise (Dalli type) #		**9,000**	**9,000**	**8,708**	**8,396**	**8,084**	**7,772**	**7,460**	**7,147**	**6,837**	**6,524**	**6,212**	**5,900**	**5,900**	**5,900**
H	Hokkaido	-	-	-	-	-	-	-	-	-	-	-	-	-	
H	Aomori	-	-	-	-	-	-	-	-	-	-	-	-	-	
H	Iwate	-	-	-	-	-	-	-	-	-	-	-	-	-	
H	Miyagi	-	-	-	-	-	-	-	-	-	-	-	-	-	
Dall's porpoise (Truei type) #		**8,700**	**8,700**	**8,168**	**7,916**	**8**	**7**	**7,160**	**6,908**	**6,656**	**6,404**	**6,152**	**5,900**	**5,900**	**5,900**
H	Hokkaido	-	-	-	-	-	-	-	-	-	-	-	-	-	
H	Iwate	-	-	-	-	-	-	-	-	-	-	-	-	-	
H	Miyagi	-	-	-	-	-	-	-	-	-	-	-	-	-	
Rough-toothed dolphin													-	**40**	**40**
H	Okinawa	-	-	-	-	-	-	-	-	-	-	-	-	-	
D	Wakayama	-	-	-	-	-	-	-	-	-	-	-	-	-	
Killer whale													0	0	-
D	Okinawa	-	-	-	-	-	-	-	-	-	-	-	-	-	
Melon-headed whale								-					-	**390**	**260**
D	Wakayama	-	-	-	-	-	-	-	-	-	-	-	-	-	

**For Baird's beaked whale, carryover is permitted. Where quota is given as x+y (e.g. 66+10) the second number is the carryover from the previous season.
#The great east Japan earthquake and tsunami (11 Mar. 2011) affected the Dall's porpoise fishery area causing a drop in catch to well below pre-earthquake levels.
$Small type quota was 33 of which 2 were caught. The remaining 31 were transferred to the drive/hand harpoon fishery quota giving a drive/hand harpoon quota of 135+31=166. Thus, the total quota was 168 (=2+31+135).
^The Pacific white-sided dolphin quota was established in the 2007/08 season (see Progress Report on small cetacean research, JFA, 2008/09).

Sources	Data year	Sources	Data year
National Progress Reports submitted to the IWC	Up to 1999	**Small cetacean fisheries and resource study (in Japanese), Fisheries Research Agency:**	
Progress reports on small cetacean research, Japan Fisheries Agency:		*http://kokushi.job.affrc.go.jp/H19/H19/H19_45.pdf;* (Unable to open).	(Not available)
https://www.jfa.maff.go.jp/j/whale/w_document/pdf/h12_progress_report.pdf	2000	*http://kokushi.job.affrc.go.jp/H20/H20_45.pdf;* (Unable to open).	(Not available)
https://www.jfa.maff.go.jp/j/whale/w_document/pdf/h13_progress_report.pdf	2001	*http://kokushi.job.affrc.go.jp/H21/H21_45.pdf;* (Unable to open).	(Not available)
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h14_progress_report.pdf	2002	*http://kokushi.fra.go.jp/H22/H22_45.pdf*	2009
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h15_progress_report.pdf	2003	*http://kokushi.fra.go.jp/H23/H23_45.pdf*	2010
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h16_progress_report.pdf	2004	*http://kokushi.fra.go.jp/H24/H24_45.pdf*	2011
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h17_progress_report.pdf	2005	*http://kokushi.fra.go.jp/H25/H25_45.pdf*	2012
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h18_progress_report.pdf	2006		
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h19_progress_report.pdf	2007		
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h20_progress_report.pdf	2008		
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/110425_progress_report.pdf	2009		
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/120516_progress_report.pdf	2010		
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/130531_progress_report.pdf	2011		
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h24.pdf;	2012		
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h25.pdf	2013		
http://www.jfa.maff.go.jp/j/whale/w_document/pdf/h26.pdf	2014		
https://www.jfa.maff.go.jp/j/whale/attach/pdf/research-15.pdf	2015		
http://www.jfa.maff.go.jp/j/whale/w_document/attach/pdf/index-9.pdf	2016		
https://www.jfa.maff.go.jp/j/whale/w_document/attach/pdf/index-17.pdf	2017		
http://www.jfa.maff.go.jp/j/whale/attach/pdf/research-4.pdf	2018 + correction for 2017 (Dall's porpoise)		

Table 2

Catches (by calendar year). SW=small type whaling; D=drive fishery; H=hand harpoon fishery. The number includes whales sold alive and any used for research. If the number includes live captures, the number of live captures is given in brackets – e.g. 76(25) means 76 whales were caught of which 25 were live captures. The data sources are listed below Table 1.

		Takes																					
	Prefecture	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Baird's beaked whale **																							
SW	Hokkaido	1	2	10	10	10	10	10	10	14	12	14	13	14	14	30	14	14	14	12	12	4	1
SW	Miyagi/Chiba	26/27	26/26	26/26	26/26	26/26	26/26	26/26	26/26	26/26	25/26	27/26	25/26	27/26	26/26	5/26	31/26	26/22	26/30	21/24	25/24	14/10	25/27
H	Chiba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Short-finned pilot whale (northern form)																							
SW	Miyagi	50	35	60	50	47	47	42	13	22	7	-	-	-	-	-	-	-	-	-	-	-	-
Short-finned pilot whale (southern form)																							
SW	Chiba/Wakayama	5/22	3/46	13/31	7/49	4/36	1/35	-/27	-/29	-/24	-/10	-/16	-/20	-/22	-/10	-/-	1 / 15	-/10	1 / 2	5 / 15	3 / 2	2/-	2/-
D	Wakayama	204	84	211	109	212 (2)	55	55	62	40 (2)	198 (8)	243 (5)	99 (1)	219 (1)	-	74 (6)	172 (7)	88 (1)	41 (2)	80	41	57	-
H	Okinawa	66	61	79	89	92	38	36	72	90	56	79	62	54	34	46	25	47	18	9	21	22	7
Risso's dolphin																							
SW	Wakayama	20	20	12	20	17	12	19	7	8	7	20	-	-		-	-	-	-	-	-	-	-
D	Wakayama	60	160 (3)	250	367	353 (3)	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	118	227
H	Wakayama	148	265	227	119	107	154	168	60	46	105	185	122	94	126	104	52	38	103	13	1	7	-
False killer whale																							
SW	Wakayama	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	1	3	-	-	-	-
D	Shizuoka	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	Wakayama	40 (15)	40 (3)	-	-	29 (11)	7	17 (5)	-	-	30 (24)	-	-	-	-	17 (10)	-	-	-	-	-	-	-
H	Okinawa	3	8	5	8	8	-	4	3	1	5	4	5	1	-	3	-	-	-	1	-	2	-
Striped dolphin																							
D	Shizuoka	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
D	Wakayama	545	376	520	235	418	565	382	554	397 (2)	479	384	533 (5)	321	458 (2)	406 (8)	508 (2)	498 (1)	367	353	625	299	435
H	Chiba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
H	Wakayama	57	73	76	65	66	77	68	83	60	36	86	65	98	100	96	94	67	63	22	10	18	1
Bottlenose dolphin																							
D	Shizuoka	-	-	77 (6)	-	-	-	-	24(15)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	Wakayama	287 (53)	164 (21)	596 (85)	1,339 (68)	207 (12)	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	127	97
H	Wakayama	57	95	68	79	44	38	52	43	66	75	97	93	77	38	40	73	68	35	43	11	47	12
H	Okinawa	8	7	8	8	8	3	7	10	10	12	4	1	4	1	3	3	3	-	-	5	3	2
Pantropical spotted dolphin																							
D	Shizuoka	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	Wakayama	-	397	-	27	-	400	102	-	-	400 (13)	-	329 (6)	-	125 (16)	106 (2)	98	126 (45)	145 (35)	59	20	17	-
H	Wakayama	23	63	38	12	10	18	30	2	13	5	16	-	3	7	2	12	4	18	-	2	27	-
Pacific white-sided dolphin																							
D	Shizuoka	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
D	Wakayama	-	-	-	-	-	-	-	-	-	-	-	21 (16)	14 (13)	27 (17)	24 (21)	2 (2)	39 (29)	5 (4)	7	6	21	19
H	Iwate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	Wakayama	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	2	-	-	-	-	-	-

		Takes																					
	Prefecture	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Dall's porpoise (Dalli type) #																							
H	Hokkaido	999	994	670	1,203	1,413	1,328	1,655	647	1,240	719	841	467	308	116	-	-	-	-	-	-	17	-
H	Aomori	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	Iwate	7,433	4,116	5,632	6,106	6,960	6,057	6,427	3,796	5,394	3,312	2,975	1,947	1,362	1,140	89	29	77	14	11	1	5	-
H	Miyagi	99	193	77	204	57	229	226	171	246	181	254	180	103	-	-	-	18	2	4	-	2	-
Dall's porpoise (Truei type) #																							
H	Hokkaido	31	69	57	69	100	89	84	66	51	44	44	66	-	2	-	-	-	-	-	-	-	-
H	Iwate	9,976	6,013	8,371	8,589	8,120	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	1,057	1,342	864
H	Miyagi	-	-	-	-		3	3	-	-	-	-	-	-	129	8	-	-	32	28	1	22	15
Rough-toothed dolphin																							
H	Okinawa	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	Wakayama	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27	6
Killer whale																							
D	Okinawa	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Melon-headed whale																							
D	Wakayama	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	156	110

Annex K

Intersessional E-mail Groups

This list contains the intersessional groups identified at SC68B. 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/68B. 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 SC68B.

(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
Item 8.1. IA	SG-1	North Pacific humpback whales	Further the preparations for the North Pacific humpback whale Comprehensive Assessment, including organize an intersessional meeting.	Clapham (Convenor), Baker, Calambokidis, Cheeseman, Donovan, Katsumata, Kitakado, Ivashchenko, Matsuoka, Mizroch, Palka, Punt, Urbán, Wade, Weinrich, Yoshida, Zerbini. E-mail: *nphumpack@groups.iwc.int*
Item 8.1.2 IA	SG -2	North Pacific sei whales	Continue progress on developing the North Pacific sei whale Comprehensive Assessment.	Cooke (Convenor), Allison, Butterworth, Kitakado, Matsuoka, Mizroch, Palka, Punt, Walløe, Yoshida. E-mail: *npsei@groups.iwc.int*
Item 8.1.3 IA	SG-3	WNP common minke whales	Further the preparations for the western North Pacific common minke whales In-depth Assessment, including organize an intersessional meeting.	Donovan, (Convenor), Allison, Butterworth, de Moor, Hakamada, Kishiro, Kitakado, Palka, Punt, Tiedeman, Walløe, Wilberg. E-mail: *wnpminke@groups.iwc.int*
Item 8.1.4 IA	ICG-4	NA humpback whales	Identify and evaluate data available for a potential future assessment of North Atlantic humpback whales.	Robbins (Convenor), J. Allen, Allison, Cholewiak, Clapham, Donovan, Jones, Lang, Mallette, Mattila, Øien, Palka, Palsbøll, Punt, Rosenbaum, Tiedemann, Weinrich, Wilberg, Witting. E-mail: *nahmpback@groups.iwc.int*
Item 8.2.4 NH	ICG-5	NP blue whales	Locate and/or analyse data on abundance, catches and stock structure to prepare for a future assessment.	Branch (Convenor), Allison, Brownell, Clapham, Ivashchenko, Matsuoka, Mizroch, Monnahan, Olson, Palacios, Širović, Sremba. E-mail: *npbwa@groups.iwc.int*
Item 8.2.5 NH	ICG-6	NA sei whales	Continue to identify and evaluate data on distribution, abundance, stock structure and catches, with a particular focus on the western North Atlantic.	Cholewiak (Convenor), Allison, Breiwick, Brownell, Mallette, Mizroch, Palka, Robbins, Víkingsson, Weinrich. E-mail: *nasei@groups.iwc.int*

SC Agenda Item Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 15.1 E	SG-7	Pollution	Planning activities and work priorities for Pollution 2025 (SC68C).	Holm (Convenor), Cholewiak, Domit, Donovan, Fernandez, Kershaw, Plön, Rowles, Simmonds, Staniland, S. Smith, Stimmelmayr, Stockin, Schwacke, Tulloch. E-mail: *pollution@groups.iwc.int*
Item 15.2 E	SG-8	Diseases of concern	Planning focus session for 2021 (SC68C).	Stimmelmayr (Convenor), Fernández, M. Grigg, Gulland, G. Hernandez, Kershaw, Mazzariol, Rowles, Sacristan, Sierra Pulpillo, S. Smith. E-mail: *diseasesofconcern@groups.iwc.int*
Item 15.4 E	ICG-9	Noise	Advance underwater noise topics of interest, including collaboration with the Conservation Committee and consideration of IMO MEPC outcomes on noise.	Cholewiak, Leaper (Convenors), Burkhardt, Cerchio, Genov, Lundquist, Reyes, Ritter, Rosenbaum, Simmonds, Širović, Smith, Sutaria, Torres, Webster, Williams. E-mail: *noiseicg@groups.iwc.int*
Item 15.5.1 E	ICG-10	Marine debris	Follow up on the recommendations from the WS and monitor the issue.	Simmonds (Convenor), Baulch, Donovan, Eisfeld, Fossi, Genov, Holm, Long, Marcondes, Mattila, Nunny, Pierantonio, Rowles, S. Smith, Sutaria, Svoboda, Tulloch, Williams. E-mail: *marinedebris@groups.iwc.int*
Item 15.5.2 E	SG-11	Climate change	Planning workshop on climate change 2020/21.	Simmonds (Convenor), Donovan, Frey, Holm, Kitakado, Leaper, Nunny, Palka, Stachowitsch, Staniland, S. Smith, Trujillo, Webster. E-mail: *climatechange@groups.iwc.int*
Item 15.2 EM	ICG-12	Best practices for multi-species distribution modelling (MSDM)	(1) to finalize the guidelines for single species distribution models (SDMs); (2) to conduct a literature review of multi-species distribution models (MSDMs); and (3) to develop possible simulation platforms to evaluate these models.	Kitakado (Convenor), Biuw, Burkhardt, Friedlaender, Genov, Herr, Kelly, McKinlay, Miller, Murase, New, Palacios, Palka. E-mail: *msdm@groups.iwc.int*
Item 15.3 EM	ICG-13	Development of individual-based energetics models (IBEMs)	(1) to further develop individual-based energetics models (IBEMs), inter alia for progressing the emulator model to use in RMP trial specifications; (2) to discuss new strategies for model development that utilize new data; and (3) to infer functional responses using an IBEM for rorqual foraging dives.	Friedlaender (Convenor), Biuw, Cooke, de la Mare, Donovan, Kitakado, Palacios, Palka. E-mail: *ibems@groups.iwc.int*
Item 15.4.1 EM	ICG-14	Effect of long-term environmental variability on whale populations	Compile a literature review on the subject of how environmental variability may affect whale populations.	Cooke (Convenor), Butterworth, de la Mare, Friedlaender, Kitakado, Palacios, Tulloch. E-mail: *eltevwp@groups.iwc.int*
Item 15.1.1	SG-15	Cetacean and ecosystem functioning: a gap analysis workshop	Prepare a Workshop under a Steering Group.	Ritter (Convenor), Biuw, Butterworth, Cavanagh, Donovan, Frisch, Ferris, Galletti, Haug, Kitakado, McKinlay, Punt, Roman, Smith, Suydam. E-mail: *cefgapanawksp@groups.iwc.int*

SC Agenda Item Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 17.1.2 WW	SG-16	Modelling and Assessment of Whale Watching Impacts (MAWI) Steering Group	Planning for the questionnaire and potential workshop.	New (Convenor), Baldwin, Cook, Cosentino, Currie, Forestell, Frey, Jiménez-Assmus, Leaper, Minton, Noren, Parsons, Reyes, Robbins, Rose, C. Smith, S. Smith, Vermeulen, Weinrich. E-mail: *modassmawi@groups.iwc.int*
Item 17.1 WW	ICG-17	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, Currie, Fonseca, Forestell, Minton, Parsons, Vail, Wells. E-mail: *hibcc@groups.iwc.int*
Item 17.1 WW	AG-18	Communication with the Indian Ocean Rim Association (IORA) Advisory Group	Help provide advice to IORA when appropriate; facilitate communication between IORA and the sub-committee; and consider ways to promote appropriate training workshops.	Smith, S. (Convenor), Baldwin, Iñíguez, New, Parsons, Simmonds, C. Smith, Weinrich. E-mail: *commiora@groups.iwc.int*
Item 18 WW	ICG-19	Timor-Leste whale watching	Address the outcomes of the scheduled meeting in 2021 between the Government of Timor-Leste and Committee members and to draft comments on the Timor-Leste draft guidelines for whale watching.	New and Porter (co-Convenors), Noren, Parsons, Rose, Ritter. E-mail: *timorlesteww@groups.iwc.int*
Item 18.3.2 WW	ICG-20	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, Porter, Rojas-Bracho. E-mail: *riverdolphnint@groups.iwc.int*
Item 11 ASI	SG -21	Abundance Steering Group	(1) Coordinate the intersessional review of abundance estimates by the ASI SWG. (2) Appoint expert small group to conduct review of abundance estimates required for next year's meeting.	Zerbini (Convenor), Allison, Donovan, Givens, Jackson, Kitakado, Palka, Robbins, Staniland, Suydam, Walløe. E-mail: *reviewofae@groups.iwc.int*
Item 11.1.4 ASI	SG-22	Franciscana abundance review group	(1) Coordinate the intersessional review of franciscana abundance estimates. (2) Produce a report of the review for presentation next year.	Zerbini (Convenor), Andriolo, Cañadas, Cremer, Crespo, Danilewicz, Domit, Doniol-Valcroze, Donovan, Ferguson, Fortuna, Herr, Miller, Sucunza, Palka. E-mail: *franciscanaarg@groups.iwc.int*
Item 11.3 ASI	SG-23	Amendment of RMP Guidelines	Develop a set of specific instructions for the amendment of the RMP guidelines to consider model-based abundance estimates.	Fortuna (Convenor), Butterworth, Cooke, Donovan, Herr, Kelly, Kitakado, Miller, Palka, Punt, Staniland, Zerbini. E-mail: *rmpguidelines@groups.iwc.int*

SC Agenda Item Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 11.4 ASI	SG-24	Advice on Status of Stocks	Use the existing guidelines for the provision of advice to the Commission on status of stocks to develop a draft report for review by the Committee at SC68C for the species/regions identified.	Donovan (Convenor), Allison, Branch, Brownell, Butterworth, Cooke, Givens, Jackson, Palka, Porter, Punt, Staniland, Suydam, Trujillo, Walløe, Zerbini. E-mail: *status@groups.iwc.int*
Item 11.6 ASI	ICG-25	NP minke abundance	(1) Review the applicability of the accepted $g(0)$ estimate to other cruises. (2) Try to develop robust estimates for use in the in-depth assessments and/or to provide management advice and/or to provide broader estimates for the public.	Kitakado (Convenor), Allison, Butterworth, Donovan, Hakamada, Kelly, Matsuoka, Miyashita, Palka, Punt. E-mail: *npminkeabun@groups.iwc.int*
Item 9.1 SM/CMP	ICG-26	Franciscana CMP	Co-ordinate presentation of CMP projects across sub-committees.	Iñíguez (Convenor), Brito-Junior Santos, Cremer, Crespo, Cunha, Di Tullio, Domit, Macondes, Ott, Pasadore, Secchi, Siciliano, Torres-Florez, Trujillo, Zerbini. E-mail: *franciscana@groups.iwc.int*
Item 16 SM	ICG-27	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, Ingram, Jiménez, Parsons, R. Reeves, Simmonds, Trujillo. E-mail: *pdtsc@groups.iwc.int*
Item 16 SM	AG-28	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), Genov, Porter, R. Reeves, Rojas-Bracho, Staniland, Thomas, Tarzia, Trujillo. E-mail: *smallcetaceantaskteam@groups.iwc.int*
Item 16 SM	ICG-29	*Sotalia guianensis*	Continue to compile relevant information on *Sotalia guianensis* to provide an action plan and recommendations to the Scientific Committee.	Domit (Convenor), Caballero, Porter, Torres-Florez, Trujillo, Zerbini. E-mail: *sotaliaworkshop@groups.iwc.int*
Item 16 SM	ICG-30	Africa-Focused Sousa Task Team	To identify and study, as a matter of urgency, high priority areas and populations of Sousa in Africa and start working towards developing a comprehensive framework of conservation actions.	*No Convenor identified* Andrianarivelo, Atkins, Ayissi, Bamy, Berggren, Bilal, Bjorne, Braulik, Cerchio, Cockroft, Collins, Debrah, Dossou-Bodjrenou, Dulau, Fogwan Nguedia, Hodgins, Keith-Diagne, Kema, Leeney, Minton, Mwangombe, Ndong, Perez, Plön, Porter, Segniagbeto, Sohou, Spilsbury, Takoukam, Tarzia, Tchibozo, Trujillo, Van Waerebeek, Vermeulen, Weir. E-mail: *Sousa_tt@groups.iwc.int*

SC Agenda Item Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 16 SM	ICG-31	Asian River Dolphin Task Team	To assess emerging issues from across the range of the genus Platanista with a view to providing timely advice to the Task Team Steering Group.	Kelkar, Sutaria (co-Convenors), Alom, Arshad, Braulik, Paudel, Thakuri, Tarzia. E-mail: *Asianriverdoltt@groups.iwn.int*
Item 16 SM/CMP	ICG-32	South American River Dolphins	Examine the scientific aspects of the proposed CMP for South American river dolphins.	Brownell. E-mail: *sarivdol@groups.iwc.int*
Item 16 SM	ICG-33	SM Review of Recommend-ations	Develop a strategy to review the past recommendations of the SM Sub-Committee so that they are current relevant and prioritised and conform to the new SC recommendation format.	Porter (Convenor), Di Tullio, Jiménez, Scheidat, Simmonds, Suydam, Zerbini. E-mail: *smrevrec@groups.iwc.int*
Item 16 SM	ICG-34	Lahille's Dolphin Task Team	(1) Coordinate regional efforts; (2) work cooperatively with fishing communities and fisheries authorities to reduce bycatch; and; (3) explore possible synergies with the Franciscana CMP.	Fruet (Convenor), Tarzia. E-mail: *lahilles@groups.iwc.int*
Item 10.2 SD&DNA	ICG-35	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, Waples. E-mail: *dnaquality@groups.iwc.int*
Item 10.3 SD&DNA	ICG-36	Sample depletion	Discuss and provide recommendation on genomic approaches to maximise the utility of tissue samples, particularly those in danger of depletion.	Lang (Convenor), Archer, Baker, Bickham, Buss, Carroll, Hoelzel, Goto, Jackson, Morin, Palsbøll, Robertson, Sremba, Taguchi, Tiedemann, Torres-Florez. E-mail: *sampledepletion@groups.iwc.int*
Item 10 SD&DNA	ICG-37	Gray whale population structure	To clarify the terminology used to describe the gray whale stock structure hypotheses; and to re-evaluate the plausibility of the hypotheses, including consideration of adding new variants if needed, to inform the Range-wide Review of the Status and Population Structure of gray whales.	Lang (Convenor), Bickham, Donovan, Hoelzel, Goto, Pampoulie, Punt, Scordino, Tiedemann, Weller. E-mail: *graypopstruct@groups.iwc.int*
Item 10 SD&DNA/SM	ICG-38	Franciscana population structure	Summarize the data available from other (i.e., non-genetic) lines of evidence that could be used to infer population structure; evaluate the level of support for each of the proposed subdivisions based on this combined data and provide advice on future work (additional analyses, sample collection efforts) to address remaining questions.	Lang and Ott (Co-Convenors), Andriolo, Cipriano, Cunha, Farro, Gariboldi, Hoelzel, Mendez, Pampoulie, Oliveira, Passadore, Secchi, Tiedemann, Torres-Florez, Zerbini. E-mail: *franciscanapopstruct@groups.iwc.int*
Item 10 SD&DNA/SM	ICG-39	*Sotalia guianensis* population structure	Review genetic and other evidence relating to population structure in *Sotalia guianensis*; provide advice on the proposed management unit delineations.	Lang and Caballero (Co-Convenors), Archer, Baker, Briceño, Cipriano, Cunha, Domit, Fruet, Natoli, Tiedemann, Torres-Florez, Zerbini. E-mail: *sotaliapopstruct@groups.iwc.int*

SC Agenda Item Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 6.2 SD&DNA	ICG-40	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, Hoelzel, Lang, Scordino. E-mail: *terminology@groups.iwc.int*
Item 8.2.1.6 SH	ICG-41	SH mark recapture	Advise on construction and analysis of southeast Pacific, southeast Indian Ocean and southwest Pacific mark recapture datasets, including timespan, regions to include, and modelling framework.	Jackson (lead), Barlow, Butterworth, Cooke, Double, Findaly, Galletti, Gill, Jenner, Möller, Olson, Salgado-Kent, Torres-Florez, Weinrich, Zerbini. E-mail: *shmarkre@groups.iwc.int*
Item 8.2.2.1 SH	ICG-42	Antarctic blue whale song	Low- and mid-latitude analysis of Antarctic blue whale song to establish any differences between wintering grounds.	Buchan (lead), Barlow, Branch, Cerchio, McCauley, Miller, Samaran, Shabangu, Širović, Stafford, Torres. E-mail: *antbluesong@groups.iwc.int*
Item 8.2.3.4 SH	ICG-43	Southern right whale calls	Assess what southern right whale call data exists offshore and at high latitudes (including both IMOS and SOHN data), and consider an appropriate analysis framework for using these data to assess southern right whale offshore distribution.	Širović (lead), Burkhardt, Calderan, Carroll, Charlton, Findlay, Friedlaender, Leaper, McCauley, Miller, Reyes Reyes, Vermeulen, Ward, Webster. E-mail: *srightcalls@groups.iwc.int*
Item 8.2.3.5 SH	ICG-44	Southern right whale modelling	Progress towards development of a common population modelling framework for Southern right whale calving grounds, to assess common: (1) population dynamics patterns; and (2) environmental drivers.	Charlton (Convenor), Agrelo, Brandão, Butterworth, Carroll, Cooke, Double, Groch, Leaper, Rayment, Ross-Gillespie, Rowntree, Seyboth, Sironi, van den Berg, Vermeulen, Watson. E-mail: *sright@groups.iwc.int*
Item 8.2.3.5 SH	ICG-45	Southern right whale condition	Develop a global, standardized southern right whale body condition and visual health assessment protocol for IWC endorsement.	Christiansen, Vermeulen (co-Convenors), Charlton, Findlay, Leslie, Minton, Moore. E-mail: *srightcond@groups.iwc.int*
Item 8.2.3.5 SH	ICG-46	Southern right whale catch data	Assess if there is any unpublished regional catch data for southern right whales held in Best, Bannister and Dawbin archives in South Africa and Australia respectively. Compile new SRW catch series and update regional catch estimates.	Jackson (Convenor), Allison, Carroll, Charlton, Double, Findlay, Kemper, Paton, Vermeulen, Zerbini. E-mail: *srightdata@groups.iwc.int*
Item 12 HIM	ICG-47	BMIS review	To assist Tarzia and the Expert Panel in addressing the requested review by BMIS including: (i) review of each mitigation technique description relevant to cetaceans; (ii) advice on prioritising cetacean mitigation techniques according to gear type; and (iii) review of descriptions of cetacean interactions by fishing gears/methods employed in pelagic tuna and billfish fisheries.	Tarzia (Convenor), Baird, Dolman, Heinemann, Hines, Rojas-Bracho, Slooten, Sutaria. E-mail: *bmisrev@groups.iwc.int*

SC Agenda Item Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 12 HIM	ICG-48	Review of methodology to assess RFMO bycatch	Provide advice to Elliot on methodology to assess involvement of tuna RFMOs in addressing cetacean bycatch.	Elliot, Tarzia. E-mail: *revmethrfmobycatch@groups.iwc.int*
Item 13 HIM	ICG-49	Ship Strikes Data Review Group	To continue to assist the Ship Strike Co-ordinators in reviewing cases submitted to the IWC global database and to provide advice on how to reduce the backlog of cases.	Leaper (Convenor), Brownell, Cañadas, Donovan, Double, Herr, Holm, Mattila, Panigada, Ritter, Rowles, Weinrich. E-mail: *ssdatareview@groups.iwc.int*
Item 13 HIM	ICG-50	Ships Routeing Group	Consider how best to respond to requests for advice on routeing measures.	Leaper (Convenor), Bjørge, Donovan, George, Mattila, Panigada, Rojas-Bracho, Webster. E-mail: *shipsrouteing@groups.iwc.int*
Item 13 HIM	ICG-51	Database publications and public summary	Consider options for dissemination/ publication of summary data from the ship strikes database.	Ritter (Convenor), Leaper, Panigada, Staniland, Wilson. E-mail: *dbpubs@groups.iwc.int*
Item 13 HIM	ICG-52	Review of WWF shipping report	Provide critical review of the report, technical input and assessment of whether it would be useful outreach material for IWC.	Minton (Convenor), Collins, Hines, Leaper, Scheidat, Willson, Weinrich. E-mail: *revwwf@groups.iwc.int*
Item 21.1 ASI	SG-53	IWC POWER-SOWER	To provide advice on the 2020/21 IWC-POWER cruises (including holding the Planning Meetings), on data analyses, storage and on requests for data/sample use of IWC-POWER/SOWER cruises.	Matsuoka (Convenor), Bravington, Brownell, Clapham, Donovan, Kato, Kelly, H-W. Kim, Kitakado, Miyashita, Murase, Palka, Pastene, Staniland, Wade, Zerbini, Zharikov. E-mail: *iwcpowersower@groups.iwc.int*

Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG)

Tokyo, Japan, 18-19 January 2020

Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG), January 2020[1]

The meeting was held at the Japanese Fisheries Agency Crew House, Tokyo, from 18-19 January 2020. The list of participants is given as Annex A.

1. INTRODUCTORY ITEMS

1.1 Opening remarks and welcoming address

Matsuoka (Convenor) opened the meeting and welcomed the participants, especially those from abroad. He called for a minute's silence in remembrance of Seiji Ohsumi who had been a key contributor to the IDCR/SOWER programme, predecessor to the IWC-POWER programme, as well as the POWER programme itself and who has been an important member of the IWC's Scientific Committee for many decades.

Moronuki (Fisheries Agency of Japan) also welcomed the participants to Tokyo. He noted that the IWC-POWER programme, with its broad coverage of the North Pacific Ocean and with participation of experts from a number of countries, has made a substantial contribution to the development of scientific knowledge and evidence for proper conservation and management of large whales in the North Pacific. Given its outstanding scientific significance and development, Japan is proud of having co-sponsored the IWC-POWER programme over the last ten years. Although it has now left the IWC, Japan is willing to continue the IWC-POWER programme under a co-operative relationship with the IWC Scientific Committee and its scientists and is looking forward to discussing the future direction of the programme.

On behalf of the IWC, Donovan reiterated that the IWC-POWER programme represents an important component of international cooperation within the IWC. Scientists from Australia, Japan, Republic of Korea, Mexico, UK and the USA have contributed to the design and implementation of the programme thus far, in addition to the contribution of the Scientific Committee and the Commission. Of course, none of this would be possible without the extremely generous donation each year of a vessel and crew by Japan. He noted that in terms of data availability, data from IWC cruises are available to Scientific Committee members upon request. He also noted that for both the IWC-SOWER and IWC-POWER cruises, Japan has always held all of the data as well as shared the biopsy samples. He saw no reason to change this co-operative approach even though Japan was no longer a member of the IWC.

1.2 Election of Chair

Kitakado was elected Chair with Matsuoka as co-Chair.

1.3 Adoption of Agenda

The adopted Agenda is given as Annex B.

1.4 Appointment of rapporteurs

Palka and Crance were appointed rapporteurs, assisted by Donovan and Matsuoka.

1.5 Review of documents

The list of documents is given as Annex C.

2. REVIEW OF THE SURVEY RESULTS FROM 2010-19

2.1 Summary of survey results including 2019

Fig. 1 shows a map of the survey areas covered since 2010.

2.2 Review of Scientific Committee recommendations

The TAG reviewed the recommendations of the Scientific Committee relevant to the IWC-POWER cruises and these are referred to where relevant under the agenda items below. It was noted that the budget cut implemented by the Commission this year allowed for cruises in 2019 and 2020 but achieved this by using reserve funds previously allocated to additional cruise-related work (e.g. the development of the long-term database and some work on photo-identification validation). This is discussed further below under the relevant agenda items.

2.3 Other relevant sighting surveys

2.3.1 Russian waters

No new information was received this year. The previous TAG report (IWC, 2020a) summarised Russian sightings surveys that took place from 2015-17.

[1]Presented to the Scientific Committee as SC/68B/REP/01.

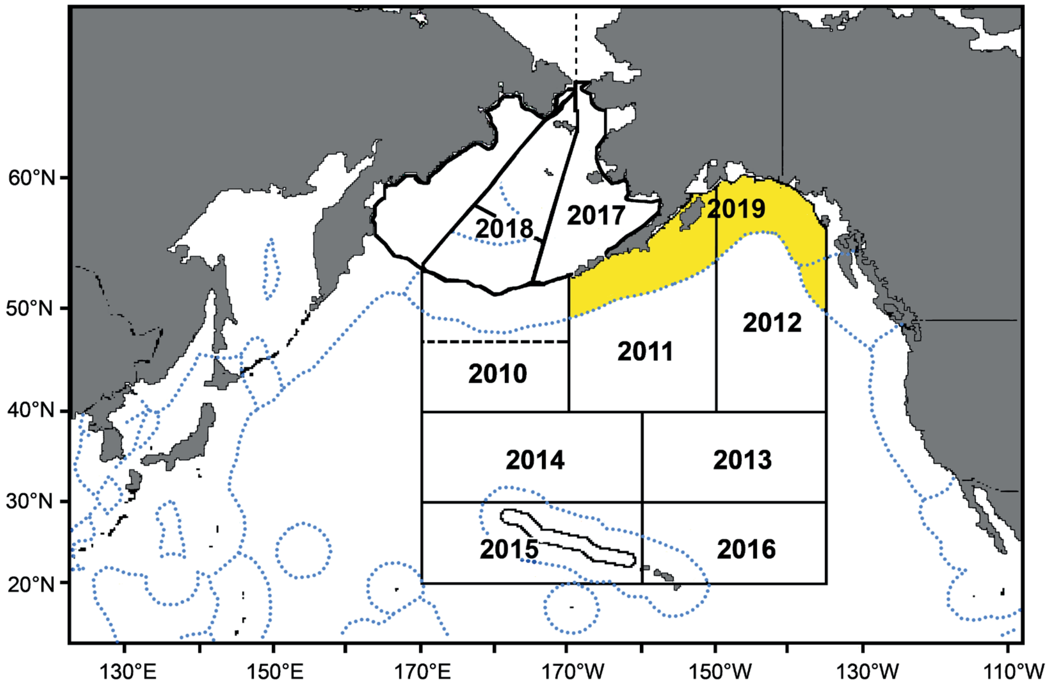

Fig.1. Research areas covered by IWC-POWER 2010-19 (EEZ shown by blue dotted line).
The yellow highlighted area is the most recently surveyed.

Recommendation
The TAG **reiterated** *the importance of surveys in Russian waters to the objectives of IWC-POWER and* **requested** *updates of any survey work undertaken in Russian waters in 2018 and 2019. It encouraged Russia to consider incorporating its cruises as part of the IWC-POWER programme in the future.*

2.3.2 Korean waters
No new information was received and a paper is expected to be presented at SC68B. The proposed schedule for sightings cruises by Korea has been included as part of the *Implementation Review* for common minke whales (IWC, 2020b).

Recommendation
The TAG **looked forward** *to updates of work undertaken in Korean waters at SC68B and* **encouraged** *Korea to consider incorporating its cruises as part of the IWC-POWER programme.*

2.3.3 Other waters
Although no other countries provided information directly to the TAG meeting it was noted that: (a) researchers from the Pacific Islands Fisheries Science Center are embarking on a winter research cruise to study cetaceans and seabirds around the main Hawaiian Islands aboard the NOAA Ship *Oscar Elton Sette* from January to March, a time of year not previously studied; and (b) there is also a proposal for a US cruise in the Gulf of Alaska in 2022.

3. OBJECTIVES AND PRIORITIES

3.1 Long-term
The IWC agreed (IWC, 2012a) that the long-term IWC-POWER programme:

> *'will provide information to allow determination of the status of populations (and thus stock structure is inherently important) of large whales that are found in North Pacific waters and provide the necessary scientific background for appropriate conservation and management actions. The programme will primarily contribute information on abundance and trends in abundance of populations of large whales and try to identify the causes of any trends should these occur. The programme will learn from both the successes and weaknesses of past national and international programmes and cruises, including the IDCR/SOWER programme.'*

Table 1

Suggestions for updated medium-term priorities based upon results from Phase 1 for IWC-POWER (*refers to likelihood of obtaining an abundance estimate at least in some areas; **refers to likelihood of obtaining biopsy and/or photo-ID data from encountered schools).

Initial priority/feasibility	Rationale/comments
Blue whale (High) Medium direct*, high opportunistic**	• Depletion level (i.e. highly depleted based on catch history). • Initial abundance estimates from IWC-POWER (still being finalised) suggest it remains heavily depleted. • Results of analyses of existing samples (27 IWC-POWER samples available) in conjunction with other samples (e.g. samples collected under Japanese national programmes) important in addressing population structure in context of idea/scope of occasional focussed cruises, especially samples from the west (see (4) below). • Potential for some blue whale focussed cruises in specific areas (including directional acoustics) should be considered (e.g. Gulf of Alaska) as well as continuing opportunistic studies. • Continued collaboration with existing photo-id work e.g. US and Japanese national programmes is important (42 individuals available from IWC-POWER) – and Japan west existing samples. • Consider telemetry studies.
Fin whale (High) High direct*, high opportunistic**	• Depletion level (i.e. high based upon catch history). • Initial abundance estimates from IWC-POWER (still being finalised) suggest some recovery. • Results of genetic analyses important to contribute to future survey strategy and future Comprehensive Assessment (e.g. is there evidence of more than one stock from the existing 124 biopsy samples that cover waters from 170°E to 135°W?). • Work in Russian Federation waters provided appropriate permits can be obtained is important. • Co-ordination with national programmes in Japan, Korea and USA needed including existing samples.
Right whale (High) Medium direct*, high opportunistic**	• Depletion level: (i.e. highly depleted based on catch history). • Still critically low numbers in east (from US studies and IWC-POWER). • Feasibility of collecting biopsy and photo-ID data high if targeted and using acoustics. • Feasibility of obtaining abundance in east from line-transect low given such small numbers; may be much higher in west e.g. Sea of Okhotsk and southeast of Kamchatka Peninsula where population is at least 10X larger or more. • Although new area, consideration should be given to a targeted survey in Sea of Okhotsk - high feasibility and priority to obtain good abundance, photo-id and biopsy data provided appropriate permits can be obtained from the Russian Federation.
Sei whale (Medium) High direct*, high opportunistic**	• Depletion level: (i.e. high based on catch history). • Initial abundance estimates from IWC-POWER (still being finalised) and Japan suggest some recovery. • IWC-POWER has provided valuable information for the ongoing Comprehensive Assessment (the 2020 backup cruise will provide biopsy samples from a poorly covered area). • Results of that CA will help focus future IWC-POWER medium-term strategy and priority for this species - e.g.: (a) possible focussed biopsy sampling in postulated coastal stock areas; and (b) frequency and scope dedicated abundance surveys in ‘pelagic’ area to examine trends.
Humpback whale (Medium) High direct*, high opportunistic**	• Good information already available from SPLASH and national programmes suggests overall high abundance (genetic and photo-ID mark-recapture) hence medium priority. • Continue to contribute to existing genetic and photo-ID databases. • Ongoing Comprehensive Assessment will assess status and potential depletion of [sub-] populations. • Abundance estimates from IWC-POWER (still being finalised) can provide interesting ‘snapshot’ estimates to compare with mark-recapture estimates by population/feeding aggregation. • The results of the CA will assist in developing medium-term strategy and priority for this species within IWC-POWER.
Sperm whale (Medium) Medium direct* and medium opportunistic**	• Depletion level: (unknown but possibly high given catch history). • Lack of good information on population structure and status at present although good distributional data from IWC-POWER. • Obtaining abundance estimates from visual surveys can be problematic due to long dive times and other issues. • Combined acoustic (towed array)/visual surveys have been successful for sperm whales however feasibility in the context of IWC-POWER depends on availability of equipment and practicality in light of other priorities. • Possibility of using towed acoustic arrays in some years should be considered.
Gray whale (Medium) Low direct*, high opportunistic**	• There are ASW hunts but that primary data sources to evaluate those are from other visual, genetic and photo-ID programmes (e.g. US, Mexico, Sakhalin Island) – hence medium priority. • Main IWC-POWER contribution is in obtaining biopsy/photo-ID in areas outside those programmes for comparison and information on population structure. • Sharing of data with other programmes should continue.
Bryde’s whale (Medium) High direct*, high opportunistic**	• Suggest low priority for first six or so years of next phase of POWER because: - recently completed IR shows good population status and apparently low level of threats; and - removing from target species allows a great reduction in size of priority research area to north of 40°N. • If required, a targeted survey or surveys could be designed towards end of 10-year period (e.g. from 2027).
Common minke whale (Low) Suggest only opportunistic	• Depletion level (probably low east/central based upon catch history) and in west dealt with by national programmes. • However, if Okhotsk Sea is able to be covered for high priority species (e.g. right whales) then would provide valuable information incl. biopsy samples. • If permission granted by Russian Federation then consider modifying present ‘acceptable’ conditions as at the present high range they are unsuitable for estimating abundance for this species.

Table 2

Summary of biopsy work undertaken during 2010-19 cruises, including transit surveys between Japan and the research areas (number of individuals sampled).

Biopsy	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Blue whale	1	4	2	0	1	0	1	0	6	12	27
Fin whale	2	12	12	1	0	0	0	28	24	45	124
Sei whale	13	31	36	0	0	0	1	0	0	4	85
Bryde's whale	0	0	0	6	78	34	16	0	0	0	134
Common minke whale	0	0	0	0	0	0	0	0	0	0	0
Humpback whale	0	1	0	0	0	0	0	18	29	12	60
North Pacific right whale	0	0	0	0	0	0	0	3	3	0	6
Gray whale	0	0	0	0	0	0	0	9	7	2	18
Sperm whale	0	0	0	0	0	1	5	0	0	0	6
Killer whale	2	0	1	0	1	2	0	2	7	0	15
Total	18	48	51	7	80	37	23	60	76	75	475

Table 3

Status of the biopsy samples collected from 2010-19 including during transit between Japan and the research areas. SWFSC=Southwest Fisheries Science Center; ICR=Institute of Cetacean Research.

Analysts	Status/comments	References
Blue whale (*n*=27)		
SWFSC	Mitogenome sequences for the IWC-POWER biopsy samples collected through 2017 (*n*=9) have been generated for use in a project evaluating the global subspecies taxonomy of blue whales.	An update on this work will be presented at SC68B.
ICR	Laboratory work to start in 2020 for mtDNA CR sequencing and microsatellite (17 loci). Plan to analyse the genetic data in conjunction with genetic data available for the western North Pacific from other sources. IWC-POWER biopsy samples for 2018 and 2019 are not available to ICR but will be shipped to ICR from SWFSC shortly.	An update on this work will be presented at future SC meetings.
Fin whale (*n*=124)		
SWFSC	Laboratory work ongoing to develop method to genotype several thousand SNP loci. Currently using non-POWER samples for pilot project but will include ~ 40 IWC-POWER samples in later genotyping.	An update on this work will be presented at SC68B.
ICR	Laboratory work to start in 2020 for mtDNA CR sequencing and microsatellite (17 loci). The plan is to analyse these in conjunction with additional genetic data available for the western North Pacific from other sources. IWC-POWER biopsy samples for 2018 and 2019 are not available to ICR but will be shipped to ICR from SWFSC shortly.	An update on this work will be presented at future SC meetings.
Sei whale (*n*=85)		
ICR	All IWC-POWER biopsy samples have been analysed apart from 4 samples from the 2019 survey. Two genetic markers were used, mtDNA CR sequencing and microsatellites at 17 loci. The analyses were conducted in conjunction with additional genetic data available for the western and eastern North Pacific from other sources. Documents have been presented to the IWC SC Comprehensive Assessment of North Pacific sei whales. There are few samples available for the area between about 170°E-180° and 35°-45°N and in coastal areas in both sides of the North Pacific but this may be rectified if the backup plan for 2020 is implemented. Parent-Offspring analyses are ongoing. Use of these to estimate abundance is being considered.	Pastene *et al.* (2016a); Pastene *et al.* (2016b). A paper is being prepared for publication.
Bryde's whale (*n*=134)		
ICR	All IWC-POWER biopsy samples have been analysed. Two genetic markers were used, mtDNA CR sequencing and microsatellite at 17 loci. Analyses were conducted in conjunction with additional genetic data available for the western North Pacific from other sources. Documents were presented to the IWC SC *Implementation Review* of North Pacific Bryde's whale. Few samples are available for areas east of 150°W.	Pastene *et al.* (2016b); Pastene *et al.* (2016c); Taguchi *et al.* (2017).
Humpback whale (*n*=60)		
None yet	No samples have been analysed yet. Samples are available for analysis under the IWC process (*www.iwc.int*).	
North Pacific right whale (*n*=6)		
ICR/ SWFSC	All IWC-POWER biopsy samples have been analysed for mtDNA CR sequencing in conjunction with additional genetic data available for the western and eastern North Pacific from other sources. A document was presented to the 2018 IWC SC meeting and a new document is being prepared for publication. There remains a need to analyse the available samples with nuclear markers.	Pastene *et al.* (2018). A paper is being prepared for publication.
Gray whale (*n*=18)		
None yet	No IWC-POWER samples have been analysed yet. Samples are available for analysis under the IWC process (*www.iwc.int*) - would need to be part of a wider study given small sample size.	-
Sperm whale (*n*=6)		
None yet	No IWC-POWER samples have been analysed yet. Samples are available for analysis under the IWC process (*www.iwc.int*) - would need to be part of a wider study given small sample size.	-
Killer whale (*n*=15)		
None yet	No IWC-POWER samples have been analysed yet. Samples are available for analysis under the IWC process (www.iwc.int) - would need to be part of a wider study given small sample size.	-

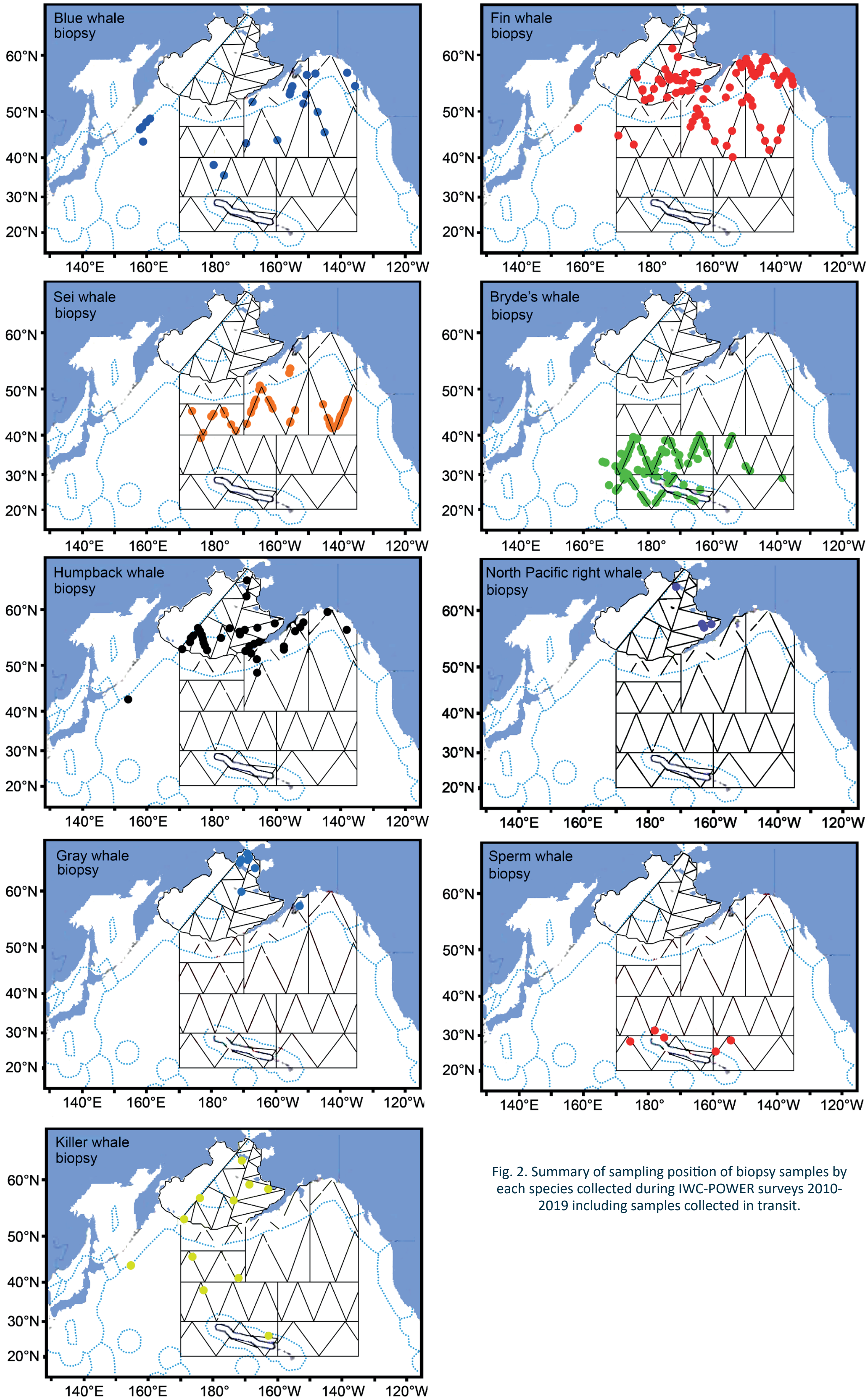

Fig. 2. Summary of sampling position of biopsy samples by each species collected during IWC-POWER surveys 2010-2019 including samples collected in transit.

3.2 Short-term

The identified 'least studied' areas of the central and Eastern North Pacific will soon have been covered under IWC-POWER (pending permission to operate in Russian waters of the Bering Sea), thereby completing the 'short-term' objectives (IWC, 2012b). Analyses of these data will form the basis of the medium-term plan (see discussion under Items 3.3 and 8 below) and may also result in one or two more cruises aimed at filling specific knowledge gaps before implementing the medium-term programme (see discussion of a 'backup plan' for the 2020 cruise if permission to operate in Russian waters is not received).

3.3 Medium-term

The TAG reviewed the priorities previously agreed for the medium-term (IWC, 2017) in the light of the review of information obtained up until 2019, and revised these as shown in Table 1. Further discussion on the next phase of IWC-POWER in light of the medium-term priorities is provided under Items 8 and 9.

Recommendation
The TAG **recommends** *the revised medium-term priorities for the future IWC-POWER programme as provided in Table 1.*

4. STOCK STRUCTURE AND MOVEMENTS

4.1 Genetics

4.1.1 Available genetic samples

Table 2 and Fig. 2 summarise the 475 biopsy samples taken under the IWC-POWER programme from 2010-19. The TAG noted that the programme has greatly increased the number of available biopsy samples in the North Pacific, particularly for blue, fin, sei and Bryde's whales, for which few if any samples were previously available from the survey area.

Table 4

Summary of photo-identification work undertaken during 2010-19 cruises including transit surveys between Japan and the research areas (**estimated number of individuals photographed, requires confirmation, especially of the killer whales from 2019).

Photo-ID	2010	2011	2012	2013	2014	2015	2016	2017	2018**	2019	Total
Blue whale	3	9	4	0	1	0	1	0	8	16	42
Fin whale	0	25	59	3	0	0	0	79	69	51	286
Sei whale	0	27	51	2	0	0	1	0	0	0	81
Bryde's whale	0	0	0	6	73	49	12	0	0	0	140
Common minke whale	0	0	0	0	0	0	0	0	4	0	4
Humpback whale	5	48	26	0	0	0	0	48	39	30	196
North Pacific right whale	0	0	1	0	0	0	0	12	3	0	16
Gray whale	0	0	0	0	0	0	0	16	41	6	63
Sperm whale	0	0	1	0	4	22	2	0	4	0	33
Killer whale	45	18	50	0	3	4	0	84	33	19	256
Total	53	127	192	11	81	75	16	239	201	122	1,117

Table 5

Summary of the status of the photo-identification work undertaken.

Species	Analysts	Status/comments
Blue whale	Cascadia/ICR	Photos submitted for matching from 2010 to 2012, 2014, 2016. Photos for 2019 will be submitted.
Fin whale	Secretariat and others/ICR	Photos being checked and matched, 2011-13, 2017-18.
Sei whale	Secretariat and others/ICR	Photos available for 2011-13, 2016.
Bryde's whale	Secretariat and others/ICR	Photos available for 2013-16.
Common minke	TBD	Photos available for 2018.
Humpback whale	Cascadia, HappyWhale	Photos submitted for matching from 2010 to 2017. Photos for 2018 and 2019 will be submitted.
	TUMSAT/ICR	TUMSAT and ICR will collaborate in analysis.
Gray whale	Cascadia/ICR	Photos submitted for matching for 2017. Photos for 2018 will be submitted.
NP right whale	AFSC/ICR	Photos submitted for matching from 2012, 2017, 2018.
Killer whale	AFSC/ICR	Photos submitted for matching from 2010 to 2017, 2018. Photos for 2018 and 2019 will be submitted.
Sperm whale	ICR	B Photos available for 2012, 2014, 2015, 2016, 2018.

4.1.2 Status of analyses

Table 3 summarises the status of the analyses of the collected biopsy samples.

> *Recommendation*
> *The TAG* **reiterated** *the importance of the biopsy sampling work undertaken and* **welcomed** *the analyses of these samples. They have already made a major contribution to the recently completed Implementation Review of Bryde's whales in the western North Pacific and to the ongoing Comprehensive Assessment of sei whales. The gray whale samples can contribute to the forthcoming Implementation Review of gray whales. Analyses of the blue and fin whale data will provide greatly needed information on the stock structure of these species in the North Pacific and contribute to future discussions of the assessment of their status and planning for the next phase of IWC-POWER. An overview of the results in light of stock structure should be developed for SC68B.*

4.2 Individual identification

Table 4 summarises the estimated >1,100 individuals photo-identified under the IWC-POWER programme from 2010-19 (note that individual identification is also possible using genetic techniques). Table 5 summarises the work underway on these photographs.

> *Recommendation*
> *The TAG* **reiterated** *the importance of the photo-identification studies and* **welcomed** *the matching work on these photographs. For some species (e.g. blue, gray, humpback, right, killer and sperm whales) there are existing catalogues to which the IWC-POWER photographs make an important contribution. For other species (fin, sei and Bryde's), the IWC-POWER photographs are being analysed to develop IWC catalogues. It is also stressed the great value of the full IWC-POWER photographic database that stored and categorised all photographs from the cruises.*

5. DISTRIBUTION, ABUNDANCE AND TRENDS

5.1 Review of available data

5.1.1 Sightings data

Annex D summarises the available sightings data over the 2010-19 period when a total of almost 23,500 n.miles were covered in the research areas and almost 80% of the planned tracklines were achieved. Annex D also provides maps of the distribution of sightings for the major species.

Table 6

Summary of duplicates and total sightings during IO mode surveys, 2015-19.

Species	2015	2016	2017	2018	2019	Total
Gray whales	0	0	4 / 8	2 / 2	0	6 / 10
Common minke whales	0	0	1 / 7	0 / 5	1/1	2 / 13
Bryde's whales	5 / 11	13 / 20	0	0	0	18 / 31
Sei whales	0	0	0	0	12/16	12/16
Fin whales	0	0	33 / 81	34 / 67	60/74	127 / 222
Blue whales	0	0	0	0	4/6	4/6
Humpback whales	0	0	26 / 80	10 / 16	34/42	70 / 138
Right whales	0	0	1 / 2	0 / 1	0	1 / 3
Sperm whales	1 / 5	17 / 30	5 / 12	14 / 22	8/16	45 / 85

Table 7

Summary of sonobuoy deployments, successful sonobuoy deployments, success rate and recording hours for the 2017-19 cruises.

Year	No. sonobuoys deployed	No. successful deployments	% success rate	Recording time (hh:mm:ss)
2017	240	219	91.25%	841:05:06
2018	253	217	85.7%	699:46:12*
2019	229	212	92.6%	821:32:57
Total	722	648	89.75%	2362:24:15

*The lower monitoring time is the result of less time spent in the North Pacific right whale critical habitat.

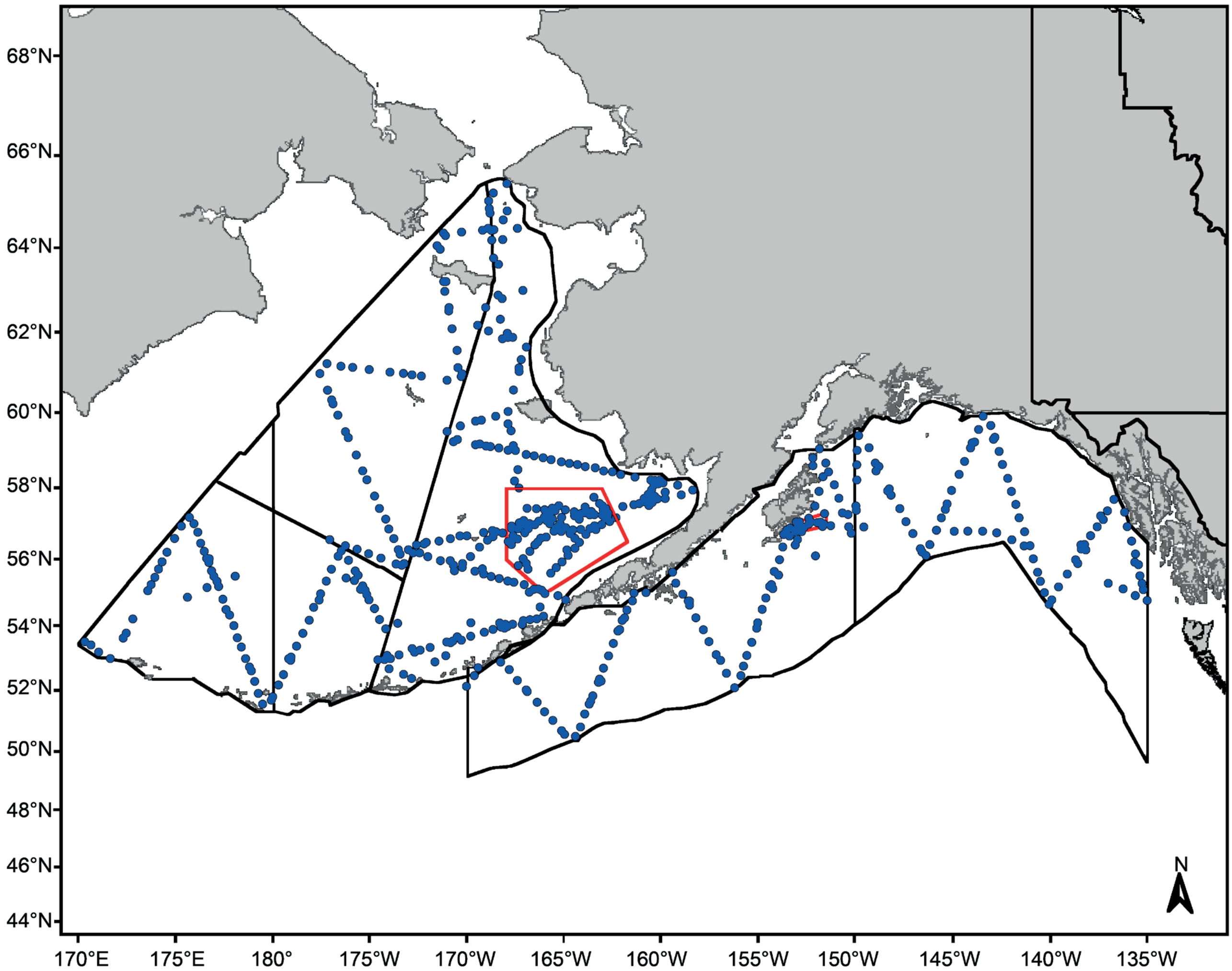

Fig. 3. Map showing location of all sonobuoy deployments during the 2017-19 IWC-POWER cruises. Black lines indicate study areas. Red polygons=North Pacific Right Whale Critical Habitat. Maps of detections by species can be found in Annex E.

The initial surveys were covered under normal sighting mode. Since 2015, Independent Observer (IO) mode has also been undertaken to see if it was possible to estimate *g*(0) for some species. Table 6 shows that with the existing information it should be possible to estimate *g*(0) for fin, humpback and sperm whales in addition to the already completed analysis for Bryde's whales (Hakamada *et al.*, 2018) and the work on sei whales discussed further under Item 5.2 below.

5.1.2 Environmental data

The TAG recognises that oceanographic data are valuable for *inter alia* spatial modelling. However, when developing the IWC-POWER programme it was agreed that it was not feasible to collect detailed oceanographic data at the necessary frequency without interfering with the primary task of collecting line-transect data for cetaceans.

> *Recommendation*
> *In 2016, the TAG had noted that if sufficient funds had been available, oceanographic data could be obtained using a SeaGlider and it* ***reiterated*** *that this should be considered as part of the medium-term programme discussion.*

5.1.3 Mark-recapture data

The estimation of abundance using individual identification mark-recapture data obtained from the IWC-POWER programme alone is impractical for most species given the time needed to collect sufficient biopsy or photo-identification data. However, data collected from IWC-POWER contributes to wider efforts for several species (see Tables 4 and 5) and the data are also valuable for studies of stock structure (see Tables 2 and 3) and movements.

Table 8
Species detected per year for the 2017-19 IWC-POWER cruises.

Year	Fin	Sperm	Killer	Hump	Right	Blue	Gray	Sei	Baird's	Other
2017	112	44	49	23	38	0	4	0	0	Cuvier's beaked – 1; seismic airgun - 2
2018	101	72	56	24	27	0	10	0	1	Earthquake - 2
2019	119	112	76	47	10	54	0	4	3	Pacific white-sided - 3; earthquake - 33
Total	332	228	181	94	75	54	14	4	4	Cuvier's beaked - 1; Pacific white-sided - 3; seismic airgun - 2; earthquake - 35

5.1.4 Acoustic data

Paper SC/TAG/2020/WP/05 summarised the acoustic results from the 2017 to 2019 IWC-POWER surveys. Passive acoustics monitoring using sonobuoys was successfully implemented for the first time in 2017; after its successful first year, it was included in the two following years. Over the course of three years, a total of 722 buoys were deployed, of which 648 were successful, for a combined total of over 2,362 hours of acoustic monitoring (Fig. 3, Table 7). Note, unsuccessful deployments are nearly always due to deployment of old expired sonobuoys.

Table 8 shows that the most frequently detected species were fin whales, heard on 332 total buoys (51.2%), sperm whales (228, 35.1%), and killer whales (181, 27.9%), followed by humpback whales (94, 14.5%), North Pacific right whales (75, 11.5%), blue whales (54, 8.3%), gray whales (14, 2.1%), and sei whales (4, 0.6%). Maps of detections by species can be found in Annex E.

Acoustic detections were in good agreement with the visual sightings in all three years. There were, however, some differences. The more frequently acoustically active killer whales and sperm whales were detected more frequently with acoustics than they were visually sighted whilst the reverse was true for quieter common minke and gray whales - in fact there were no acoustic detections of common minke whales in any year. Of the 12 total sightings of North Pacific right whales, seven were the result of acoustic localisation where the first cue had been sounds (5 in 2017, 2 in 2018). During two sighting/acoustic encounters (one each in 2017 and 2018), right whale song was detected; these data contributed to a manuscript published by Crance *et al.* (2017). Although right whales were acoustically detected in 2019, there were no visual sightings due to inclement weather and infrequent calling of the animal.

Recordings of species that are not often detected (e.g. Baird's and Cuvier's beaked whales, Pacific white-sided dolphins) were made during the cruises. The 2017-19 results further emphasise the utility of using sonobuoys to monitor for marine mammals, particularly in remote areas or for visually cryptic species.

Recommendation
The TAG **thanked** *Crance for the report on the successful acoustic work undertaken from 2017-19 (SC/TAG/2020/WP/05) and* **thanked** *the Government of the USA for providing the necessary equipment and experts. It* **recommended** *that when possible such studies should be undertaken during future cruises and noted the value of the use of directional acoustic work for targeted studies of rare species such as blue and North Pacific right whales.*

5.1.5 Other data

The TAG noted that other datasets can assist in examining distribution, stock structure and status during mid-term planning discussions, e.g. the revised IWC catch database and the JSV data (Miyashita *et al.*, 1995).

5.2 Review of results from visual sightings

Table 9 summarises the status of the analyses of the visual sightings data. Most progress has been made with large baleen whales. In addition there are 10 species codes (Cuvier's beaked whale, Mesoplodon spp, *Ziphiidae*, Risso's dolphin, spotted dolphin, striped dolphin, common dolphin, Pacific white-sided dolphin, Northern right whale dolphin, Dalli type Dall's porpoise) with more than 15 sightings and TUMSAT will examine these to see if useful abundance estimates can be obtained.

5.2.1 Analytical methods to estimate g(0)

Last year the TAG recommended that additional IO mode data (especially for sei whales) be collected to confirm whether or not the assumption that $g(0)=1$ is appropriate for large whales. The value of $g(0)$ is the probability of detecting groups on the trackline. As a result, IO mode was conducted for over 1,400 n.miles during 125 hours in the 2019 survey. The 2019 survey resulted in over 234 sightings of 7 species (blue (9), fin (102), sei (22), humpback (48), sperm (26) and killer whales (15)) that could be used to estimate $g(0)$ (from Table 2c in SC/TAG/2020/WP/03).

Hakamada reported on the initial results of mark-recapture distance sampling analyses (SC/TAG/2020/WP/06rev) of the 2019 IWC-POWER data of North Pacific sei whales to estimate $g(0)$. Group size and Beaufort Sea State were potential covariates for the mark-recapture (MR) or distance sampling (DS) models. Interactions between the covariates and with

Table 9

Summary of work on the analyses of the sightings data*.
D=design based; M=model based.

Species	Analysts	Status and schedule
Blue whale	ICR/TUMSAT (D, M)	Revised version of Kitakado *et al.* (2018) expected at SC68B.
Fin whale	TUMSAT/ICR (D, M)	Draft by Inai *et al* (SC/TAG/2020/WP/07) reviewed here, revised version expected at SC68B.
Sei whale	ICR (D)	Hakamada *et al.* (2017).
	TUMSAT (D, M)	Draft by Inai *et al* (SC/TAG/2020/WP/07) reviewed here, revised version expected at SC68B.
Bryde's whale	ICR (D)	Completed up to 2015 survey (Hakamada *et al.*, 2018) to be updated with 2016 data in 2020.
	TUMSAT (D, M)	Draft by Inai *et al.* (SC/TAG/2020/WP/07) reviewed here, revised version expected at SC68B.
Humpback whale	TUMSAT/ICR (D, M)	Draft by Inai *et al.* (SC/TAG/2020/WP/07) reviewed here, revised version expected at SC68B.
Sperm whale	ICR	No work conducted to date-this is correct for SWFSC-rlb.
Killer whale	TUMSAT/ICR	Initial estimates expected at the next TAG meeting.
Dolphin sp.	TUMSAT+NRFSFS+ICR	Initial estimates expected at the next TAG meeting.
Marine debris	TUMSAT/ICR	Draft by Yasuhara *et al*. (SC/TAG/2020/WP/09) reviewed here. Expected 2020 publication (see Item 6.2).

*The feasibility of estimating the abundance of common minke whales will be considered by ICR given the non-optimal 'acceptable' conditions for this low priority species for IWC-POWER.

the platform were also considered. The hazard rate and half normal detection functions were considered and both point and full independence were investigated. Using the AIC value, the best fitting model resulted in an estimate of $g(0)$ for the topman team of 0.867 (CV=0.089). However, it was noted that: (a) sample size was small; and (b) even the best model fits were poor for the detection function for the IO platform.

Recommendation
The TAG thanked the authors of SC/TAG/2020/WP/06 revised, and **recommended** *that a revised version be submitted to the next TAG meeting where the same methodology is also applied to other species. Several suggestions were made that might improve the analysis including consideration of:*

(1) *models that improve the fit to the IO team's detection function;*
(2) *other diagnostics such as the Cramer-von Mises criterion; and*
(3) *pooling the sei whale data with another similar species that has a larger sample size (e.g. fin whales) to develop species-specific estimates of g(0).*

5.2.2 Distance and angle experiments
In response to previous advice from the TAG and the Scientific Committee, Kitakado presented a review of the annual distance and angle experiments that are conducted on all of the IWC-POWER cruises (SC/TAG/2020/WP/08). The analysis showed that although (as expected) there is variation in ability to estimate angles and distances there was no evidence of any systematic underestimation or overestimation that would translate into any significant bias in abundance estimates. Although the buoys used in the experiments were concentrated forward of the ship with limited locations near abeam of the ship, the design and implementation of the experiment meant that this was acceptable. Estimated radial distances and angles, along with the calculated perpendicular distances were shown on average to be unbiased but variable. Radial distances showed more variability at farther distances from the ship whilst angle estimates were more variable close to the ship. These patterns held for the various platforms, within different Beaufort sea states and across years. As one would expect, 'novice' observers were generally found to be more variable. In discussion it was noted that perhaps the reason Beaufort sea state had little effect was because the buoy (3.5m above the sea surface) was easier to see than an actual whale. Observer experience should be considered when accounting for measurement error in actual abundance estimates.

Recommendation
The TAG **commended** *the authors of SC/TAG/2020/WP/08 for this through investigation and* **recommended** *that the paper be submitted to SC68B and for publication.*

5.2.3 Abundance estimates
Inai presented initial abundance estimates for humpback, fin, Bryde's and sei whales using sightings data from the 2010-18 IWC-POWER surveys (SC/TAG/2020/WP/07). She also presented initial information on the analysis of fin whale data from a cruise carried out to the east of Kamchatka in 2005 (SC/TAG/2020/WP/14). In SC/TAG/2020/WP/07, both design-based line transect methods and model-based spatial modelling methods (generalised additive model (GAM), random forest, and

boosting regression tree methods) were investigated. It was assumed that $g(0)=1$ for all analyses although the potential to estimate g(0) for these species was recognised. Transit data were included to estimate the effective strip half width but not final abundance. Covariates considered in the design-based analysis included: year of survey, group size, cue, visibility and wind speed. Covariates considered in the spatial modelling included: latitude, longitude, sea surface temperature, depth, distance from the coast, sea surface salinity, oxygen, silica, phosphate and nitrate. The best spatial model was selected by the deviance explained. The most commonly selected environmental covariates chosen were sea surface temperature, sea surface salinity and nitrate. Preliminary abundance estimates derived from the design-based methods were approximately 20,000 humpback whales, 40,000 fin whales, 27,000 Bryde's whales and 30,000 sei whales. In general, the CVs of the abundance estimates from the design-based and GAM methods were larger than those from the machine learning methods (random forest and boosting regression tree methods). The point estimates from all of the model-based methods were less than those from the design-based methods but not significantly different give the CVs.

Recommendation

The TAG **commended** *the authors for the work presented in SC/TAG/2020/WP/07 and* **recommended** *that it be updated and submitted to the SC68B meeting and made several suggestions for the updated paper:*

(1) *provide more explanation of the machine learning methods;*
(2) *consider why the inclusion of transit sightings changed the effective strip half width as much as it did – understanding the robustness esw calculations will assist in designing future analyses;*
(3) *include multiple diagnostics to choose the preferred model, including investigating the top few models (rather than simply the best) if they have similar AIC values;*
(4) *consider restricting the analyses by removing areas where there are none (or very few) animals and assuming that abundance there is zero – this should lead to lower CVs;*
(5) *consider using the 2019 IWC-POWER data to validate the habitat-density models developed using the 2010-2018 data;*
(6) *provide a more through comparison of the IWC-POWER estimates to published estimates from other projects using similar or other analytical methods; and*
(7) *include the estimates for humpback whales in the waters off Kamchatka.*

No new abundance estimates were presented for species other than those discussed under Item 5.2.1.

The TAG **recommended** *that the most up-to-date analysis for all species for which there were sufficient data be presented to the SC68B meeting. This could be a summary of previously approved estimates or the provision of either new or updated analyses taking into account previous TAG and SC advice on potential improvements of previous estimates.*

Kitakado presented the early results of a simulation study to investigate spatial line transect methods by applying the model-based methods used in SC/TAG/2020/WP/07 (generalised additive and random forest methods) to simulated spatially distributed whales and 100 random tracklines place within a simulated whale distribution (SC/TAG/2020/WP/12). As a simplification, strip transect methods were used to remove the need to consider possible effects of a detection function from the evaluation at this stage. Two general spatial distributions were investigated: a random distribution and a distribution similar to that seen for humpback whales during the IWC-POWER cruises, which was dependent on sea surface temperature, depth, latitude and longitude. The initial results showed that for the simulated randomly distributed whales, the generalised additive model performed better. For the 'humpback' distributed whales, the random forest abundance estimates performed better. The authors reported that future work would included using different underlying distributions of whales and different analysis methods, including 2-stage analysis techniques.

Recommendation

The TAG **commended** *the simulation-based approach and* **encouraged** *its continuation.*

5.2.4 Future detection of trends

SC/TAG/2020/WP/10 reported on a preliminary analysis of the statistical power of the IWC-POWER surveys to detect a trend (either decrease or increase) of whale abundance from two abundance estimates. The first estimate was from the IWC-POWER series from 2010-18 and the second was from future surveys, under the assumption of no additional variance. This analysis showed, like other similar analyses, when the CV for an estimate is high (greater than 0.4), then it is difficult or impossible to detect a change in abundance. The smaller the true change, the harder it is to detect it with statistical confidence.

In discussion it was noted that the results re-emphasise the importance of such studies to the design of the next phase of IWC-POWER and meeting the long-term objective of obtaining information on trends. As noted under Item 5.2.3 it is important to develop ways to reduce the variability of abundance estimates given the resources available. For example by excluding large areas of the overall study area for which the density of a particular species is zero or very low, pooling to produce more precise estimates of the detection function, using spatial habitat models and investigating perhaps machine learning and other techniques that may produce more accurate, less variable estimates. With improved information on population structure, it may be possible to reduce the size of the study areas for particular cruises in a targeted manner to obtain a longer time series within a smaller area to increase the statistical power to detect a trend. Also, when appropriate, the variability of an abundance estimate may be reduced.

Recommendation
The TAG **reiterated** *the importance of such analyses based upon the initial phase of IWC-POWER to the development of the next phase of the programme (as had originally been envisaged) and thanked the authors for this initial study. It recommended that an updated version of SC/TAG/2020/WP/10 be submitted to SC68B with more description of the results and discussion.*

5.3 Mark-recapture methods
As noted under Item 5.1.3, there are no plans to develop mark-recapture estimates from the IWC-POWER data, although the data can contribute to broader efforts (e.g. humpback whales as part of the Comprehensive Assessment).

5.4 Acoustic methods
The acoustic data collected using sonobuoys, whilst useful to inform distribution, are not suitable (at least at present) to use to develop abundance estimates. The use of directional acoustic studies (such as occurred for North Pacific right whales) should be considered for rare species such as North Pacific right and blue whales in phase 2 of IWC-POWER. Similarly, the possibility of occasional targeted cruises using towed arrays (e.g. to estimate sperm whale abundance) should be evaluated for the next phase of IWC-POWER, recognising the limitations this may impose (e.g. with respect to biopsy sampling and photo-ID studies).

6. OTHER ASSOCIATED STUDIES

6.1 Oceanographic studies
Only basic oceanographic information (e.g. SST) is collected during the cruises (see discussion under Item 5.1.2). However, the TAG noted that oceanographic data from remote sensing has proved valuable in spatial modelling approaches (e.g. see Item 5.2.3).

6.2 Marine debris
SC/TAG/2020/WP/09 provided an updated version of the abundance estimation of floating marine debris using the 2010-16 IWC-POWER data that incorporated comments provided at the last TAG and SC meetings. A multiple covariate distance sampling analysis showed that environmental covariates such as sea state and weather condition can affect the detectability of debris. A model-based method showed that densities of debris were high in between 20°N-40°N and concentrated in and around 145°W. The authors suggested that some of the debris might be attributed to the 2011 tsunami in Japan. They also indicated this paper was submitted to *Marine Pollution Bulletin*.

Recommendation
The TAG **welcomed** *the contribution IWC-POWER was making to the issue of marine debris,* **thanked** *the authors for the update in SC/TAG/2020/WP/09 and* **looked forward** *to its publication.*

6.3 Other
On several occasions the IWC has been asked to consider the collection of data on other marine life than cetaceans. For example, the North Pacific Marine Science Organization (PICES) has suggested that bird surveys would be valuable. However, the proposed survey protocols require a bird specialist and the workload would interfere with the cetacean studies and as such it would be unrealistic for the present IWC-POWER programme and vessel.

Recommendation
The TAG **reiterated** *that provided it did not interfere with cetacean work, IWC-POWER could record marine turtles and pinnipeds (using only general codes). If sightings could be identified to species and/or where photographs could be obtained, this would be included in the 'comments' column.*

7. DATA COLLECTION, STORAGE AND ANALYSES

7.1 On board recording

7.1.1 'Information for researchers'

The TAG welcomed news that the Guide for Researchers had been updated to include guidance on the process to import photographs into the IWC Lightroom Photo-catalogue. Improvements to the *Information for Researchers* are regularly made by Matsuoka and Donovan in the light of recommendations from planning meetings and experiences on the cruise and this should continue.

7.1.2 ICR automated data acquisition system

The TAG welcomed the news from Matsuoka that the ICR system had been and was continuing to be improved and updated (e.g. to include weather and effort data and an English language version).

Recommendation

The TAG **thanked** *Matsuoka for his work in this regard and* **recommended** *that he continues to: (a) work with the IWC Secretariat to ensure the prompt validation of the data after each cruise; and (b) provide the GPS data and shape files for the research area and cruise tracks to the Secretariat.*

7.2 Potential software/hardware systems including the long-term database

As noted under Item 2.2, the present funding situation means that work previously identified with respect to onboard acquisition of data in conjunction with the development of a new long-term database is unlikely to occur within the next few years.

The TAG reiterated the importance of the IWC-POWER photographic database that stores, classifies and keywords all photographs taken on the cruises. This provides an extremely valuable resource that will facilitate use of the photographs in ancillary studies related to, for example, ship strikes, entanglement and health.

The TAG **reiterates:**

(1) *the need for an improved long-term database for the IWC-DESS system but noted that this is unlikely to occur under the present financial restrictions; and*
(2) *continued support for the IWC-POWER photographic database.*

The TAG also confirms that in terms of data availability, Japan and the IWC share all the data and biopsy samples from IWC-POWER cruises, and that these are available to Scientific Committee members upon request.

8. INTEGRATED STRATEGY TO ACHIEVE SHORT-MEDIUM GOALS

8.1 Short-term plan (up to 2020 including backup plan)

The TAG **reiterated** the importance of completing the Bering Sea survey areas as agreed by the Scientific Committee in the last three years. However, given the difficulties previously experienced, the TAG **agreed** that it was important to consider a backup plan for the 2020 cruise. If the Russian area cannot be covered in 2020 then every effort should be made to cover this in 2021 given its importance to meeting the objectives of the IWC-POWER programme.

The TAG examined the existing data and SC/TAG/2020/WP/11 when considering a backup plan for 2020.

With respect to the backup plan, it was **agreed** that a high priority should be to try to obtain sufficient IO data to allow an estimate of $g(0)$ to be obtained for sei whales and other species, as possible. There was some discussion about how best to achieve this. It was also noted that the cruise could incorporate acoustics and target any North Pacific blue and right whales that might be encountered.

Recommendation

The TAG **agreed** *that the draft backup plan considering the waters to the west of 170°E (the westernmost border of IWC-POWER to date) adjacent to the southern strata covered in 2010 with some overlap with the 2010 survey should form the basis of further discussions at the planning meeting for the 2019 cruise. Those discussions should consider:*

(1) *undertaking IO mode surveys during transits as well as during the survey (the vessels will need to return to Japan for refuelling half-way through the cruise) to increase sample size for g(0) estimation;*
(2) *the extent to which it is possible to cover waters to the east of 170°E to enable comparison with the results from 2010, recognising also that in 2010 sightings of at least fin and sei whales were made right up to the western boundary;*
(3) *biopsy sampling in this region will fill an important gap for sei whales as well as provide valuable data for the other species (see Table 3); and*
(4) *a sighting survey in this region will fill a gap in previous sighting surveys.*

8.2 Medium-term plan (6-10 years starting in 2022)

As previously noted, development of a medium-term programme (in light of the revised priorities given in Table 1) is heavily dependent on considering the analyses of the data collected under the first phase of IWC-POWER and an understanding of the likely resources that may be made available.

Recommendation

The TAG considered the available information and developed the advice and recommendations given below.

(1) *Updated power analyses should be undertaken. TUMSAT* **agreed** *to try to undertake this work in advance of the 2020 Scientific Committee meeting.*

(2) *Japanese, Korean and Russian scientists are encouraged to develop an overview of the survey information (including cruise tracks, effort, sightings, encounter rates and available abundance estimates by species), biopsy data and photo-identification data available from national cruises in the waters west of 170°E since 2010 for presentation either at SC68B or the next TAG meeting.*

(3) *In the light of (2) and data from the first phase of the programme, the need to undertake IWC-POWER surveys west of 170°E (including the Okhotsk Sea) with a focus on blue, North Pacific right, fin, humpback and other large whales should be evaluated as part of the next phase.*

(4) *IWC members and especially Japan, Korea, the Russian Federation and the USA should be* **encouraged** *to participate even more fully in the IWC-POWER programme to ensure co-ordinated research and facilitation of permit issuance.*

(5) *The Scientific Committee should hold a pre-meeting in 2021 to develop a detailed proposal for a workshop to design the next phase of the IWC-POWER programme before the 2021 Scientific Committee meeting with an emphasis on participation from all range states and on the availability of analyses/data required - as noted in Table 1, that workshop should include consideration of more methodologically focussed cruises in some years (e.g. use of a towed acoustic array, telemetry work, use of SeaGlider, etc.).*

Table 10

Work plan for IWC-POWER related work.

Item	Activity	Responsible persons (**lead in bold type**)	Time
Data			
(1)	Complete validation of IWC-POWER sightings and effort data for the period up to the 2019 cruise and submit GPS and shape files.	**Matsuoka** and Hughes	By end of February 2020
(2)	Encourage continued collaboration with other groups holding genetic samples and individual identification data.	**Brownell, Donovan** and Steering Group	Report progress to SC68B
(3)	Complete importation and classification of 2019 IWC-POWER photographs into the IWC photographic database.	Taylor and **Donovan**	Report progress to SC68B
(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	Report progress to SC68B if not completed
(5)	Liaise with the USA, Japan, Republic of Korea and Russian Federation on providing a compilation of the results from their national surveys and plans for future national surveys in relation to IWC-POWER data and future IWC-POWER surveys.	Brownell, Kim, Miyashita, **Matsuoka**, Zharikov	Report progress at SC68B and final summaries to 2020 autumn TAG meeting
Analyses			
(1)	Complete review of angle/distance experiments, following the guidance provided in IWC (2019), Item 6.2.1, and publish.	**Kitakado** and Team DAE	Submit revise to SC68B and then publish
(2)	Develop updated abundance estimates (design- and model-based) for humpback, blue, fin, sei and Bryde's whales following the advice provided at this meeting (incorporating estimates from (3) below if available).	**Kitakado** and scientists from TUMSAT/ICR	By SC68B
(3)	Provide updated estimates of $g(0)$ for those species it is considered possible (including fin, sei and humpback) following the advice provided at this meeting.	**Hakamada** and scientists from TUMSAT/ICR	By the next TAG meeting
(4)	Develop abundance estimates for small cetacean species.	**Kim, Matsuoka and Kitakado** and others	Paper to 2020 autumn TAG meeting
(5)	Continue simulation work investigating spatial modelling approaches following advice provided at this meeting.	**Kitakado, Inai** and Palka	Submit revise to SC68B
(6)	Continue work on power analyses following advice provided at this meeting.	**Kitakado, Inai,** Palka and Donovan	Submit revise to SC68B
(5)	Develop summary overview paper of results of genetic studies that have included data from IWC-POWER and develop proposal for additional analyses of genetic data, including those from IWC-POWER, to inform *inter alia* stock structure discussions related to medium-term plans	**Pastene** and colleagues	Progress report at SC68b with a draft to 2020 autumn TAG meeting
Future			
(1)	Develop a summary document of the results of IWC-POWER up to 2019 focussing on achievements and how to develop the next phase.	**Donovan** and Steering Group	Present at SC68B
(2)	Hold pre-meeting associated with SC68C, to focus on the next phase of IWC-POWER in light of medium-term priorities (see Table 1) and results of the analyses of the data thus far.	Steering Group	Develop proposal for workshop to design the next phase prior to SC69A

9. WORK PLAN

The TAG reviewed progress on the previous work plan (IWC, 2020a) and developed the updated work plan provided in Table 10.

10. ADOPTION OF REPORT

The meeting closed at 5pm on 19 January 2020. The final report was agreed by e-mail on 14 February 2020.

Kitakado thanked the participants for their hard work and in particular thanked the Cruise Leader, Matsuoka, for processing the 2019 data so promptly. He also thanked the rapporteurs. The participants thanked Kitakado for his efficient handling of the meeting and noted the considerable work outlined under Item 9. The meeting also thanked the Fisheries Agency of Japan for the excellent working environment.

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Annex A

List of Participants

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Annex B

Agenda

1. Introductory items
   - 1.1 Opening remarks and welcoming address
   - 1.2 Election of Chair
   - 1.3 Adoption of Agenda
   - 1.4 Appointment of rapporteurs
   - 1.5 Review of documents
2. Review of the survey results from 2010-2019
   - 2.1 Summary of survey results including 2019
   - 2.2 Review of Scientific Committee recommendations
   - 2.3 Other relevant sighting surveys
     - 2.3.1 Russian waters
     - 2.3.2 Korean waters
     - 2.3.2 Other waters
3. Objectives and priorities
   - 3.1 Long-term
   - 3.2 Short-term
   - 3.3 Medium-term
4. Stock structure and movements
   - 4.1 Genetics
     - 4.1.1 Available genetic samples
     - 4.1.2 Status of analyses
   - 4.2 Individual identification
5. Distribution, abundance and trends
   - 5.1 Review of available data
     - 5.1.1 Sightings data
     - 5.1.2 Environmental data
     - 5.1.3 Mark-recapture data
     - 5.1.4 Acoustic data
     - 5.1.5 Other data
   - 5.2 Review of results from visual sightings
     - 5.2.1 Analytical methods including $g(0)$ estimation
     - 5.2.2 Distance and angle experiments
     - 5.2.3 Abundance estimates
     - 5.2.4 Future detection of trends
   - 5.3 Mark-recapture methods
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6. Other potential associated studies
   - 6.1 Oceanographic studies
   - 6.2 Marine debris
   - 6.3 Other
7. Data collection, storage and analyses
   - 7.1 On board recording
     - 7.1.1 'Information for researchers'
     - 7.1.2 ICR automated data acquisition system
   - 7.2 Potential software/hardware systems including the long-term database
8. Integrated strategy to achieve short-medium goals
   - 8.1 Short-term plan (up to 2020 including backup plan)
   - 8.2 Medium-term plan (6-10 years starting in 2022)
9. Work plan
10. Adoption of report

Annex C

List of Documents

SC/TAG/2020/WP/

01. International Whaling Commission. 2020. Report of the 2018 meeting of the IWC-POWER Technical Advisory Group (TAG). *J. Cetacean Res. Manage (Suppl.)* 21: 311-332.
02. International Whaling Commission. 2020. Report of the Planning Meeting for the 2019 IWC-POWER Cruise. *J. Cetacean Res. Manage. (Suppl.)* 21: 333-346.
03. Matsuoka, K. *et al.* Cruise report of the 2019 IWC-POWER.
04. Summary of IWC-POWER surveys (2010-19).
05. Crance, J. and Matsuoka, K. Results of the passive acoustic component of the IWC-POWER cruises, 2017-19.
06. Hakamada, T. Estimation of $g(0)$ for North Pacific sei whale based on 2019 POWER sighting data.
07. Iani, K., Matsuoka, K. and Kitakado, T. Abundance estimation for the North Pacific large baleen whales using IWC-POWER data (2010-18).
08. Kitakado, T. and Matsuoka, K. Measurement errors in the distance and angle in the line transect surveys in the IWC-POWER data and their possible impact to the abundance estimation.
09. Yasuhara, Matsuoka, K. and Kitakado, T. Abundance estimation of floating marine debris in the North Pacific using 2010-16 IWC-POWER data.
10. Kitakado, T. and Inai, K. Power analysis for the IWC-POWER.
11. Matsuoka, K., Takahashi, M. and Hakamada, T. Proposal for the backup plan of 2020 IWC-POWER future survey.
12. Inai, K. and Kitakado, T. Some progress on simulation studies for assessing effectiveness of spatial line transect methods.
13. Hakamada, T. Updates on estimation of $g(0)$ for North Pacific sei whale.
14. Inai, K. Updates on humpback in Kamchatka.

Annex D

Summary of Effort and Sightings Information From 2010-19

Compiled by Koji Matsuoka

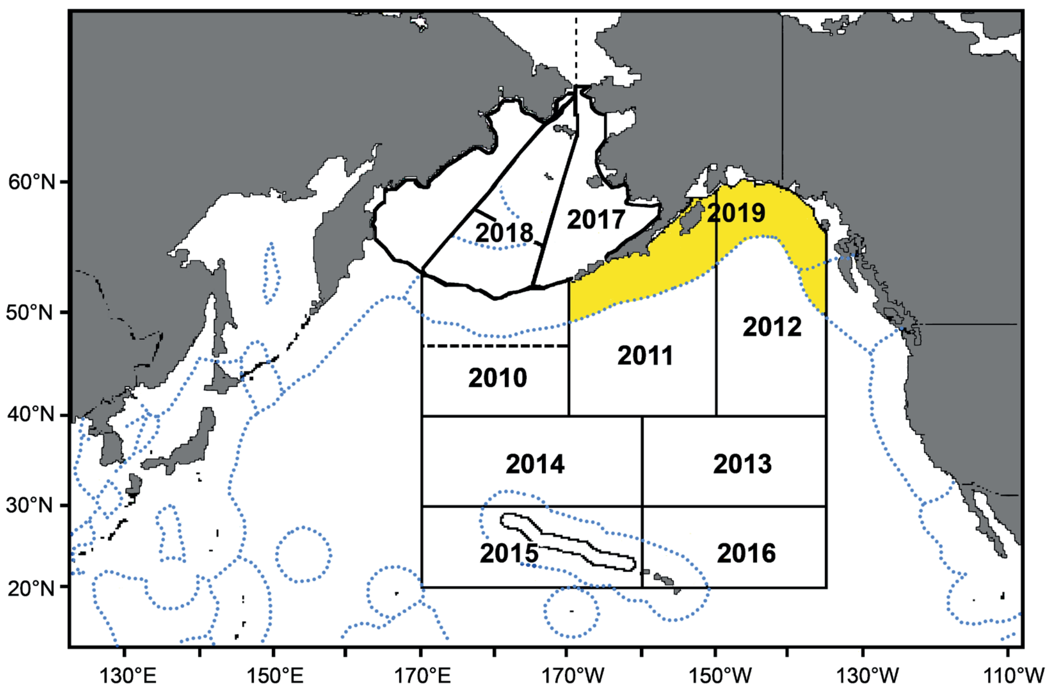


Fig. 1. Research area for the 2010-2019 IWC-POWER cruises. Yellow: 2019 research area. Dotted blue line: EEZs.

Table 1

Summary of effort and sighting of large whales during 2010 to 2019 POWER surveys.

Year	2010											
Vessel	*Kaiko-Maru*											
Area	Transit to R.A		Transit from R.A		Transit total		Northern stratum		Southern stratum		R.A total	
Planned distance (n.miles)	-		-		-		1,347.8		2,023.3		3,371.1	
Searching effort (n.miles)	0.0		170.1		170.1		490.5		1,325.7		1,816.2	
Searching coverage (%)	-		-		-		34.0		70.0		53.9	
Species	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.
Blue whale	0	0	2	2	2	2	1	1	2	2	3	3
Fin whale	0	0	5	7	5	7	16	38	7	10	23	48
Like fin	-	-	-	-	-	-	-	-	-	-	-	-
Sei whale	0	0	9	17	9	17	4	4	49	97	53	101
Like sei	-	-	-	-	-	-	-	-	-	-	-	-
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0
Like Bryde's	-	-	-	-	-	-	-	-	-	-	-	-
Common minke whale	0	0	0	0	0	0	8	8	0	0	8	8
Like minke	0	0	0	0	0	0	1	1	0	0	1	1
Humpback whale	0	0	0	0	0	0	5	8	0	0	5	8
Like humpback	-	-	-	-	-	-	-	-	-	-	-	-
NP right whale	0	0	0	0	0	0	0	0	0	0	0	0
Like right	-	-	-	-	-	-	-	-	-	-	-	-
Gray whale	0	0	0	0	0	0	0	0	0	0	0	0
Like gray	-	-	-	-	-	-	-	-	-	-	-	-
Sperm whale	0	0	8	8	8	8	22	22	45	62	67	84
Like sperm	-	-	-	-	-	-	-	-	-	-	-	-
Total	0	0	24	34	24	34	57	82	103	171	160	253

Year	2011											
Vessel	*Yushin-Maru No.3*											
Area	Transit to R.A		Transit from R.A		Transit total		Northern stratum		Southern stratum		R.A total	
Planned distance (n.miles)	-		-		-		1,290.2		2,145.5		3,435.7	
Searching effort (n.miles)	467.3		232.7		699.9		723.8		1,674.0		2,397.8	
Searching coverage (%)	-		-		-		58.0		78.0		69.8	
Species	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.
Blue whale	0	0	1	1	1	1	1	1	8	8	9	9
Fin whale	1	1	1	1	2	2	47	91	33	48	80	139
Like fin	-	-	-	-	-	-	-	-	-	-	-	-
Sei whale	0	0	20	22	20	22	0	0	38	73	38	73
Like sei	-	-	-	-	-	-	-	-	-	-	-	-
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0
Like Bryde's	-	-	-	-	-	-	-	-	-	-	-	-
Common minke whale	0	0	0	0	0	0	1	1	1	1	2	2
Like minke	0	0	0	0	0	0	1	1	1	1	2	2
Humpback whale	0	0	0	0	0	0	74	131	2	2	76	133
Like humpback	-	-	-	-	-	-	-	-	-	-	-	-
NP right whale	0	0	0	0	0	0	0	0	0	0	0	0
Like right	-	-	-	-	-	-	-	-	-	-	-	-
Gray whale	0	0	0	0	0	0	0	0	0	0	0	0
Like gray	-	-	-	-	-	-	-	-	-	-	-	-
Sperm whale	23	23	15	22	38	45	6	10	51	64	57	74
Like sperm	-	-	-	-	-	-	-	-	-	-	-	-
Total	24	24	37	46	61	70	130	235	134	197	264	432

Year	2012											
Vessel	*Yushin-Maru No.3*											
Area	Transit to R.A		Transit from R.A		Transit total		Northern stratum		Southern stratum		R.A total	
Planned distance (n.miles)	-		-		-		959.7		1,898.7		2,858.4	
Searching effort (n.miles)	550.5		0.0		550.5		767.5		1,358.6		2,126.1	
Searching coverage (%)	-		-		-		80.0		85.0		-	
Species	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.
Blue whale	0	0	0	0	0	0	0	0	4	4	4	4
Fin whale	35	41	0	0	35	41	76	116	38	53	114	169
Like fin	-	-	-	-	-	-	-	-	-	-	-	-
Sei whale	6	13	0	0	6	13	2	4	79	147	81	151
Like sei	-	-	-	-	-	-	-	-	-	-	-	-
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0
Like Bryde's	-	-	-	-	-	-	-	-	-	-	-	-
Common minke whale	0	0	0	0	0	0	1	1	1	1	2	2
Like minke	0	0	0	0	0	0	0	0	0	0	0	0
Humpback whale	14	26	0	0	14	26	7	7	0	0	7	7
Like humpback	-	-	-	-	-	-	-	-	-	-	-	-
NP right whale	0	0	0	0	0	0	1	1	0	0	1	1
Like right	-	-	-	-	-	-	-	-	-	-	-	-
Gray whale	0	0	0	0	0	0	0	0	0	0	0	0
Like gray	-	-	-	-	-	-	-	-	-	-	-	-
Sperm whale	5	5	0	0	5	5	17	24	28	28	45	52
Like sperm	-	-	-	-	-	-	-	-	-	-	-	-
Total	60	85	0	0	60	85	104	153	150	233	254	386

Year	2013							
Vessel	*Yushin-Maru No.3*							
Area	Transit to R.A		Transit from R.A		Transit total		R.A total	
Planned distance (n.miles)	-		-		-		3,233.8	
Searching effort (n.miles)	854.9		451.4		1,306.3		3,035.9	
Searching coverage (%)	-		-		-		93.9	
Species	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.
Blue whale	0	0	0	0	0	0	0	0
Fin whale	0	0	2	2	2	2	1	1
Like fin	-	-	-	-	-	-	-	-
Sei whale	0	0	4	4	4	4	0	0
Like sei	-	-	-	-	-	-	0	0
Bryde's whale	48	58	0	0	48	58	6	6
Like Bryde's	-	-	-	-	-	-	-	-
Common minke whale	0	0	1	1	1	1	0	0
Like minke	0	0	0	0	0	0	0	0
Humpback whale	0	0	0	0	0	0	0	0
Like humpback	-	-	-	-	-	-	-	-
NP right whale	0	0	0	0	0	0	0	0
Like right	-	-	-	-	-	-	-	-
Gray whale	0	0	0	0	0	0	0	0
Like gray	-	-	-	-	-	-	-	-
Sperm whale	21	23	13	26	34	49	33	50
Like sperm	-	-	-	-	-	-	-	-
Total	69	81	20	33	89	114	40	57

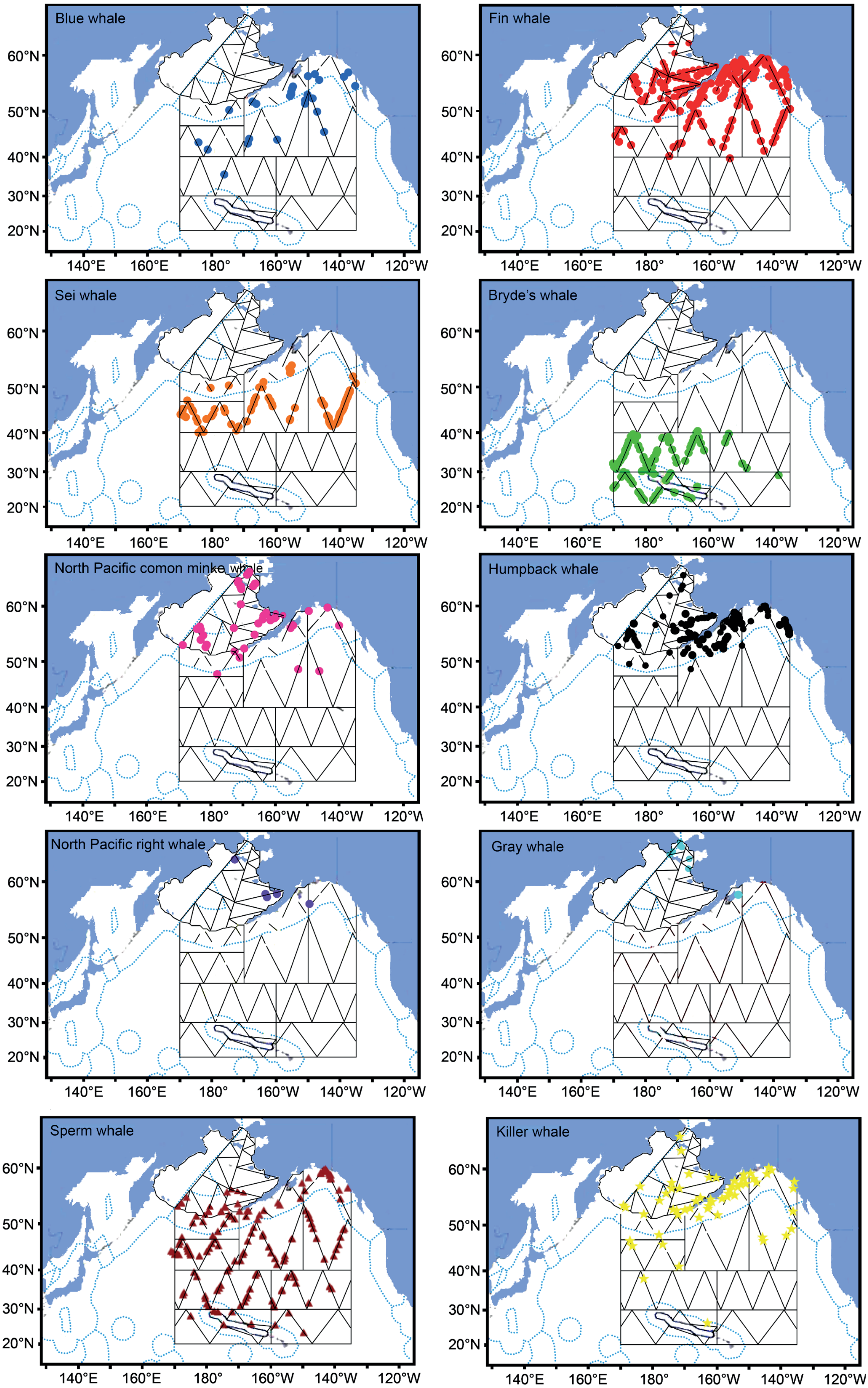
Year	2014							
Vessel	*Yushin-Maru No.3*							
Area	Transit to R.A		Transit from R.A		Transit total		R.A total	
Planned distance (n.miles)	-		-		-		3,878.4	
Searching effort (n.miles)	234.9		293.2		528.1		3,233.0	
Searching coverage (%)	-		-		-		83.4	
Species	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.
Blue whale	0	0	0	0	0	0	1	1
Fin whale	0	0	0	0	0	0	0	0
Like fin	0	0	0	0	0	0	0	0
Sei whale	0	0	0	0	0	0	1	1
Like sei	0	0	0	0	0	0	0	0
Bryde's whale	29	41	1	1	30	42	88	98
Like Bryde's	0	0	0	0	0	0	3	3
Common minke whale	0	0	0	0	0	0	0	0
Like minke	0	0	0	0	0	0	0	0
Humpback whale	0	0	0	0	0	0	0	0
Like humpback	0	0	0	0	0	0	0	0
NP right whale	0	0	0	0	0	0	0	0
Like right	0	0	0	0	0	0	0	0
Gray whale	0	0	0	0	0	0	0	0
Like gray	-	-	-	-	-	-	-	-
Sperm whale	7	10	6	8	13	18	65	137
Like sperm	0	0	0	0	0	0	0	0
Total	36	51	7	9	43	60	158	240

Year	2015							
Vessel	*Yushin-Maru No.3*							
Area	Transit to R.A		Transit from R.A		Transit total		Total	
Planned distance (n.miles)	-		-		-		3,588.7	
Searching effort (n.miles)	765.2		291.9		1,057.1		3,248.5	
Searching coverage (%)	-		-		-		90.5	
Species	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.
Blue whale	0	0	0	0	0	0	0	0
Fin whale	0	0	0	0	0	0	0	0
Like fin	0	0	0	0	0	0	0	0
Sei whale	0	0	0	0	0	0	0	0
Like sei	0	0	0	0	0	0	0	0
Bryde's whale	17	18	2	2	19	20	27	32
Like Bryde's	10	12	0	0	10	12	2	2
Common minke whale	0	0	0	0	0	0	0	0
Like minke	0	0	0	0	0	0	0	0
Humpback whale	0	0	0	0	0	0	0	0
Like humpback	0	0	0	0	0	0	0	0
NP right whale	0	0	0	0	0	0	0	0
Like right	0	0	0	0	0	0	0	0
Gray whale	0	0	0	0	0	0	0	0
Like gray	-	-	-	-	-	-	-	-
Sperm whale	21	43	0	0	21	43	11	50
Like sperm	0	0	0	0	0	0	0	0
Total	48	73	2	2	50	75	40	84

Year	2016							
Vessel	*Yushin-Maru No.3*							
Area	Transit to R.A		Transit from R.A		Transit total		R.A Total	
Planned distance (n.miles)	-		-		-		2,302.7	
Searching effort (n.miles)	626.2		580.1		1,206.3		2,237.5	
Searching coverage (%)	-		-		-		97.2	
Species	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.
Blue whale	1	1	0	0	1	1	0	0
Fin whale	0	0	0	0	0	0	0	0
Like fin	0	0	0	0	0	0	0	0
Sei whale	1	1	0	0	1	1	0	0
Like sei	0	0	0	0	0	0	0	0
Bryde's whale	14	18	13	13	27	31	1	1
Like Bryde's	2	2	6	6	8	8	0	0
Common minke whale	0	0	0	0	0	0	0	0
Like minke	0	0	0	0	0	0	0	0
Humpback whale	0	0	0	0	0	0	0	0
Like humpback	0	0	0	0	0	0	0	0
NP right whale	0	0	0	0	0	0	0	0
Like right	0	0	0	0	0	0	0	0
Gray whale	0	0	0	0	0	0	0	0
Like gray	-	-	-	-	-	-	-	-
Sperm whale	2	3	24	82	26	85	6	30
Like sperm	0	0	0	0	0	0	0	0
Total	20	25	43	101	63	126	7	31

Year	2017											
Vessel	*Yushin-Maru No.2*											
Area	Transit to R.A		Transit from R.A		Transit total		Transit survey in R.A		R.A original trackline		R.A total	
Planned distance (n.miles)	-		-		-		-		2,183.7		-	
Searching effort (n.miles)	288.3		0.0		288.3		130.7		1,570.9		1,701.6	
Searching coverage (%)	-		-		-		-		71.9		-	
Species	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.
Blue whale	0	0	0	0	0	0	0	0	0	0	0	0
Fin whale	2	3	0	0	2	3	2	2	141	193	143	195
Like fin	0	0	0	0	0	0	0	0	17	20	17	20
Sei whale	0	0	0	0	0	0	0	0	0	0	0	0
Like sei	0	0	0	0	0	0	0	0	0	0	0	0
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0
Like Bryde's	0	0	0	0	0	0	0	0	0	0	0	0
Common minke whale	0	0	0	0	0	0	1	1	22	22	23	23
Like minke	1	1	0	0	1	1	0	0	1	1	1	1
Humpback whale	7	8	0	0	7	8	5	5	124	152	129	157
Like humpback	0	0	0	0	0	0	0	0	9	12	9	12
NP right whale	0	0	0	0	0	0	2	4	5	11	7	15
Like right	0	0	0	0	0	0	0	0	2	2	2	2
Gray whale	0	0	0	0	0	0	1	1	14	21	15	22
Like gray	0	0	0	0	0	0	0	0	0	0	0	0
Sperm whale	10	18	0	0	10	18	0	0	15	15	15	15
Like sperm	0	0	0	0	0	0	0	0	0	0	0	0
Total	20	30	0	0	20	30	11	13	350	449	361	462

Year	2018														2019																			
Vessel	*Yushin-Maru No.2*														*Yushin-Maru No.2*														Total					
Area	Transit to R.A		Transit from R.A		Transit Total		Northern stratum		Southern stratum		Transit survey in R.A		R.A Total		Transit to R.A		Transit from R.A		Transit Total		Western stratum		Eastern stratum		Transit survey in R.A		R.A Total		Subtotal Transit		Subtotal R.A (original trackline)		Total (Transit + R.A)	
Planned distance (n.miles)	-		-		-		994.0		1,243.9		-		2,237.9		-		-		-		1,263.7		1,212.5		-		2,476.2		-		29,566.6		-	
Searching effort (n.miles)	89.9		100.4		190.3		708.5		1,035.5		536.4		1,744.0		322.3		115.0		437.3		1,030.7		1,088.1		420.0		2,118.8		6,434.1		23,659.5		30,093.6	
Searching coverage (%)	-		-		-		71.3		83.2		-		77.9		-		-		-		81.6		89.7		-		85.6		-		80.0		-	
Species	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.	sch.	ind.
Blue whale	4	7	4	5	8	12	0	0	0	0	0	0	0	0	1	1	1	1	2	2	10	10	7	9	0	0	17	19	14	18	34	36	48	54
Fin whale	12	22	3	5	15	27	40	64	67	87	13	21	120	172	0	0	0	0	0	0	77	149	162	256	27	53	266	458	61	82	747	1,182	808	1,264
Like fin	1	2	0	0	1	2	8	10	7	7	3	3	18	20	0	0	0	0	0	0	8	15	11	13	1	2	20	30	1	2	55	70	56	72
Sei whale	0	0	5	7	5	7	0	0	0	0	0	0	0	0	16	22	1	1	17	23	9	20	0	0	0	0	9	20	62	87	182	346	244	433
Like sei	0	0	2	2	2	2	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	2	0	0	0	0	1	2	3	3	1	2	4	5
Bryde's whale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	124	151	122	137	246	288
Like Bryde's	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	20	5	5	23	25
Common minke whale	1	1	0	0	1	1	11	11	5	5	0	0	16	16	1	1	0	0	1	1	1	1	4	4	0	0	5	5	3	3	56	56	59	59
Like minke	0	0	0	0	0	0	1	1	1	1	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	6	6	7	7
Humpback whale	1	1	0	0	1	1	3	3	52	72	30	46	85	121	0	0	0	0	0	0	95	224	52	65	26	113	173	402	22	35	475	828	497	863
Like humpback	0	0	0	0	0	0	0	0	3	3	0	0	3	3	0	0	0	0	0	0	6	14	0	0	1	1	7	15	0	0	19	30	19	30
NP right whale	0	0	0	0	0	0	1	1	0	0	2	2	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	19	11	19
Like right	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2
Gray whale	0	0	0	0	0	0	26	86	0	0	1	2	27	88	0	0	0	0	0	0	6	15	0	0	0	0	6	15	0	0	48	125	48	125
Like gray	0	0	0	0	0	0	1	4	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	1	4
Sperm whale	0	0	9	9	9	9	1	1	25	26	0	0	26	27	16	27	14	14	30	41	14	14	6	6	0	0	20	20	194	321	345	539	539	860
Like sperm	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
Total	19	33	23	28	42	61	92	181	161	202	49	74	302	457	34	51	17	17	51	68	227	464	242	353	55	169	524	986	503	723	2,110	3,388	2,613	4,111


Blue whale
Fin whale
Sei whale
Bryde's whale
North Pacific comon minke whale
Humpback whale
North Pacific right whale
Gray whale
Sperm whale
Killer whale
60°N
50°N
40°N
30°N
20°N
140°E
160°E
180°
160°W
140°W
120°W

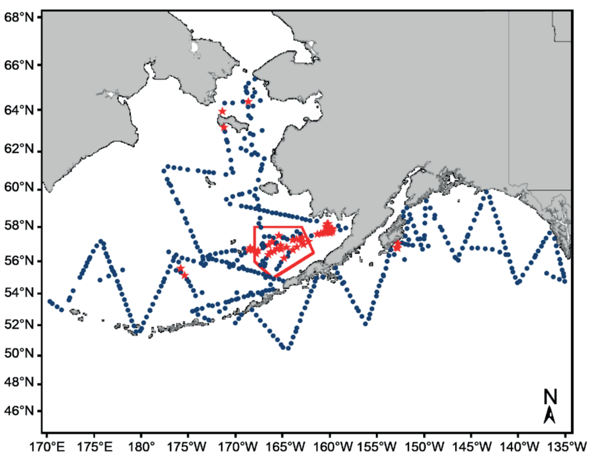
Annex E

Summary of Acoustic Information From 2017-19

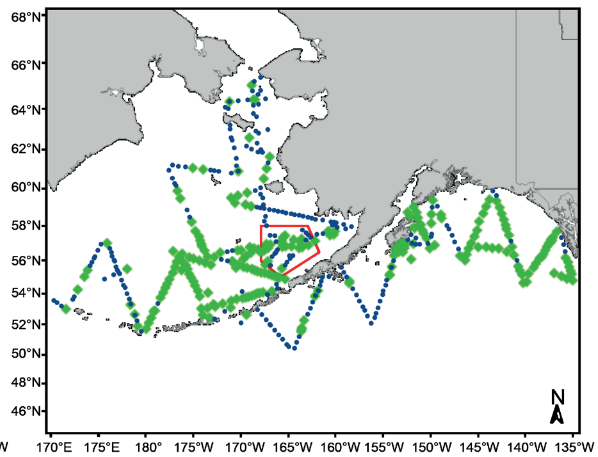
Compiled by Jessica Crance

MAPS SHOWING ACOUSTIC DETECTIONS BY SPECIES FOR THE 2017-19 CRUISES

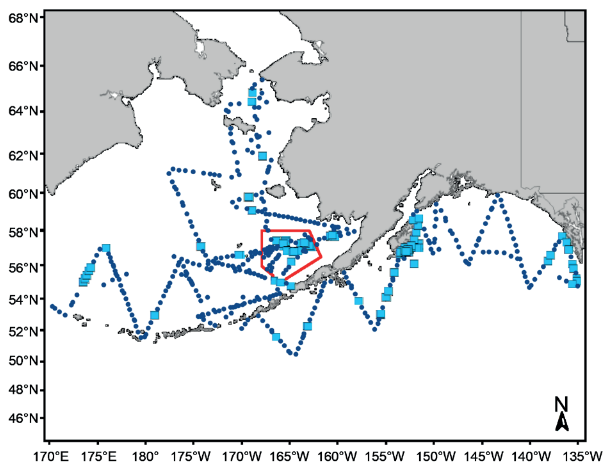
Dark blue dots show the sonobuoy deployments and the red polygons represent designated North Pacific Right Whale Critical Habitat.



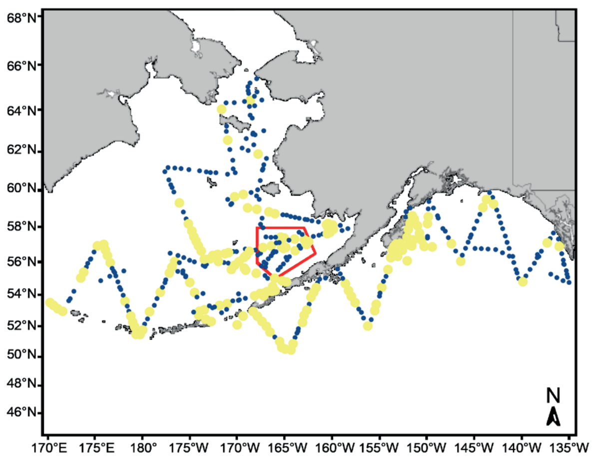
North Pacific right whale detections



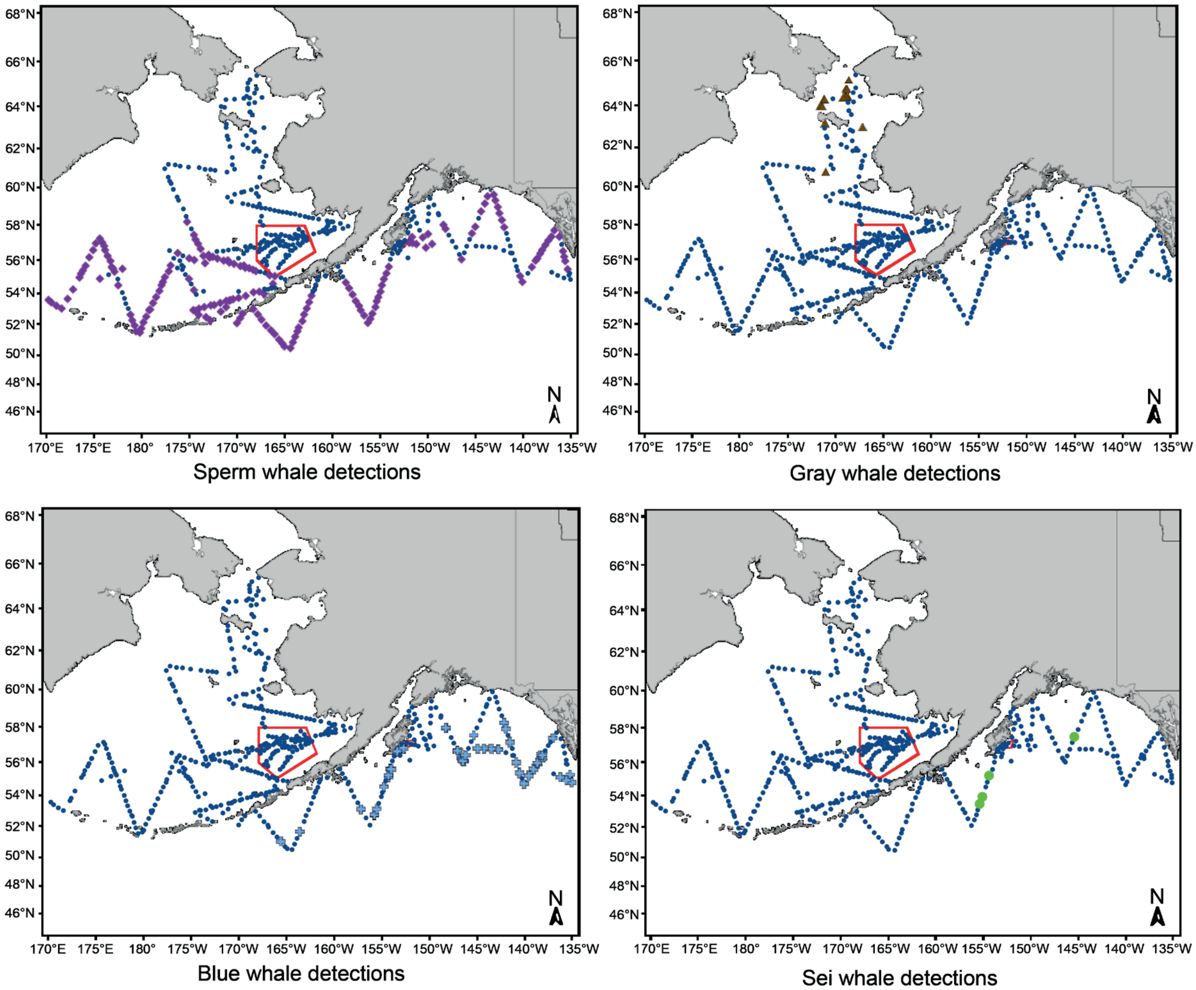
Fin whale detections



Humpback whale detections



Killer whale detections


68°N
66°N
64°N
62°N
60°N
58°N
56°N
54°N
52°N
50°N
48°N
46°N
N
170°E 175°E 180° 175°W 170°W 165°W 160°W 155°W 150°W 145°W 140°W 135°W
Sperm whale detections
Gray whale detections
Blue whale detections
Sei whale detections

Report of the Planning Meeting for the 2020 IWC-POWER Cruise

Tokyo, Japan, 20 January 2020

Report of the Planning Meeting for the 2020 IWC-POWER Cruise[1]

The Planning Meeting was held at the Japanese Fisheries Agency Crew House on 20 January 2020 (the report was drafted on 21 January).

1. INTRODUCTORY ITEMS

1.1 Opening remarks and welcoming address

Matsuoka (Convenor) welcomed the participants. Moronuki (Fisheries Agency) reiterated the importance of the IWC-POWER programme to Japan although it had left the IWC last year, noting that the tenth such cruise had been completed successfully. He thanked all the researchers and crew who participated in the cruise. He hoped that the next phase of the programme could be completed in co-operation with the IWC and its Scientific Committee. He looked forward to a fruitful and constructive planning meeting and noted that Japan was working with the Russian authorities to try to obtain the necessary permit to hold the 2020 cruise in the western Bering Sea and also recognised the importance of developing a backup plan in the event that permission could not be obtained.

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 have been extremely important to the IWC and our knowledge of whales in the North Pacific regions that had largely been unstudied in recent decades; a considerable amount of very valuable information is being accrued as was discussed at the recent IWC-POWER TAG meeting (SC/68B/REP/01). The programme continues to provide an excellent example of international cooperation.

1.2 Election of Chair

Kato was elected Chair with Matsuoka as co-Chair.

1.3 Adoption of Agenda

The adopted agenda is given as Annex B.

1.4 Appointment of rapporteurs

Crance, Brownell and Palka were appointed rapporteurs, assisted by Donovan and Matsuoka.

1.5 Review of documents

The list of documents is given as Annex C.

2. REVIEW OF DISCUSSIONS AT SC68A AND THE TAG MEETING

2.1 Progress since last planning meeting

2.1.1 Distance and angle experiments

The TAG had reviewed an updated analysis of the 2010-18 distance and angle experiments that took into account comments made at the previous TAG and Scientific Committee meetings. The analysis showed that although (as expected) there is variation in ability to estimate angles and distances there was no evidence of any systematic underestimation or overestimation that would translate into any significant bias in abundance estimates. A final version of the paper will be presented at the next Scientific Committee meeting.

2.1.2 Abundance estimation

The TAG received updated and new analyses of the 2010-18 data to obtain estimates of abundance for the main large whale species. This included both standard line-transect approaches and spatial modelling approaches. The work was well received and some suggestions were made to facilitate completing the analyses before the next Scientific Committee meeting. Provided the updates can meet the one month deadline, it is hoped that they can be agreed upon at SC68B.

2.1.3 Analyses of marine debris data

The TAG welcomed an updated version of the paper analysing the marine debris data that has been submitted for publication (SC/TAG/2020/WP/09).

[1]Presented to the Scientific Committee as SC/68B/REP/02.

2.1.4 Medium-term plans

The TAG reviewed the results of the IWC-POWER programme thus far (recognising that Phase I was almost complete) in the light the development of the medium-term plan. A revised list of priority species/populations was developed that will be proposed to the Scientific Committee.

2.1.5 Backup plan for 2020

The TAG meeting recognised the need to develop a backup plan for the 2020 cruise which is proposed to be in Russian waters. The TAG developed options for the backup plan (all in the high seas so no permit is required) that are discussed further below.

3. PRELIMINARY RESULTS FROM THE 2019 CRUISE

3.1 Sightings

Matsuoka presented a short summary of the preliminary cruise report from the 10th IWC-POWER cruise that took place from 3 July to 25 September 2019; more details can be found in the report of the TAG meeting (SC/68B/REP/01). The cruise was successfully conducted and good (over 75%) coverage of the planned tracklines was achieved. Fin (239 sightings/405 individuals) and humpback (147/289) whales were the most frequently seen species with sightings of blue, sei, gray, sperm and common minke whales, as well as several small cetacean species being sighted. No North Pacific right whales were seen although there were some acoustic detections.

The crew of the vessel and international researchers worked well together to meet the objectives of the survey and follow IWC guidelines.

3.2 Acoustics

An acoustic component was included for the 3rd time to acoustically monitor for the presence of marine mammals, with a particular focus on detecting and locating North Pacific right whales. A total of 229 sonobuoys were deployed, for a total of over 820 monitoring hours. Species detected included fin whales (over 55% of sonobuoys), sperm whales (over 50%), killer whales (over 35%), blue whales (about 25%), humpback whales (over 20%), and North Pacific right whales (about 5%). The acoustic data were consistent with the distribution data from the sightings.

3.3 Biopsy sampling

A total of 75 biopsy (skin and sometimes blubber) samples were collected from five species: blue (12), fin (45), humpback (12), gray (2) and sei (4) whales.

3.4 Photo-identification

Preliminary analyses of the photo-ID data revealed about 122 unique individuals from six species: gray (6), blue (16), fin (51), humpback (30) and killer (19) whales.

3.5 Other

A total of 42 objects of marine debris were observed.

> *Recommendation*
>
> *The Planning Meeting was* **impressed** *with the provision of the draft cruise report 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, experts and the scientific permits to survey in US waters and enter a US port. Finally, the Planning Meeting* **thanked** *the cruise leader, Matsuoka, for his hard work, dedication to the project and leadership skills.*

3.6 Recommendations from cruise team

3.6.1 VHF radios

On the 2018 and 2019 cruises, photographers had used VHF radios on loan from NOAA. During photo-ID experiments it is useful to be able to coordinate between researchers on separate platforms in order to maximise the number of individuals photographed, rather than have three isolated photographers all focusing on the closest animal. The cruise report recommended that VHF radios are available for future cruises.

> *Recommendation*
>
> *The meeting* **recognised** *the value of having VHF radios on board,* **thanked** *NOAA for the loan of equipment in 2019 and agreed that Donovan and Matsuoka would investigate whether these can be acquired for 2020 and beyond within the existing budget.*

3.6.2 Lightroom, camera and computer equipment

Images collected during the 2019 cruise were again uploaded to Lightroom, greatly reducing post-processing time, facilitating development of rapid photo-analysis summaries and expediting image access/sharing. The cruise report had recommended that this process continues and that the guidelines for the IWC Lightroom Photographic Database be updated. The new IWC-POWER laptop with fast processor, high resolution wide screen and ample memory and drive storage was welcomed. The cruise report also recommended that the IWC Nikon D7000 camera and GPS unit be serviced and if necessary or possible, replaced.

Recommendation
The meeting **reiterated** *the value of the IWC-POWER Lightroom photographic database and Donovan and Matsuoka will ensure that an updated manual and the most recent version of the database are available on the IWC laptop prior to the 2020 cruise. They will investigate the possibility of purchasing a new IWC camera if the Nikon D7000 cannot be repaired.*

4. GENERAL ISSUES

4.1 Availability of research vessel(s) from Japan and elsewhere

The Fisheries Agency of Japan is hoping to provide the *Yushin-Maru No. 2* or a similar vessel with an international license for the 2020 cruise.

Although no other countries will be able to provide vessels this year as a formal part of the IWC-POWER programme, it was noted that: researchers from the Pacific Islands Fisheries Science Center are embarking on a winter research cruise to study cetaceans and seabirds around the main Hawaiian Islands aboard the NOAA Ship *Oscar Elton Sette* from January to March, a time of year not previously studied. The survey is called the Winter Hawaiian Islands Cetacean and Ecosystem Assessment Survey (WHICEAS, pronounced 'why-sees'). There is also a proposal for a US cruise in the Gulf of Alaska in 2022.

4.2 Budget (including accommodation and food costs)

Donovan reported that funds for the 2020 cruise had been approved. The meeting was informed that the costs for food and accommodation on the vessel is the same as in previous years (¥2,500 per day).

4.3 Research permit for Russian waters

Suzuki (Fisheries Agency of Japan) explained that the permit application for the 2020 IWC-POWER survey in the Western Bering Sea had been submitted to Russia in December 2019 via diplomatic channels (the application for the 2019 cruise in those waters had been refused in March 2019 but no specific reasons for the refusal had been provided). It was noted that the IWC Chair and the Secretariat had also written to the Russian Commissioner seeking support for the application.

5. PRIORITIES AND 2020 CRUISE PLAN (INCLUDING BACKUP PLAN)

Given the potential difficulties in obtaining a permit for Russian waters in 2019, noted under Item 4.3, it was **agreed** that a backup plan should be developed. Both the original plan (hereafter 'Russian option' originally discussed at last year's planning meeting) and the backup plan (hereafter 'backup plan') are incorporated into the discussion below.

5.1 Research priorities

The Planning Meeting confirmed that the 2020 cruise objectives will be broadly the same as in previous years but the details will differ depending on the options as discussed below. The cruise will thus focus on the collection of line transect data to estimate abundance as well as collection of biopsy and photo-identification data. For logistical reasons, no acoustic work will be undertaken under the Russian option.

Either option, the Russian or the backup, 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 ongoing assessments of North Pacific sei, humpback and gray whales in terms of abundance, distribution and stock structure;
(b) information on endangered North Pacific right whales;
(c) baseline information on distribution, stock structure and abundance for a poorly known area for other cetacean species/populations, including those that were known to have been depleted in the past but whose status is unclear; and
(d) 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.

For the Russian option, a primary focus will also be to complete the surveyed area for fin whales to obtain comprehensive abundance estimates. For the backup option, a primary focus will be to collect IO data to allow more robust estimation of $g(0)$ for at least fin and sei whales as well as to provide comparable coverage of the western part of the southern stratum of the 2010 survey.

Table 1

Proposed itinerary for the IWC-POWER cruise assuming 76 days (Russian and backup option). For reasons of refuelling and supplies, the maximum time in the research area will be about 60 days for the Russian option and 53 days for the backup option.

Option 1: Russian		Option 2: Backup	
Date	Event	Date	Event
11 July 2020	Pre-cruise meeting at Shiogama	10 July 2020	Pre-cruise meeting in Shiogama
12 July	Vessel departs Shiogama	11 July	Vessel departs Shiogama
18 July	Vessel arrives Petropavlovsk-Kamchatskiy	17 July	Vessel starts research area survey
21 July	Vessel departs Petropavlovsk-Kamchatskiy	13 August	Vessel completes first half of survey
26 July	Vessel starts survey in research area	17 August	Vessel arrives Kushiro for refuelling
12 September	Vessel leaves the research area	20 August	Vessel leaves Kushiro
16 September	Vessel arrives Petropavlovsk-Kamchatskiy	25August	Vessel starts research area survey
19 September	Vessel leaves Petropavlovsk-Kamchatskiy	18 September	Vessel completes survey
24 September	Post-cruise meeting on vessel	24 September	Vessel arrives Shiogama
25 September	Vessel arrives Shiogama	25 September	Post-cruise meeting in Shiogama

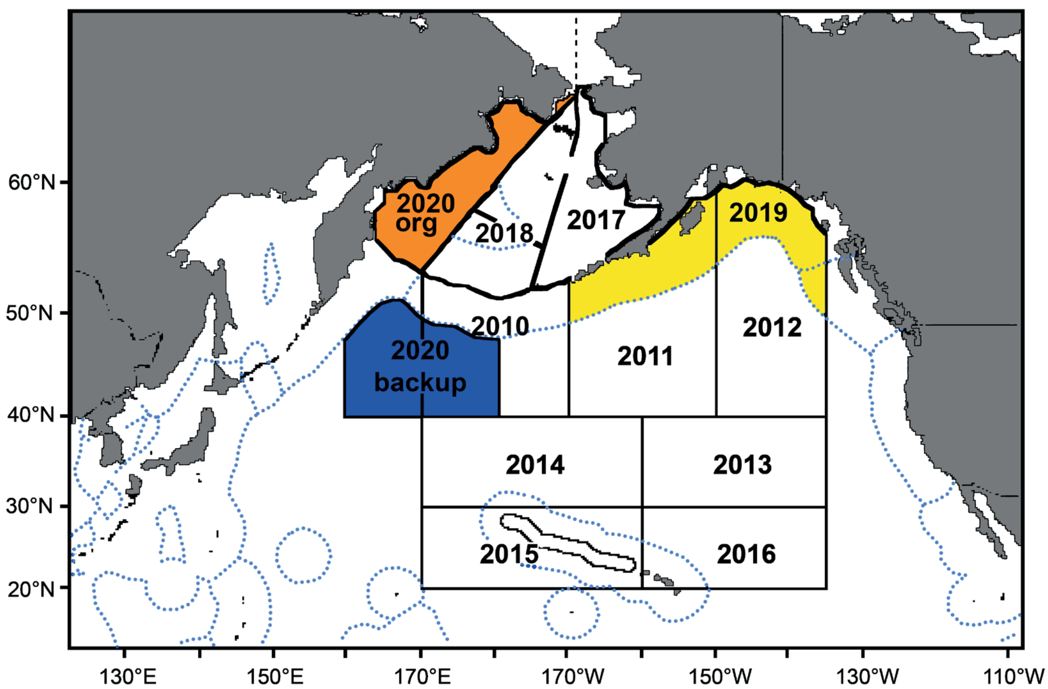


Fig. 1. Map showing the areas surveyed thus far under IWC-POWER (2010-19) with the proposed 2020 area. The preferred Russian option is shown in orange and the back-up option is shown in blue.

5.2 Research area(s)
Fig. 1 shows the boundaries of the Russian option (single stratum) and the backup option (two strata) for 2020.

5.3 Research vessel and days available (general itinerary)
The proposed itineraries for each option are provided in Table 1.

5.4 Cruise track design
Fig. 2 shows the proposed cruise track design for each option.

5.5 Sighting survey (including transit)
5.5.1 Survey modes and allocation of effort (including number of crew, research speed)

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

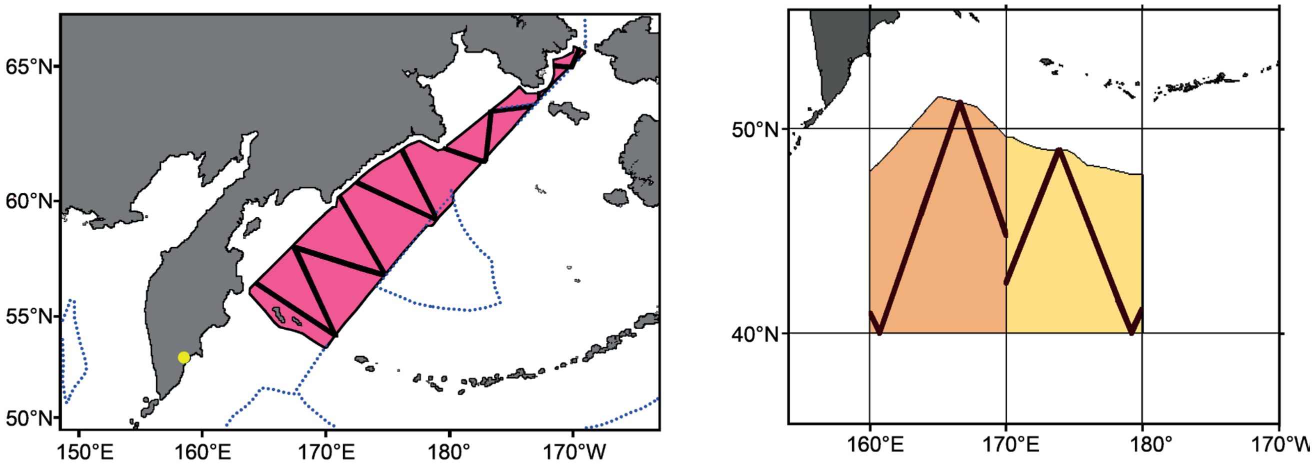


Fig. 2. Proposed tracklines for the Russian option (left) and the backup option (right). The Russian option excludes the Anadyr Gulf and waters around Karaginskiy Island to facilitate the granting of a permit. The actual tracks can be further modified if requested.

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 both options, the survey will alternate modes between Normal Closing Mode (NSP) and Independent Observer Mode (IO) (*circa* every 50 n.miles). However:

(1) if the high density of whales in the research 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; and
(2) given the high priority assigned to obtaining IO data for sei and fin whales, the Cruise Leader in consultation with the captain may decide to increase IO effort beyond 50%.

Research hours during the cruise will be the same as on previous POWER cruises. This will involve a maximum 12 hours per day between 6:00 and 19:00, including 30 minutes for meals (lunch and supper) during IO mode. Days will begin 60 minutes after sunrise and end 60 minutes before sunset. For biopsy sampling/photo-identification work on priority species, there may be occasions when it is beneficial to extend the research activities outside the normal research hours. The basis for any such extension of research hours will involve mutual agreement between the captain and cruise leader and an allocation of equivalent time-off the following morning or evening.

The research day in transits will begin 30 minutes after sunrise and end 30 minutes before sunset, with a maximum of a 12-hour research day. Time-zone changes will be in 30-minute intervals, coming into effect at midnight. Research mode will operate after Day 2 when on transit.

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 will be an additional person on the IO platform (e.g. researcher). The number of researchers to be used is discussed further in Item 13.1 below.

As in 2019, a speed of 11.5 knots (through the water) will be maintained during research, although in conditions of heavy swell, searching speed might have to be reduced.

5.5.2 Acceptable conditions

The usual guidelines will apply, i.e. visibility (in principle for seeing common minke whales) >2.0 n. miles; wind speed <21 knots; sea state <Beaufort 6. The upper ranges of these conditions are not suitable to reliably see common minke whales but are sufficient for the other large whale species.

5.5.3 Angle and distance experiment

The experiment is designed to calibrate and identify any biases in individual observers' estimation of angle and distance. The experiment should be conducted during weather and sea conditions representative of the conditions encountered during the survey. The equipment and methods will follow the improved approach developed since 2015. Attempts will be made to conduct the experiment in higher wind speeds (e.g. 15 knots) but with due consideration given to time and other constraints. The detailed protocol can be found in the Guide for Researchers.

5.5.4 Data recording and format

The survey will be conducted using the ICR data acquisition system (an English language version is now available in response to a previous recommendation of the TAG, see SC/68A/REP/01) and data forms where appropriate. Whilst cetaceans are the priority, opportunistic data on other taxa may be collected at the discretion of the cruise leader (e.g. turtles or pinnipeds).

Recommendation

The meeting **agreed** *that Donovan and Matsuoka will update the Guidelines for Researchers as necessary for the 2020 cruise.*

5.6 Biopsy sampling

5.6.1 Priority species

Biopsy sampling will only be undertaken for the backup option. The highest priority species for biopsy sampling is the North Pacific right whale, followed by blue, fin, gray and sei whales. Medium-priority species include sperm, common minke and killer whales.

With respect to humpback whales, for the Russian option 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. Elsewhere, humpback whales have been sampled in large numbers and so in those areas the species is considered low priority for biopsy sampling, although (as for other large whale species encountered) opportunistic samples are useful.

5.6.2 Equipment

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 safety reasons, life vests are to be worn for all activities below the bridge, including biopsy sampling.

For large cetaceans, small samples (<1 gram) 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 will be determined by the subjective judgment of experienced field biologists. They should err on the side of caution.

5.6.3 Sample storage

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 Japanese samples. The blubber sample will be retained whole (i.e. not be split) and held at ICR since 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.

5.7 Photo-identification studies

5.7.1 Priority species

As appropriate and decided by the Cruise Leader, research time will be allocated for the photo-ID and/or videotaping 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-ID of adults 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 photographs are the initial priority.

For safety reasons, life vests are to be worn for all activities below the bridge, including photo-ID work.

5.7.2 Equipment and collection

The existing camera equipment is considered sufficient if the Nikon D7000 can be fixed (see Item 3.6.2). If funds can be found, VHF radios will also be available (see Item 3.6.1). US scientists offered to assist with equipment loan as needed.

5.7.3 Analysis and archiving

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.

As noted under Item 3.6, the instructions for use of the Lightroom database will be updated.

Photographs that have been examined and catalogued as individuals for identification purposes will also be archived within a set of IWC-POWER Catalogues. 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 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 IWC Secretariat.

5.8 Acoustic studies

5.8.1 Priority species

Acoustic studies will only be undertaken under the backup option. The highest priority species for acoustics will be North Pacific right whales, followed by blue whales. As in previous cruises, the acoustician will not disclose the species detected on sonobuoys to avoid biasing the sighting effort of the observers, with the exception of North Pacific right whales.

5.8.2 Equipment

Equipment will be provided by the Alaska Fisheries Science Center (AFSC), including sonobuoys, laptop computer, antennae, cables, and analytical software. AFSC will also provide a dedicated, experienced acoustic observer (Crance or alternative) to conduct all acoustic monitoring operations on the cruise.

Ideally, the general acoustic schedule will involve deployment of one sonobuoy every 20-25 n.mile, as well as one at night, leading to 6 buoys per day under good conditions, provided sufficient buoys are available. When drifting for fog, one buoy can be monitored for the full 8 hours; no new deployment would be necessary unless the battery runs out or the buoy unexpectedly fails. The acoustic expert will determine the necessary number of sonobuoys deployed per day.

Recommendation

Japan will examine if sonobuoys can be used in the Japanese EEZ (including laws on acceptable frequencies). If it is permissible, decisions on whether to launch will be at the discretion of the Cruise Leader and Captain in consultation with the Acoustician). A small group comprising Crance, Matsuoka, Suzuki and Brownell was established to work on logistics and permissions for the acoustic work.

5.8.3 Analysis and archiving

The NOAA Marine Mammal Laboratory will continue to act as the curator of acoustic data on behalf of the IWC. Proposals for use of these data should be submitted through the IWC Secretariat in the usual manner.

5.9 Other studies

5.9.1 Marine debris

The Planning Meeting reiterated the importance of observations of marine debris and analyses of the data collected to date was discussed at the TAG meeting (SC/68B/REP/01). The protocol adopted for recording such material (15 minutes in every hour) will continue in 2020 to prevent compromising cetacean sightings searching effort.

5.9.2 Oceanographic studies

As noted previously (e.g. IWC, 2016), 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 to date.

5.9.3 Satellite tagging studies

No activities are planned for the 2020 cruise. IWC (2016) had agreed that the use of such equipment should be considered when designing the medium-term programme. If satellite equipment is available for potential use in the 2020 cruise its use must be discussed within the Steering Group **prior** to approval for use **and** follow IWC guidelines, including the need for an experienced tagger to carry out the work.

6. LOGISTICAL ISSUES FOR THE 2020 CRUISE (INCLUDING BACKUP PLAN)

6.1 International researchers and allocation of research personnel

All researchers will join the vessel in Japan. For the backup plan there is the possibility of the researchers leaving or joining the vessel at the refuelling port in the middle of the cruise.

For 2020, the framework detailed in Table 2 for researcher involvement was agreed, depending upon destination.

Table 2

Personnel for each cruise option.

Russian option*		Backup option 1st leg/ 2nd leg	
Matsuoka	Cruise Leader	Matsuoka/Murase	Cruise Leader
Zharikov?	Russia	Gilpatrick/Possibly Olson	USA
Gilpatrick	USA	Crance/Wright or Kimber	USA, Acoustician*
Katsumata	Japan	Katsumata/Katsumata	Japan
		Yoshimura/Takahashi*	If no acoustics

*Korea may be able to provide an experienced scientist as a backup.

6.2 Transportation of data, samples and equipment including permits

6.2.1 Home port organiser and entry/exit permits

The home port will be Shiogama and the home port organiser in Japan (and Kushiro for the backup plan refuelling) will be Hakamada. For the Russian option, Zharikov will act as home port organiser.

6.2.2 Sightings: equipment, data, permits and responsible persons

As in previous years, ICR (Matsuoka) and Kyodo Senpaku (Yoshimura) will check the sightings equipment to ensure that all is working/available. No permits are required. Within two months of the end of the cruise, all validated sightings data will be forwarded to IWC by the Cruise Leader (Matsuoka).

6.2.3 Biopsy: equipment, samples, permits and responsible persons

Biopsy samples will be taken using the Larsen gun system or a compound crossbow for the backup option; no biopsy sampling will occur if the Russian option is implemented. Matsuoka will ensure that the necessary equipment, including darts, plugs and vials are available. For the backup option, the same process as used previously will be followed using a permit for 'introduction from the sea'. For the backup option, ICR will ensure that the IWC samples are sent to the SWFSC in accordance with CITES procedures. A small intersessional group was established comprising Matsuoka (convenor), Taguchi and Brownell to finalise the process following past experience.

6.2.4 Photo-identification: equipment, permits and responsible persons

As in previous years, ICR (Matsuoka) and Kyodo Senpaku (Yoshimura) will check the camera equipment to ensure that all is working/available. Donovan and Matsuoka will ensure that the additional equipment agreed under Item 3.6 is purchased/ serviced as possible. No permits are required. Matsuoka will submit all identification photographs/videos and accompanying data to IWC within two months of the cruise.

6.2.5 Acoustics: equipment, permits and responsible persons

No acoustic work will be undertaken on the Russian option. For the backup option with acoustics, acoustic equipment (as much as possible will be sent well in advance) will be loaded in Shiogama, where Crance will join the vessel for the first part of the cruise. Testing of cables/GPS already fitted on the vessel will be undertaken by the crew in conjunction with Crance, well in advance of the cruise so that new equipment can be purchased if necessary. Data will be archived at NOAA's Marine Mammal Laboratory.

Arrangements to dispose of the trash materials in Shiogama (including costs) will be determined by a small group comprising Matsuoka, Crance and Yoshimura.

6.3 Communications

6.3.1 Safety aspects (daily report, etc.)

The vessel will be equipped with AIS. Daily vessel position reports will be submitted to ICR, NRIFS, the Fisheries Agency and Kyodo Senpaku Co Ltd. For the Russian option, daily reports may be necessary depending on the area, and in this case Zharikov will be responsible for contacting the relevant authorities. For the backup option there is no need for regular communication with the Japanese Coast Guard.

6.3.2 Between Cruise leader and IWC

As in previous years, weekly reports (every Monday) will be provided to the IWC Secretariat and members of the Steering Group.

6.3.3 Weather information

It was agreed that fog information will be required and this will be obtained as usual via a Japanese agency.

6.3.4 Other official communications

For the Russian option, arrangements will be made to comply with any requirements specified in the permit. Zharikov will investigate this. There are no additional requirements for the backup option.

6.3.5 Private communications

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. 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).

6.4 Meetings (including responsible persons)

6.4.1 Pre-cruise meeting (and possible mid-cruise meeting)

For both options, all researchers will join the vessel in Japan and the pre-cruise meeting will be held in Shiogama and organised by Hakamada. If there is a change in personnel in Kushiro under the backup plan, there will need to be a mid-cruise meeting on 18 August to facilitate the handover. The venue is to be decided.

The Cruise Leader will ensure that the report of the pre-cruise meeting(s) is/are circulated to the IWC-POWER Steering Group when completed.

6.4.2 Post-cruise meeting

For the Russian option, the post-cruise meeting will be held in Shiogama when the vessel returns to port; it will be organised by Hakamada. For the backup option, the post-cruise meeting will be held in Shiogama, on 25 September and organised by Hakamada.

6.5 Reports

6.5.1 Planning meeting report

This planning meeting report will be uploaded onto the IWC website as a Scientific Committee report for SC68B.

6.5.2 Cruise report

As usual, the cruise report will be drafted on the return journey of the cruise following the guidelines provided by Donovan. The report will be discussed at the next planning meeting and then a final version will be sent to the Secretariat for submission to the next Scientific Committee meeting after that.

6.6 Press releases

The Cruise Leader (or representative) in consultation with the IWC Secretariat (Kate Wilson and Greg Donovan) and, if necessary, Russia will prepare a press release before and after the cruise. The IWC, ICR, Russia (if required) 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 be given to providing a weekly or bi-weekly review of activities on the IWC website as the cruise progresses, along with a summary at the end of the cruise. Any additional press releases during the cruise precipitated by unusual observations (e.g. the finding of right whales) will be circulated for comment and approval by the Steering Group and the Cruise Leader prior to release.

6.7 Security

For the Russian option, the Fisheries Agency, ship agents and Zharikov will investigate the situation for Petropavlovsk-Kamchatskiy and ensure that adequate security measures are in place. No security problems are anticipated for the backup option. The IWC banner will be readily visible.

7. OTHER

7.1 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.

7.2 IWC website

Donovan reported that he will liaise with the Secretariat's Communications Officer, Kate Wilson, to update the IWC-POWER pages so that they are updated in light of the present meeting and the preceding TAG meeting after the reports are adopted at the 2020 Scientific Committee meeting. Crance will provide a selection of interesting acoustic recordings (e.g. of the Baird's beaked whale) and Donovan and Taylor will review the photographic archive to update those sections of the website.

8. CONCLUDING REMARKS AND ADOPTION OF REPORT

A list of action points arising from the meeting is given as Table 3. Kato thanked the meeting members for their participation and looked forward to a successful cruise in 2020.

The Captain thanked the participants for their work and promised the full and active participation of the crew to ensure another successful cruise in 2020.

Table 3
Task list for the 2020 cruise.

Item	Task	Responsible persons	Timeline
(1)	Update IWC-POWER pages on the website.	Secretariat and Steering Group	Continuing task
(2)	Contact researchers and check availability.	Brownell and Steering Group	By end of February
(3)	Decide where the 2020 cruise will be in light of permit situation.	Steering Group based upon advice from Japan	By 1 April 2020
(4)	Determine logistics and permissions for acoustic work for the backup plan.	Crance, Matsuoka, Brownell and ??	By 1 May 2020
(6)	Update 'Guide for Researchers' including the Lightroom manual, purchase new equipment in light of budget and update IWC computer.	Matsuoka and Donovan	By SC68B

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.

The meeting 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. Discussions at the meeting had been facilitated by the availability of the very good cruise report of the 2019 cruise.

The meeting adopted the report by e-mail on 1 February 2020.

Reference

International Whaling Commission. 2016. Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG), 8-10 October 2014, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 17:443-58.

Annex A

List of Participants

Robert Brownell	Southwest Fisheries Science Center, USA
Jessica Crance	Alaska Fisheries Science Center, USA
Greg Donovan	Head of Science, IWC
Yoshihiro Fujise	Institute of Cetacean Research, Japan
Takashi Hakamada	Institute of Cetacean Research, Japan
Yurie Hosoda	Fisheries Agency of Japan
Hidenori Kasai	Captain, Kyodo Senpaku Co., Ltd., Japan
Hidehiro Kato	Institute of Cetacean Research, Japan
Koji Matsuoka	Institute of Cetacean Research, Japan
Tomio Miyashita	National Research Institute of Far Seas Fisheries, Japan
Joji Morishita	Tokyo University of Marine Science and Technology, Japan
Hideki Moronuki	Fisheries Agency of Japan
Hiroto Murase	Tokyo University of Marine Science and Technology, Japan
Debra Palka	Northeast Fisheries Science Center, USA
Shinichi Suzuki	Fisheries Agency of Japan
Mioko Taguchi	Institute of Cetacean Research, Japan
Megumi Takahashi	Institute of Cetacean Research, Japan
Hideyoshi Yoshida	National Research Institute of Far Seas Fisheries, Japan
Isamu Yoshimura	Kyodo Senpaku Co., Ltd., Japan
Saemi Baba	Interpreter, Japan
Hiroko Yasokawa	Interpreter, Japan

Annex B

Agenda

1. Introductory items
    - 1.1 Opening remarks and welcoming address
    - 1.2 Election of Chair
    - 1.3 Adoption of Agenda
    - 1.4 Appointment of rapporteurs
    - 1.5 Review of documents
2. Review of discussions at SC68A and the TAG Meeting (SC/68B/REP/01)
    - 2.1 Progress since last planning meeting
        - 2.1.1 Distance and angle experiments
        - 2.1.2 Abundance estimation
        - 2.1.3 Analyses of marine debris data
        - 2.1.4 Other
3. Preliminary results from the 2019 cruise
    - 3.1 Sightings
    - 3.2 Acoustics
    - 3.3 Biopsy sampling
    - 3.4 Photo-identification
    - 3.5 Other
    - 3.6 Recommendations from cruise team
        - 3.6.1 VHF radios
        - 3.6.2 Lightroom, camera and computer equipment
4. General issues
    - 4.1 Availability of research vessel(s) from Japan and elsewhere
    - 4.2 Budget (including accommodation and food costs)
    - 4.3 Research permit for Russian waters
5. Priorities and 2020 cruise plan (including backup plan)
    - 5.1 Research priorities
    - 5.2 Research area(s)
    - 5.3 Research vessel and days available (general itinerary)
    - 5.4 Cruise track design
    - 5.5 Sighting survey (including transit)
        - 5.5.1 Survey modes and allocation of effort (including number of crew, research speed)
        - 5.5.2 Acceptable conditions
        - 5.5.3 Angle and distance experiment
        - 5.5.4 Data recording and format
    - 5.6 Biopsy sampling
        - 5.6.1 Priority species
        - 5.6.2 Equipment
        - 5.6.3 Sample storage
    - 5.7 Photo-identification studies
        - 5.7.1 Priority species
        - 5.7.2 Equipment and collection
        - 5.7.3 Analysis and archiving
    - 5.8 Acoustic studies
        - 5.8.1 Priority species
        - 5.8.2 Equipment
        - 5.8.3 Analysis and archiving
    - 5.9 Other studies
        - 5.9.1 Marine debris
        - 5.9.2 Oceanographic studies
        - 5.9.3 Satellite tagging studies
6. Logistical issues for the 2020 cruise (including backup plan)
    - 6.1 International researchers and allocation of research personnel
    - 6.2 Transportation of data, samples and equipment including permits
        - 6.2.1 Home port organiser and entry/exit permits

6.2.2 Sightings: equipment, data, permits and responsible persons
6.2.3 Biopsy: equipment, samples, permits and responsible persons
6.2.4 Photo-identification: equipment, permits and responsible persons
6.2.5 Acoustics: equipment, permits and responsible persons
6.3 Communications
6.3.1 Safety aspects (daily report etc.)
6.3.2 Between Cruise leader and IWC
6.3.3 Weather and sea temperature information
6.3.4 Other official communications
6.3.5 Private communications
6.4 Meetings (including responsible persons)
6.4.1 Pre-cruise Meeting
6.4.2 Post-cruise Meeting
6.5 Reports
6.5.1 Planning meeting report
6.5.2 Cruise report
6.6 Press releases
6.7 Security
7. Other
7.1 Data validation and analysis
7.2 IWC website
8. Concluding remarks and adoption of Report

Annex C

List of Documents (same as for TAG Meeting)

SC/TAG/2020/WP/

01. International Whaling Commission. 2020. Report of the 2018 meeting of the IWC-POWER Technical Advisory Group (TAG). *J. Cetacean Res. Manage (Suppl.)* 21: 311-332.
02. International Whaling Commission. 2020. Report of the Planning Meeting for the 2019 IWC-POWER Cruise. *J. Cetacean Res. Manage. (Suppl.)* 21: 333-346.
03. Matsuoka, K. *et al.* Cruise report of the 2019 IWC-POWER.
04. Summary of IWC-POWER surveys (2010-19).
05. Crance, J. and Matsuoka, K. Results of the passive acoustic component of the IWC-POWER cruises, 2017-19.
06. Hakamada, T. Estimation of *g*(0) for North Pacific sei whale based on 2019 POWER sighting data.
07. Iani, K., Matsuoka, K. and Kitakado, T. Abundance estimation for the North Pacific large baleen whales using IWC-POWER data (2010-18).
08. Kitakado, T. and Matsuoka, K. Measurement errors in the distance and angle in the line transect surveys in the IWC-POWER data and their possible impact to the abundance estimation.
09. Yasuhara, Matsuoka, K. and Kitakado, T. Abundance estimation of floating marine debris in the North Pacific using 2010-16 IWC-POWER data.
10. Kitakado, T. and Inai, K. Power analysis for the IWC-POWER.
11. Matsuoka, K., Takahashi, M. and Hakamada, T. Proposal for the backup plan of 2020 IWC-POWER future survey.
12. Inai, K. and Kitakado, T. Some progress on simulation studies for assessing effectiveness of spatial line transect methods.
13. Hakamada, T. Updates on estimation of *g*(0) for North Pacific sei whale.
14. Inai, K. Updates on humpback in Kamchatka.

Report of the IWC Workshop on Marine Debris: The Way Forward

La Garriga, Catalonia, Spain, 3-5 December 2019

Report of IWC Workshop on Marine Debris: The Way Forward[1]

CHAIR'S SUMMARY

The IWC's third Workshop on Marine Debris met in La Garriga in Catalonia, Spain, 3-5 December 2019 with experts from nine countries attending. The workshop aimed to progress the IWC's work on this threat by: (i) reviewing the latest evidence on interactions with cetaceans (both ingestion and entanglement) and considering evidence for associated toxicology; (ii) identifying best protocols for gross pathology, pathology for microdebris and the standardised classification of recovered plastics and other debris; and (iii) developing liaison with other relevant expert bodies.

The workshop considered published and unpublished information, including reviews of the latest literature and a comprehensive overview of marine debris-related activities by other international organisations. It also considered a number of regional reports, including from the Adriatic, the Spanish Canary Islands, German and Dutch waters and the Mediterranean. The workshop agreed that the scale of the actual and projected increase in plastics is alarming.

Cetaceans can die after marine debris ingestion, due to gastric impaction/occlusion, perforation, or associated lesions. Besides direct lethal effects, presence of plastic debris could affect marine mammals' health if they persist in the gastrointestinal tract (GIT), for example by reducing the space for food and, subsequently, reducing their fitness and the nutritional condition. Presence of foreign bodies could also cause inflammatory changes to the GIT and/or induce stress and pain. An additional concern on the health effects of marine debris on cetaceans was related to the potential role of plastic debris as a carrier or vector of toxins and pathogens. The workshop also considered the relationship between marine debris and entanglement in fishing gear and received new information on Fisheries Aggregation Devices. Noting that approximately 640,000 tonnes of Abandoned, Lost and otherwise Discarded Fishing Gear (ALDFG) enters the oceans every year, the workshop also called for actions to address this threat, including for bowhead whales in the Bering Sea which may be at particular risk.

Based on its discussions, the workshop made a series of detailed recommendations, including: emphasising the importance of long-term studies; the need for standardised approaches to post-mortem studies; the importance of strandings networks; the assessment of floating debris during aerial surveys; and the integration of marine debris concerns into the IWC's Conservation Management Plans, where appropriate. The vulnerability of some species was highlighted, as was the potential of some to be used as indicator species. The workshop also called on the IUCN to consider marine debris in its next assessment of the sperm whale.

Other recommendations covered engagement with international bodies (the workshop encouraged the establishment of a roster of marine debris experts by the IWC who would help to represent it at key meetings) and the development of a marine debris database of information from post-mortem examinations. The joint ACCOBAMS/ASCOBANS document on 'Best practice on cetacean post-mortem investigation and tissue sampling' was strongly welcomed and commended to the Scientific Committee for its consideration. A link to this is provided in the full report.

Communicating this issue was also discussed and it was agreed that this should: (i) take into account the audience; (ii) be accurate about the underpinning scientific information and its limitations; (iii) emphasise upstream solutions in addition to end of life measures; (iv) consider consulting communication professionals or social scientists; and (v) wherever possible, focus on positive, actionable messaging.

Please see the report below for the full recommendations.

1. INTRODUCTORY ITEMS

The workshop was held from 3-5 December, 2019 in La Garriga, Catalonia, Spain. The Chair, Mark Simmonds welcomed participants to the meeting and thanked the Netherlands for supporting the workshop. Anne Marie Svoboda and Sarah Smith added words of welcome on behalf of the Netherlands and the IWC.

The workshop aimed to progress IWC work on marine debris to date, including the recommendations of the previous IWC workshops by: (i) reviewing the latest evidence on interactions with cetaceans (both ingestion and entanglement) and considering evidence for associated toxicology; (ii) identifying best protocols for gross pathology, pathology for microdebris and the standardised classification of recovered plastics and other debris; and (iii) developing liaison with other relevant expert bodies.

The Chair noted that since the IWC started to look at this issue in 2011, there had been a tremendous increase in public concern and the threat to biodiversity posed by marine debris has come more sharply into focus for all, including

[1]Presented to the Scientific Committee as SC/68B/REP/03.

policy makers. Marine debris was now recognised as a major global threat to biodiversity at a time when the accelerating loss of biodiversity needed to be ranked alongside the threat posed by climate change, to which it is of course linked. He concluded that we all needed to work expeditiously to address these existential threats.

The workshop Agenda is given in Annex 1, the documents list is in Annex 2 and the list of participants is in Annex 3. Experts from nine countries were present at the workshop.

2. THE MARINE DEBRIS ISSUE

2.1 An introduction to the marine debris issue

2.1.1 Presentation

Eisfeld-Pierantonio gave an overview of the issue of marine debris and cetaceans. The United Nations Environment Programme (UNEP, 2009) defines marine debris as any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine or coastal environment. In other words, it is human-created waste that has deliberately or accidentally been released in a sea or ocean.

Marine debris comprises various material types and can be classified into several distinct categories: plastics, metal, glass, processed timber, paper and cardboard, rubber and clothing and textiles. Plastics Europe (2019) reports global plastics production in 2016 as 335 million tonnes, rising to 359 million tonnes in 2018. Geyer *et al.* (2017) estimated that in the last 60 years, 8.3 billion metric tonnes of plastic have been created, most of which is still on this planet. Only about 30% of this plastic is still in use, 79% of it is accumulating in landfill, 12% has been incinerated and only 9% has been recycled. Ritchie and Roser (2020) provide helpful data analyses and future predictions for marine debris.

It is estimated that every minute of every day, the equivalent of one truckload of plastic enters the sea, this equates to between 4.8 and 12.7 million metric tonnes of plastic trash every year (Jambeck *et al.*, 2015), which is estimated to be more than the weight of every blue whale left in the world today. Some estimates indicate that up to 333,000 items of debris can be found per square kilometre of ocean surface (National Research Council, 2009). Plastics, which account for 60-80% of marine debris (Gregory and Ryan, 1997), are ubiquitous and occur across all oceans, including in remote areas. Evidence suggests that plastics pose a serious threat to marine wildlife, with negative effects from plastic debris established for an increasing list of species.

Bigger items of plastic break down into smaller microplastics with sun, wind and wave action. A single 1L plastic bottle could break down into enough small fragments to put one on every mile of beach in the entire world (Roorda, 2020). Between 115,000 and 1,050,000 particles/km^2 are estimated to float in the Mediterranean Sea (Panti *et al.*, 2019). Studies have shown that plastic debris meeting other pollutants in the oceans absorb some harmful chemicals from the sea water, acting like pollution sponges. One study found that virgin plastic pellets 'suck up' these persistent organic pollutants (POPs) and other toxins with a concentration factor that is almost 1 million times greater compared to the overall concentration of the chemicals in seawater (Mato *et al.*, 2001). Filter-feeding marine megafauna are particularly prone to microplastic ingestion and contamination by plastic-associated toxins because of the large volumes of water they ingest during feeding, but microplastic particles have also been found in various odontocete species in the UK (Nelms *et al.*, 2019), China (Xiong *et al.*, 2018; Zhu *et al.*, 2019), Galicia (Hernandez-Gonzalez *et al.*, 2018) and also Canada (Moore *et al.*, 2019).

Over the last 50 years, as technology has advanced and human demand has risen, there has been a dramatic increase in fishing effort in the world's oceans. During this time non-biodegradable fishing gear' primarily made from plastics' has also been introduced. As a significant source of litter in the ocean, fishing-related debris - nets, line, rope, traps, pots, floats and packing bands are a key and distinct part of the global marine debris issue with disproportionately higher impacts on marine wildlife compared to other types of debris through its potential to entangle, trap or be ingested. The effects range from immediate mortality through drowning to progressive debilitation over a period of months or years. Some plastic fishing gear, for example monofilament line and monofilament gillnets, is almost invisible in water. These are also extremely strong and very resistant to biting and chewing by trapped animals. Richardson *et al.* (2019b) estimate that 5.7% of all fishing nets, 8.6% of all traps, and 29% of all lines are lost around the world each year.

Marine plastic litter pollution is already known to be affecting more than 800 marine species through ingestion, entanglement and habitat change (Secretariat of the Convention on Biological Diversity, 2016). Sixty-nine of the 89 cetacean species officially recognised by IUCN are reported to have been affected by marine debris pollution, 60 cetacean species have been impacted by entanglement, 48 species have ingested marine debris (Pierantonio *et al.*, 2018).

Eisfeld-Pierantonio noted that there is more awareness of marine plastic pollution but that this brings an evaluation problem: are there more plastic related deaths of animals, because there is more plastic in the oceans or are people simply more aware and are looking for a plastic connection? Are funds available for plastic research, because there is more awareness? There is no reference point, since previous records (e.g. from the 1970s and 1980s) may not have specifically recorded 'plastic in the stomach', but a more general observation such as 'foreign bodies in the stomach'. When it comes to ingestion of marine debris, it remains a challenge to identify if the debris was the direct cause of death or a contributing factor.

Size categories of plastic marine litter, assuming a near-spherical form, showing common definitions and alternative options that may be appropriate for operational reasons.

Field descriptor	Relative size	Common size divisions	Measurement units	References	Alternative options	Remarks
Mega	Very large	>1m	Metres	GESAMP		
Macro	Large	25-1,000m	Metres Centimetres Millimetres	MSFD	25-50mm	
Meso	Medium	5-25mm	Centimetres Millimetres	MSFD	<25mm 1-25mm	MARPOL Anex V (pre revision)
Micro	Small	<5mm	Millimetres Microns	NOWPAP MSFD	1-5mm <1mm >330um*	Eriksen *et al.* (2014)
Nano[$]	Extremely small	<1µm	Nanometres		<10nm	Not considered for monitoring

*operationally-defined, referring to the typical mesh size of 300µm of towed plankton nets; [$]nano-sized particles can only be identified under carefully controlled laboratory conditions and may form a monolayer on one (plates) or two (fibres) dimensions.

Fig 1. Size categories of plastic marine litter, assuming a near-spherical form, showing common definitions and alternative options that may be appropriate for operational reasons (GESAMP, 2019).

She added that the scientific community appears split about the effects of microplastics - some say they cannot draw any firm conclusions on the potential biological significance of ingested microplastics and further research is required to better understand the potential chronic effects of microplastic exposure on animal health, whilst others believe that exposure to microplastics through direct ingestion and consumption of contaminated prey poses a major threat to the health of the animals.

Abandoned, lost or otherwise discarded fishing gear (ALDFG) represents a significant, yet ultimately unknown amount of global marine debris, with serious environmental and socio-economic impacts. ALDFG is incredibly hard to track and to assess, as there is no global system or enforcement for reporting of lost gear. It is also hard to determine if entangled animals were entangled by active gear or ghost gear.

2.1.2 Discussion

The workshop agreed that the scale of the actual and projected increase in plastics is alarming and noted the importance of communicating the threats posed by this impending 'tsunami' of plastic to the decision makers and the public in clear straightforward messages. Further discussion on communication is found in Item 7.

Participants discussed the relative merits of different marine debris definitions, noting that the EU (including for its Marine Strategy Framework Directive) describes marine litter as '*items that have been deliberately discarded, unintentionally lost, or transported by winds and rivers, into the sea and on beaches',* whilst UNEP (2009) as noted above (in 2.1.1) provides a global definition of marine debris. Discussion on terminology noted the use of 'marine debris' (used by the IWC) versus 'marine litter' in different fora. Some participants felt that 'litter' implies a deliberate introduction by humans, whilst 'debris' has broader implications.

The workshop noted existing categorisation of plastics by size, including that developed by Germanov *et al.* (2018) and the categorisation developed by the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection - GESAMP (2019), and see Fig 1.

Recommendation

The workshop **endorsed** *the categorisation of debris sizes set out in the report of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP, 2019).*

2.2 Review of previous IWC workshops

Simmonds provided an overview of previous IWC work on this topic, noting that recommendations from previous IWC workshops had been helpfully summarised in a contribution from the IWC Secretariat to a report of the UN Secretary General on marine debris to the Open Ended Consultative Process on Oceans and Law of the Sea (IWC, 2016a).

The IWC began to formally consider marine debris in 2011 following its endorsement of the UN Environment Programme Honolulu Commitment. The IWC finds marine debris to be of conservation and welfare concern for cetaceans throughout the oceans. To date, the IWC has held two expert workshops on marine debris. The first was held at the Woods Hole Oceanographic Institution in May 2013 and focused on evaluation of the known effects on cetaceans. Among other things it recommended that member nations of the IWC should report on marine debris interactions in their national progress reports and concluded that 'legacy and contemporary marine debris have the potential to be persistent, bioaccumalative and lethal to cetacean populations and represent a global management challenge' (IWC, 2014). The second workshop was held in August 2014 in Hawaii (IWC, 2016b). Its primary focus was to explore how the IWC might best engage with existing international and regional mitigation efforts. The workshop agreed that the IWC's primary contribution should be to ensure that cetacean-related issues are adequately represented within existing initiatives, and that its strong scientific and other expertise is made available in collaborative efforts. Working effectively with other Multilateral Environmental Agreements (MEAs) has also been emphasised as being of high importance.

Entanglement
The IWC has held workshops on large whale entanglement in all fishing gear and has also established a global network for disentanglement of whales from gear, including a training and support programme. Entanglement in active fishing gear is well established as a significant problem in conservation and welfare terms. The IWC has signalled the need to determine the degree to which marine debris *per se* has population-level effects needs further study, and the key issue is separating out the effects of active gear from lost gear.

Ingestion
In addition to the discussions and conclusions of its two previous workshops on marine debris, the IWC Scientific Committee has also received and reviewed various papers on debris ingestion by cetaceans, including Simmonds (2012), Baulch and Perry (2014a; 2014b) and Pierantonio and Simmonds (2018). To date, ingestion of debris has been documented in 48 (56%) of cetacean species, with rates of ingestion ranging from zero to as high as 31% in stranded animals from certain populations. Plastics are dominant in ingested debris and parts of fishing gear which are also frequently ingested.

The IWC has previously expressed concern regarding the high rates of debris ingestion in ziphiids, sperm whales and certain populations of Franciscana dolphins. It has also noted a need for a significant improvement in data collection and collation to improve understanding of the ingestion threat and that this should include consideration of both physical and toxicological impacts.

3. REVIEW OF NEW INFORMATION SINCE PREVIOUS IWC WORKSHOPS

3.1 New information in the scientific literature

3.1.1 Presentation
Pierantonio summarised new information in the scientific literature on marine debris. In 2018, under the framework of the 2017-2019 Work Programme of The Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS), a review of available information on the issue of interactions between marine litter and cetaceans was produced. The document was also made available to the IWC Scientific Committee Meeting in Bled, Slovenia, in May of the same year (Pierantonio and Simmonds, 2018). It was based on a review of 182 sources, the great majority being scientific peer-reviewed articles, but also including reports, conference proceedings, and other grey literature published between 1962 and March 2018. A strong positive trend in the number of published accounts detailing the occurrence of interactions between marine litter and cetaceans was clear; the number of documents made available increased by a factor of 20 since 1962.

Evidence suggested an increase in the number of cases reported per species, with a concomitant increase in the number of cetacean species recorded to have ingested or have been entangled in debris. Overall, 69 of the 89 cetacean species officially recognised by the International Union for the Conservation of Nature (IUCN) were reported to be in some way affected by marine debris pollution either by ingestion or entanglement. A higher number of species seemed to be affected by entanglement rather than ingestion, with macrolitter representing the main issue for all Families. Microlitter showed the highest incidence in the *Balaenopteridae* Family, while the *Delphinidae* seemed to be particularly affected by meso and macrolitter. Only three Families of cetaceans, together accounting for four species, were not reported to be affected in any way by marine litter, these being the *Lipotidae*, *Monodontidae* and *Platanistidae*. The authors highlighted strong geographical patterns in the species and number of animals per species that have interacted with debris. Habitat preferences, diving and feeding behaviour, as well as the 'behaviour' and position of debris in the water column, cause these differences by affecting the amount, type and rate of interaction between cetaceans and debris, with clear differences amongst species. The authors of the review concluded that cetaceans are affected by a wide range of types of debris and that effects range from negligible, through chronic to debris-related mortalities, although clear cases of ingested marine debris causing deaths remain few and scattered. The review further highlighted that, at the time, it was difficult to point at any specific debris type as presenting a particular threat to cetaceans.

Building on the 2018 review, and as a contribution to the La Garriga workshop, Pierantonio collated the most recent information concerning marine debris in terms of ingestion and entanglement: 17 new peer-reviewed journal articles, published between March 2018 and January 2020, were identified (see Annex 4). Of these, seven papers concerned abandoned, lost or otherwise discarded fishing gear (ALDFG) both globally and at regional scales, five papers specifically concerned the presence of microplastic primarily in stranded small-sized cetaceans, and, finally, five papers described the occurrence of ingested macroplastic and macrodebris by cetaceans and its potential detrimental effects. The evidence provided in these new studies support the findings of the previous review but also provide further critical information to evaluate the extent and severity of the issue of interactions between cetaceans and marine debris. Strong evidence suggests that some species ingest debris more often than others due to their prey-capture strategy rather than the presence of higher amounts of debris in the water column or of species habitat preferences and diving behaviour. For small-sized cetaceans, the new studies suggest that the ingestion of significant amounts of microplastics could add long-term toxicological effects to the more immediate consequences of macroplastic ingestion.

Whilst it is still not clear which particular items of debris are the main cause of concern, the new information seems to support the fact that plastic items, in particular plastic bags and single use items, are the most prevalent macro debris found in stranded cetaceans. Finally, even though these papers presented new information on ingestion of micro- and macro debris, no new evidence was available for entanglement of cetaceans in marine debris, particularly in relation to ALDFGs, the extent and effects of which remain extremely difficult to assess.

A brief summary of the main findings and conclusions of these papers is presented below.

- Four papers presented information from two areas under-reported in the previous review: Latin America (specifically Brazil) and portions of the seas around China.
- From Chinese waters comes the first description of ingested microplastic in a stranded Indo-Pacific humpback dolphin (*Sousa chinensis;* Zhu *et al.*, 2019) and the presence of microplastic in the intestinal tracts of East Asian finless porpoises (*Neophocaena asiaeorientalis sunameri;* Xiong *et al.,* 2018) indicating that coastal delphinids might suffer from microplastic pollution, including young calves. The studies, despite a limited sample size, represent a starting point for assessing microplastics in the endangered coastal delphinid in the Chinese Seas and highlight the lack of robust information and the necessity of further work to look for evidence of adverse effects of microplastics pollution on cetaceans in the studied areas.
- From Brazil the works by Brentano and Petry (2020) and Di Beneditto and Oliveira (2019) provided information on the presence of ingested debris in the pygmy sperm whale (*Kogia breviceps*), the Guiana dolphin (*Sotalia guianensis)* and the franciscana (*Pontoporia blainvillei*). Brentano and Petry (2020) show that, in southern Brazil, *K. breviceps* suffers intense impacts from both ingestion of anthropic material and fisheries, and so should be closely monitored. Di Beneditto and Oliveira (2019) show that the proportion of debris found in the stomach of stranded cetaceans varied among species with *P. blainvillei, a* pelagic demersal consumer, presenting a higher frequency of ingestion than *S. guianensis, a* pelagic consumer. The authors suggested that the feeding site in the water column does not predict the probability of debris ingestion, but, concerning these two species, this probability seems to be more associated with prey-capture strategies, regardless of debris availability in the environment.
- From the Mediterranean Sea, both at the basin and local scales, four papers presented new evidence on ingested macroplastics and the occurrence of fisheries related marine litter and specifically ALDFG. Alexiadou *et al.* (2019) analysed the stomach contents of 34 individuals from seven odontocete species stranded in Greece between 1993 and 2014. Macroplastic was found in the stomachs of nine individuals from four species (harbour porpoise *Phocoena phocoena*, Risso's dolphin *Grampus griseus*, Cuvier's beaked whale *Ziphius cavirostris* and sperm whale *Physeter macrocephalus*) with the highest frequency of occurrence in sperm whales. Gastric blockage following ingestion of plastic has been reported by the authors to be presumably lethal in three cases, with plastic bags being the most common finding. The authors highlighted that plastic ingestion is of particular conservation concern for endangered Mediterranean sperm whales and, therefore, a regular examination of stranded cetaceans with a standardised protocol is critical for allowing spatiotemporal comparisons within and across species. The works by Consoli *et al.* (2019), Moschino *et al.* (2019) and Sinopoli *et al.* (2020) present strong evidence that ALDFGs, particularly fish aggregating devices (FAD), greatly contribute to the Mediterranean litter-scape with an estimated 1.6 million FADs abandoned in the Mediterranean Sea between 1961 and 2017. The studies strongly highlight the potential harmful impacts of ALDFGs on the Mediterranean Sea biodiversity, including cetaceans, and recognise that preventive measures appear to be the most suitable strategies to mitigate the impact of ALDFGs on the environment.
- For European North Atlantic waters, Hernandez-Gonzalez *et al.* (2018), Nelms *et al.* (2019) and Puig-Lozano *et al.* (2018) provided information on the occurrence of microplastics in the stomach contents of common dolphin (*Delphinus delphis*) stranded on the Galician coasts of Spain, on the presence of microplastics in marine mammals stranded around the British coast and on the pathology associated with the presence of foreign bodies in stranded cetaceans in the Canary Islands, respectively. These studies provide strong evidence that microplastic is ubiquitous not only amongst large filter feeding cetaceans but also in smaller odontocete species. Nonetheless, as previously stated, the presence of microplastic remains a cause of concern for these species. Its effects cannot be assessed easily, but toxicological effects

are the most likely to be detrimental in the long term. In this context, Nelms *et al.* (2019) indicate that animals that died due to infectious diseases had a slightly higher number of particles than those that died of trauma and other drivers of mortality showing a possible relationship between the cause of death and the abundance of microplastics.
- Finally, Moore *et al.* (2019) described the occurrence of microplastics in beluga whales (*Delphinapterus leucas*) from the Eastern Beaufort Sea, raising questions regarding the significance and long-term exposure of this pollutant in this ecologically and culturally valuable species.

3.1.2 Discussion
The workshop noted that some species seem to be able to discriminate plastics from food and others cannot or are unable to avoid ingesting it. Cuvier's beaked whale, for example, can distinguish between different species of cephalopods but still ingests plastic bags. This warrants further investigation.

The workshop stressed the value of retrospective studies (i.e. studies reviewing reports of previous post-mortem investigations) in studying marine debris but advised caution in interpreting these to compare different levels in different species, stressing that sample size needed to be taken into account. In addition, it is important for necropsy reports to record zero values for marine debris, i.e. no plastics found. Previous reports might not have done this.

Participants noted that plastics are being identified in more and more species (*ca* 800; Secretariat of the Convention on Biological Diversity, 2016). Methodologies used for other species (e.g. for modelling overlap between marine debris and different species) could provide insights for further work on marine debris impacts on cetaceans.

3.2 Review of evidence from strandings investigations
3.2.1 Latest results from the Adriatic
Mazzariol presented a review of information from stranded animals from the Adriatic. The establishment of an institutional stranding network in Italy involving the Coast Guard, Veterinary Public Laboratories and Universities, has ensured constant monitoring of the 8,000km long Italian coastline since 2015.

The percentage of cetaceans stranded in the period 2015-2018 submitted to necropsy was 45%. The cause of death was hypothesised in 65% of these cases: 40% of the necropsied cetaceans died due to spontaneous causes/natural diseases (cetacean morbillivirus [CeMV] and bacteria mainly). 25% were deemed to have had an interaction with human activities. For the remaining 35% the likely cause of death was not established.

Marine debris were found in the gastro-intestinal (GI) tract of 11 individuals (3% of examined animals), mainly sperm whales (4), beaked whales (1), and striped and bottlenose dolphins. Three sperm whales were found entangled in passive nets out of 360 animals necropsied in four years (3.8%). While entanglement was deemed to be fatal in all the cases, no cetaceans displaying evidence of marine litter ingestion had plastic debris in the GI tract established as cause of death. These data are lower than results from the Spanish Canary Islands but confirm that deep divers are the species mainly affected.

Preliminary data for 2019 confirm an additional six animals, mainly sperm whales (4) with marine debris in their stomach contents, including an exceptional finding of 29kg of plastic bags and sheets in a pregnant female found stranded in Sardinia in March 2019. Additionally, a sperm whale calf was found floating entangled with the mother in the same period. Most of them were in poor nutritional condition.

All the sperm whales belonged to an outbreak of strandings which occurred between November 2018 and June 2019, with 14 mortalities. The examined animals deemed in good preservation condition for postmortem analyses (7/14) were positive to CeMV. This outbreak, and the recent findings from Italy, confirm that the sperm whale can be considered a target species for marine debris ingestion and entanglement in the Mediterranean Sea, as in other parts of the world. The concurrent presence of a spontaneous disease should be considered as the principal cause of death and it is not clear from necropsies if marine debris presented a predisposing factor, a consequence, or an incidental finding. Finding marine debris in the stomach does not directly indicate it is the cause of death: a through and detailed necropsy should be performed according to standard veterinary procedures to ascertain other possible causes. Interpretation of evidence should be undertaken using a forensic approach identifying the mechanism of death and excluding all the other possible causes.

In order to compare these data across the Mediterranean and worldwide, Mazzaroil opined that necropsies should be run routinely from fully-functioning and well-established stranding networks including, if possible, trained professionals, including veterinary pathologists. Common language, procedures and data collection are needed to create baseline data, assess the trends of ingestions in specific areas for each species and understand the real impact of marine debris and entanglement on marine mammals. The minimum data set should include location where carcass was found, species, age and gender, nutritional condition code, presence/absence of litter in the stomach or around the body of the animal, associated Gastro-Intestinal-Tract (GIT) pathology, and likely cause of death.

Mazzariol further reported that ACCOBAMS, with the support of MEDPOL (a marine pollution assessment programme of the European Environment Agency), are undertaking pilot studies on marine litter and entanglement monitoring in the

Adriatic Sea. In this basin, an Interreg[2] project, Network for the Conservation of Cetaceans and Sea Turtles in the Adriatic (NETCET), has already established transboundary cooperation with sharing of common procedures. During the inaugural workshop for the new project, a common necropsy protocol was proposed, and a common data collection method has been in place for one year. In addition to information from single countries, the workshop also reviewed an assessment of marine litter from the seabed produced by the Italian National Institute for Environmental Protection and Research (ISPRA) as a result of another Interreg Project (ML REPAIR). The amount of recovered litter from fishermen is huge and, even if a certain variety based on different countries was reported, marine litter was generally related to disposable plastic materials coming from agriculture, industry and fishing activities.

Mazzariol concluded that, reflecting on the most affected species in the Mediterranean (sperm whales) and the litter on the sea bottom, concerted actions on monitoring not just surface litter, but also litter underwater should be conducted.

3.2.2 Retrospective study of foreign body-associated pathology in stranded cetaceans, Canary Islands.

Puig-Lozano reported on long-term studies on stranded cetaceans in the Canary Islands (Arbelo *et al.*, 2013; Díaz-Delgado *et al.*, 2018). Marine debris is a growing global concern and an important threat to marine biodiversity, including cetacean species. The Canary Islands represent a hotspot for cetacean biodiversity in Europe. Its proximity to the Canary Current, which brings marine debris from the Atlantic Ocean, also makes this geographical area an interesting place for the study of interactions between cetaceans and marine debris.

After more than 20 years of systematic research on cetacean health, scientists of the Atlantic Center for Cetacean Research (University of Las Palmas de Gran Canaria) are able to present novel results of pathological findings in stranded cetaceans with foreign body (FB) ingestion. In this area, almost 8% of studied cetaceans showed FB ingestion, mostly plastics (80.55%). FB was directly associated with the death of approximately 3% of animals, due to impactions, gastrointestinal perforations, and ulcerative gastritis. In addition, to the author's knowledge, this study was the first which employed statistical analysis to identify protective (age) and risk (poor body condition and deep diver) factors for foreign body presence.

In conclusion, Puig-Lozano strongly recommended that long-term pathological studies on stranded cetaceans should continue to monitor the health of cetacean populations, including the evaluation of marine debris as a possible threat to the conservation of these populations, in particular in the Canary Islands.

3.2.3 Continuing strandings investigations in Germany

Unger presented a review of information from necropsies on harbour porpoises and seals in Germany (Unger *et al.*, 2017). Necropsies have been conducted since 1990 by the Institute for Terrestrial and Aquatic Wildlife Research (University of Veterinary Medicine, Hanover Foundation) on marine mammals regularly occurring in German waters (harbour porpoise, harbour seals and grey seals). Animals impacted by marine debris from 1990 to 2014 were examined to learn more about the health impacts associated with both entanglement and ingestion. In Germany, two federal states are located at the coastline where stranded carcasses are collected for further necropsy: Schleswig-Holstein (SH) covers parts of the North and parts of the Baltic Sea, whilst Mecklenburg-Western Pomerania (MWP) covers the German Baltic Sea. They differ in their data collection in that while SH has an established stranding network, stranded carcasses in MWP are mostly reported by tourists to the authorities. In total, 1,622 individuals were necropsied including the GIT. Out of this large sample size, 31 (9 harbour porpoises, 16 harbour seals, 6 grey seals) were found entangled in (n=14) or having ingested (n=17) marine debris. Twenty-five were found on the coastline of SH, 6 on the coastline of MWP. Comparing the species in relation to the number of stranded and dissected individuals, grey seals seemed the most impacted. The share of fishing related debris was 64.9%, and it was predominantly plastic items which were detected (73%). The major outcome of this study is the identified associated health impacts on the individuals. For entanglements, wounds and cuts, suppurative inflammation of the skin and fatal septicaemia could be diagnosed while, for ingestions, perforations and ruptures of the GIT as well as peritonitis and fatal septicaemia were identified.

The study demonstrated the value of necropsies to learn more about marine debris occurrence and its effects and, thus, underlines the importance of stranding networks. It would be useful to extend this to very mobile species such as the harbour porpoises, harbour seals and grey seals in order to be able to judge the extent of debris.

Unger suggested that other countries bordering the North and Baltic Seas should also consider seals and that a standardised method needs to be established to ensure their comparability. Unger further noted that countries with existing well-functioning strandings networks could help others establish their own.

Responding to a question, Unger confirmed that bycatch cases were excluded from the results if these were reported as bycaught animals. Animals suspected to be bycaught were excluded as well, since those cases could not clearly be associated to either ALDFG or active fishing gear.

[2]Policy learning programme for EU authorities: *https://www.interregeurope.eu/.*

3.2.4 Information from Kenya

Michael Mwangombe provided information on the marine debris situation in Kenya. There is emerging evidence of marine debris impacts in Kenya, with most work done relating to macrodebris (although there is some experience of finding smaller plastic particles in turtles). Plastics are also a problem for terrestrial species. In addition to plastic pollution, there are problems from poorly secured drift nets becoming ghost gear and posing hazards for boats and divers in addition to endangering marine life. Mwangombe suggested that there is scope for a review of previous necropsy results to further evaluate the impacts of plastics on marine mammals.

There are some positive responses to the plastic problem including removal and community recycling projects (e.g. the manufacture of flip flops from plastic waste) and the potential for such projects to be scaled up in other parts of Africa. Policy response also includes a ban on plastic bags.

Mwangobe concluded that there is a need for increased research, collaboration and capacity building in Kenya and elsewhere in Africa to improve the understanding and evaluation of marine debris impacts on cetaceans.

3.3 Discussion of evidence from strandings investigations

The workshop thanked all the presenters for the information provided in Item 3.2. It agreed the value of long-term data sets from strandings investigations and necropsy (such as those from the Canaries and Germany) in establishing impacts from marine debris and encouraged that such studies should continue.

Participants discussed the importance of strandings networks, the need for capacity development to help establish these in parts of the world where there is no coordinated strandings response and need for strengthening in several places (e.g. in Germany a gap in strandings data was attributed to a lack of strandings network coverage for the Baltic Sea, and a general lack of monitoring of pinniped strandings). They agreed on the need for better protocols for strandings investigation and necropsy, including for close observations of the GIT to identify any impacts arising from marine debris ingestion (including presence of microscopic or macroscopic lesions) and establishment of cause of death. (Further discussion on protocols for necropsy is is to found in Items 3.2 and Items 4 and 5).

Though evidence of welfare impacts has been established, it was noted that further multidisciplinary efforts were needed to further investigate the potential for population level impacts of marine debris on cetaceans, following on from improvements in establishing causes of death for individuals.

Participants further discussed vulnerability of different cetacean species and behaviours associated with debris ingestion. There is an association between feeding behaviour (e.g. bottom feeding) and macrodebris ingestion and differences in prey organisms have been shown to cause different levels of microdebris ingestion (Burkhardt-Holm and N'Guyen, 2019). There may be additional factors causing the extent of ingestion seen in some animals, for example plastics becoming coated in organisms causing an associative taste, or prey becoming wrapped in plastic. Noting that entanglement investigations try to establish whether an animal was already compromised when it became entangled, it was posed than an animal struggling to feed might become more likely to ingest plastic.

Noting the apparent vulnerability of deep diving animals to marine debris ingestion and that many marine litter surveys are surface surveys, the workshop agreed on the need for more information on marine debris on the seafloor, including through the deployment of Remotely Operated Vehicles (ROVs).

During discussions on the vulnerability of sperm whales to marine debris ingestion, it was observed that IUCN last reviewed this species in 2008, ranking it as vulnerable. However, no detail was included on marine debris and this should be explored in any future IUCN review.

Despite its focus on cetaceans, the workshop noted the apparent vulnerability of pinnipeds to marine debris ingestion and impacts and suggested that surveillance of seal strandings should be extended.

Recommendations

Noting the value of long-term datasets for investigating the role of marine debris in cetacean mortality and strandings, the workshop **recommended** *maintaining the long-term studies in the Canaries.*

The workshop also acknowledged the importance of the marine debris-associated lesions shown in results of strandings investigations and necropsies in Germany and **recommended** *that this research should be continued.*

The workshop **recommended** *that, with respect to marine debris, standardised approaches for post-mortems should be used, taking into account e.g. microscopic and macroscopic lesions, which can place marine debris in the context of the cause of death. The workshop further* **recommended** *that zero values for marine debris ingestion or entanglement should be recorded in necropsy reports.*

The workshop stressed the importance of stranding networks for obtaining information on the impacts of marine debris on cetaceans and **drew attention** *in particular to the: (i) need for continued support for existing strandings networks; (ii) capacity building and support for new networks where there are gaps; (iii) importance of government support and coordination of strandings networks; and (iv) need for networks to include appropriately trained pathologists.*

The workshop highlighted the role of the IWC strandings initiative in supporting countries to increase their capacity to respond to and investigate strandings and **recommended** *its continued funding.*

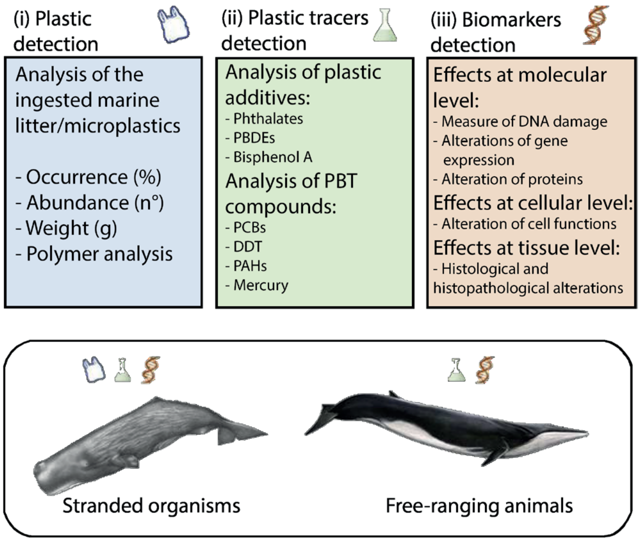


Fig. 2. The threefold monitoring approach to detect marine litter presence and impact in cetacean species (stranded and free-ranging organisms). Taken from: Fossi *et al.* (2018).

Considering the incidence of marine debris in deep diving cetaceans, the workshop **recommended** *that further work is needed to obtain information on marine debris on the seafloor, including through the deployment of Remotely Operated Vehicles (ROVs) in the deep sea.*

The workshop noted that the last global assessment of sperm whales was made by IUCN in 2008 and is now overdue and IUCN should be **encouraged** *to take marine debris into account in its next assessment of this species.*

3.4 Concerning whale entanglement in active and lost gear
Latest information concerning the entanglement of whales in active and lost gear can be found in the items above and also in Item 4.5.

3.5 Review of latest evidence on microdebris
3.5.1 Overview of latest studies on microdebris
Panti presented an overview of the latest studies on microdebris. The study of microplastic ingestion by marine mammals is a challenging task. Only a few studies have directly identified microplastics in the digestive tracts of stranded individuals (e.g. Besseling *et al.*, 2015; Lusher *et al.*, 2018). Evaluating the frequency and severity of impacts of marine debris on cetaceans is complicated by low sample sizes linked to the low rate of detection and the compounding effects of a low necropsy and publication rate. New techniques have been developed to detect plastic additives using non-lethal methods (e.g. skin biopsies; Fossi *et al.*, 2016; Panti *et al.*, 2019).

Sub-lethal impacts of plastic ingestion are more difficult to assess. Such impacts may include injury within the gastro-intestinal tracts (GITs), compromised feeding, malnutrition, disease and reduced reproduction, growth and/or longevity; these issues may be reported with the evaluation of specific molecular markers.

Field studies and monitoring indicate that interactions between marine litter and a mixture of chemical compounds are of significance. Laboratory studies could shed light over possible interactions (synergy or antagonism) learning from the field mixture toxicity.

Panti suggested that given the multiple potential physical and ecotoxicological effects of marine debris interactions, the impact of litter on marine mammals should be assessed using a new threefold approach which can add to the data on the rate of ingestion in cetaceans and data on the multiple sub-lethal stresses that marine debris ingestion can cause in the short and long term. Each of the three levels of investigation tools that make up the threefold approach can be applied independently or simultaneously and whether the animals concerned are stranded or free ranging. The threefold approach comprises the following elements.

(a) Analysis of gastro-intestinal content: Detection of the occurrence and rate of marine litter ingestion and any associated pathology through analysis of the gastro-intestinal content (with a particular focus on plastics and microplastics) in stranded cetaceans.

(b) Analysis of the levels of plastic additives, as a proxy for ingestion of additives: The indirect quantification of plastic additives can be applied both to free ranging as well as to stranded organisms. The levels of plastic additives (such as phthalates or PBDEs) and associated Persistent Bioaccumulative and Toxic (PBT) compounds allow evaluation of exposure to additives and PBT, which might have been taken up from the water, via the prey organisms, or with plastic items.

(c) Analysis of biomarker responses: Biological responses can be used to detect the potential toxicological effect related to PBT and plastic additives in free ranging individuals or in stranded organisms up to a few hours after death.

Plastic marine debris is well known to be associated with chemical contaminants. Therefore, the ingestion of plastic litter could cause severe toxicological effects due to the exposure to both chemicals absorbed by plastics and plastic components. The most common compounds used as plastic additives are brominated flame retardants (BFR), stabilisers, phthalate esters (PAEs), bisphenol A (BPA), and nonylphenols (NPs). Once in the environment, these compounds may leach out from plastic litter (both macro and microplastics) or be accumulated on the surface of plastic items. Tracers of plastic additives present in animal tissues can be used as an indirect method for detecting exposure to additives, in particular phthalate esters (PAEs). For example, eight different phthalates (MBZP, MBP, MEHP, DNHP, BBzP, DEHP, DIOIP, DNDP)[3] were detected in neustonic/planktonic samples and also in four cetacean species (blubber from skin biopsies) sampled in the Pelagos Sanctuary (North-Western Mediterranean Sea) (Baini *et al.*, 2017). The results showed different fingerprints and levels across the neustonic/planktonic samples, indicating a heterogeneous pattern of phthalates in the environment, which may be associated with microplastics. In addition, seven out of eight PAEs were also detected in the blubber of *Balaenoptera physalus*, *Tursiops truncatus*, *Grampus griseus* and *Stenella coeruleoalba* sampled in the same area, which might therefore indicate plastic ingestion, but could also result from uptake of these compounds via water or food.

Uptake and accumulation of plastic-associated chemical contaminants may produce undesirable biological effects. For example, when fin whale and sperm whale organotypic skin cell cultures were treated with increasing doses of PAEs, it showed an upregulation of the mRNA levels of the peroxisome proliferator-activated receptor gamma (PPAR'γ) gene (Fossi *et al.*, 2018); these results suggest that PAEs play an important role in the alteration of the PPAR'γ, which regulates physiological processes of lipids homeostasis, inflammation, adipogenesis, reproduction, etc.

Panti noted that another approach is an *ex-vivo* assay using organotypic skin cell cultures from the bottlenose dolphin, cultured and treated with different perfluorooctanoic acid (PFOA) and BPA concentrations (Lunardi *et al.*, 2016). The transcriptomic techniques could represent an additional application to analyse global gene expression for assessing the exposure to a certain class (or a mixture) of compounds. The skin transcriptome could reveal information about contaminant exposure. Such assays may allow researchers to assess long-term effects on health, as the genes affected are involved in immunity modulation, response to stress, lipid homeostasis, and development. The transcriptomic signature of dolphin skin could be therefore relevant as classifier for a specific contaminant such as plastic-associated contaminants. Further research on biomarkers targeting the exposure of plastic ingestion and their additives is required.

However, studies on the effects of microplastics (both toxicological and as vector of pathogens) on marine mammals (in particular) are lacking. Some evidence may be drawn from the existing literature on laboratory studies on model species (e.g. zebrafish or seabass), but very little is available about mammals and it is difficult to compare effects between species.

3.5.2 Risk of microplastic uptake in baleen whales

Holm summarised Burkhardt-Holm and N'Guyen (2019) which investigated the occurrence of microplastics in the food web of cetaceans to assess the risk of microplastic uptake in baleen whales. The common minke whale was chosen as an example because most data are available for it, and it has similar feeding behaviour to many other baleen whales. The study firstly evaluated the common minke whale diet in different regions and, secondly, reviewed available evidence of microplastic ingestion by these prey species. It was found that common minke whales forage opportunistically on fish from various families: *Ammodytidae, Clupeidae, Gadidae, Engraulidae* and *Osmeridae*. 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*. Sei whales mostly feed on copepods, *Engraulidae, Clupeidae* and *Scombridae*. High levels of microplastics contamination are reported for *Scombridae* in the Atlantic and *Engraulidae* in the northwest Pacific Ocean. Copepods exhibit low levels of microplastics ingestion in the northeast Pacific Ocean.

3.5.3 Cetaceans as potential indicators of micro- and macroplastic impact in the marine environment

Fossi reported scientific evidence and identified emerging gaps in the interactions between the charismatic megafauna (filter feeder baleen whales and deep diving cetaceans) and micro- and macroplastics. She proposed these species as candidate indicators for micro- and macro-plastic pollution, respectively, at global scale.

Regarding the interactions between whales and microplastics, the first warning was reported for Mediterranean fin whales (*Balaenoptera physalus*) in 2012, and confirmed later (high concentrations of plastic additives and specific biomarker responses, detected in skin biopsies) in the same species and for other filter feeders (basking and whale sharks) (Fossi *et al.*, 2012; 2014). Filter-feeding megafauna are susceptible to high levels of microplastics ingestion and exposure to associated toxic compounds due to their feeding strategies and because of habitat overlap with microplastic hot spots. For these reasons, the fin whale has been proposed as a candidate indicator of microplastics pollution in semi-enclosed basins.

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[3]MBZP, Mono-Benzyl phthalate (MBZP), Mono-Butyl phthalate (MBP), Mono (2-ethylhexyl) phthalate (MEHP), Di- n-Esilphthalate (DNHP), Benzyl butyl phthalate (BBzP), Bis (2-ethylhexyl) phthalate (DEHP), Diisooctyl isophthalate (DIOI), Di-n-decyl phthalate (DNDP).

Overview of the available studies on the tissue translocation of NP and MP.[a] Translocation reported by the authors. Detailed citations are provided in the supplementary material (T2/1-31) in Triebskorn *et al.* (2019).

Species	Polymer type (size/size range; ucm) PMMA	PS	PET	PE	Trans-location	Reference
Caenorhabditis elegans		0.1			+	T2/1: Zhao *et al. Env. Sci. Nano.* (2017).
Amphibalamus amphitrite	<0.2				+	T2/2: Bhargava *et al. Chem. Eng.* (2018).
Carcinus maenas		500			+	T2/3: Farrell and Nelson. *Envion. Pollut.* 177 (2013) 1-3.
		10			−	T2/4: Watts *et al. Environ. Sci. Technol.* 48 (2014) 8,823-8,830.
		8			−	T2/5: Watts *et al. Environ. Sci. Technol.* 50 (2016) 5,364-5,369.
Uca rapax		180-250			−	T2/6: Brennecke *et al. Mar. Pollut. Bull.* 96 (2015) 491-495.
Daphnia galeana		0.052			+	T2/7: Cui *et al. Sci. Rep. UK* 7 (2017).
Daphina magna		0.025			+	T2/8: Brun *et al. Nanotoxicol.* 11 (2017) 1,059-1,069.
		0.06039; 0.05745 0.05729			+	T2/9: Chae *et al. Sci. Rep. UK* 8 (2018) 284.
			60-1,400		−	T2/10: Jemec *et al. Environ Pollut.* 219 (2017) 201-209.
		0.02; 1			+	T2/11: Rosenkranz *et al. Toxicol. Chem.* 28 (2009) 2,142-2,149.
Scroblcularia piana		20			+	T2/12: Ribeiro *et al. Mar. Pollut. Bull.* (2017).
Dreissena polymorpha		1; 10			+	T2/13: Magol *et al. Sci. Total Environ.* 631-632 (2018) 778-788.
Mytilus eutdis		0.0096; 3			+	T2/14: Browne *et al. Environ. Sci. Technol.* 42 (2008) 5,026-5,3031.
				<80	+	T2/15: von Moos *et al. Environ. Sci. Technol.* 45 (2012) 11,327-11,335.
					−	T2/16: Kolandhasarny *et al. Sci. Tot. Environ.* 610/611 (2018) 635-640.
Mytilus galoprovincialis				1-50	−	T2/17: Détrée and Gallardo-Escárate. *Mollus Stud.* 83 (2017) 220-225.
Paracentrotus lividus		0.04; 0.05			−	T2/18: Della Torre *et al. Environ. Sci. Technol.* 48 (2014) 12,302-12,311.
Carasius carassius		0.040; 0.050; 0.052; 0.053; 0.057; 0.120; 0.180; 0.33			+	T2/19: Mattsson *et al. Sci. Rep. UK* 7 (2017).
Carassius auratus			50-500	>63	−	T2/20: Grigorakis *et al. Chemosphere* 169 (2017): 233-238.
Damio rerio		0.025			−	T2/21: Brun *et al. Environ. Sci. Nano.* (2018).
		0.05			+	T2/22: Chen *et al. Sci. Total Environ.* 609 (2017): 1312-1321.
		0.07; 5; 20			+	T2/23: Lu *et al. Environ. Sci. Technol.* 50 (2016): 4054-4060.
		0.042			+	T2/24: Pitt *et al. Aquat. Toxicol.* (2017).
						T2/25: Pitt *et al. Sci Total Environ.* 643 (2018): 324-334.
		0.02			+	T2/26: Skjolding *et al. Nanotoxicol.* 11 (2017): 351-359.
		0.025-0.05; 0.25; 0.7			+	T2/27: van Pomeren *et al. Aquat. Toxicol.* 190 (2017): 40-45.
					−	
Engraulis encrasicokes				124-438	+	T2/28: Collard *et al. Environ. Pollut.* 29 (2017): 1000-1005.
Mugli cephaius		10-5000		10-5000	+	T2/29: Avio *et al. Mar. Environ. Res.* 11 (2015): 18-26.
Oreochromis niloticus		0.1			+	T2/30: Ding *et al. Environ. Pollut,* 238 (2018): 1-9.
Oryzias iaripes		0.0394; 0.474; 0.932; 18.6; 42.0			+	T2/31: Kashiwada. *Environ. Health Perspect.* (2006).
Oryzias sinensis		0.06039; 0.05745; 0.05729			+	T2/9: Chae *et al. Sci Rep. UK* 8 (2018): 284.

[a] Particles > 100um tested, particle type unknown.

Fig. 3. A summary table from the Triebskorn *et al.* (2019) compilation of studies on micro- and nano-plastics.

On the other hand, deep divers such as the sperm whale and the Cuvier's beaked whale, are exposed to the ingestion of marine litter (ML), including large plastic fragments, due to their feeding in marine canyons. High occurrence of ML (75%) has been reported in stranded Mediterranean sperm whales. This species was recently proposed as a candidate indicator for the presence of ML in the Mediterranean (MSFD, Descriptor 10 and candidate IMAP indicator 24) (Claro *et al.*, 2019; Panti *et al.*, 2019). As these megafauna species are charismatic and iconic indicators that serve as flagship species for marine conservation, this research field recently started to 'trend'. However, several gaps must be resolved, such as the investigations into the feasibility and reliability of using plastic additives as tracers and the identification (through omics techniques) of the toxicological effects caused by plastic debris ingestion in these species.

3.5.4 Categorisation of microdebris by size
Holm noted a new study by Triebskorn *et al.* (2019) which compiled all studies so far conducted on the type, and the size of micro-and nanoplastic particles as well as the applied experimental design under which a tissue translocation of these particles was reported. The study covered a range of species of aquatic taxa. A summary table from this study is in Fig. 3.

3.6 Discussion of evidence on microdebris
The workshop welcomed the studies reported, noting that the understanding of potential impacts of microplastics on cetaceans is still in its infancy.

Participants noted the value of emerging results on other species, whilst also noting the limitations in extrapolating these results for cetaceans, bearing in mind differences in uptake across species groups e.g. fish take up many chemicals through skin and gills, that are not taken up via the skin by cetaceans. In addition, having the same experimental approach for cetaceans as have been obtained for fish and other laboratory animals will not be possible. However, recent studies on potential human health impacts might have useful insights for cetaceans (see also Item 5).

It was debated whether the detection of phthalates in whales is sufficient to describe these substances as 'plastic tracers'. It was pointed out that phthalates are produced in quantities of several million tonnes per year and that much of this is released into the environment. Although these substances are frequently used as plasticizers in plastics, they can also be found in other products such as cosmetics and are also dissolved in water. This means that phthalates can also be taken up by whales from water or through the food chain, and not necessarily and exclusively by being released into animals from ingested plastic debris. It is important to strictly distinguish between correlations (e.g. phthalates found in animals and phthalates found in water or other prey organisms) and causal relationships (phthalates in cetaceans released by ingested plastic waste). However, a correlation between the level of PAEs (Phthalic acid esters) and the number and type of microplastics in neustonic samples collected by manta trawl in the Pelagos Sanctuary has been found as well as detection of PAEs and euphasiid species (prey of baleen whales) in the Mediterranean Sea (Baini *et al.*, 2017).

The workshop recognised the importance of both the scientific evidence and the emerging gaps concerning the interaction between megafauna (e.g. filter feeder baleen whales and deep diving whales) and micro- and macroplastics and recommend studying the impact of plastic debris and their related potential toxicological and noxious effects. The workshop also agreed the following species as candidate indicators for microplastics (fin whale, *Balaenoptera physalus*) and macro-litter pollution (sperm whale, *Physeter macrocephalus*) at global scale, respectively. Filter-feeding megafauna (e.g. whale sharks and baleen whales) are prone to high levels of microplastics ingestion and exposure to associated toxic compounds due to their feeding strategies and for habitat overlap with microplastic hot spots (such as the Mediterranean Sea).

While the skim feeders, like right and bowhead whales, should be monitored for their possible greater susceptibility, the workshop recognised that species with a wider distribution may be better candidates as global indicators. For these the workshop suggests that the humpback and fin whales would be the best candidates for this type of monitoring. Humpback whales are generally faithful to discrete feeding grounds in several Oceans, while fin whales are believed to be more far roaming in their foraging, except for some unique, segregated populations (e.g. Mediterranean and Gulf of California). For these reasons, these whale species could be proposed as candidate indicators of microplastics pollution in both wide ocean basins and confined seas. On the other hand, deep divers such as the sperm whale and the Cuvier's beaked whale, are exposed to the ingestion of marine debris, including large plastic fragments, due to their feeding in marine canyons. Marine debris has been reported in 75% of examined stranded Mediterranean sperm whales. This species was recently proposed as a candidate indicator for the presence of marine debris in the Mediterranean (MSFD, Descriptor 10 and IMAP Ecological Objective 10, candidate indicator 24).

The workshop also supported research and investigations into new plastic tracers in the tissues of the organisms and the identification (also through omics techniques) of the potential ecotoxicological effects caused by plastic debris ingestion in these species.

Finally, it was noted that the gray whale feeds almost exclusively on the bottom and could therefore make a good candidate for monitoring microplastic impact from the benthos at appropriate depths.

It was noted that previous IWC recommendations had advocated the integration of marine debris concerns into Conservation Management Plans (CMPs), and that both the Mediterranean fin whale and sperm whale were candidates for CMP, with drafting of the Mediterranean Fin Whale CMP currently ongoing.

Recommendations

With regard to cetaceans as potential indicators of interaction with marine debris, the workshop **recommended** *that the following species were good candidates, for various reasons related to prey type, distribution and existing knowledge: fin, sperm, gray, humpback whales and beaked whales.*

The workshop **urged** *that consideration of macro- and microplastics be included in the Conservation Management Plan (CMP) currently under development for the Mediterranean fin whale.*

3.7 Review of recent work undertaken by other MEAs

3.7.1 Presentation

Smith presented document IWC/DEC19/MD/02, a review of marine debris work by other IGOs and international organisations. She noted that marine debris has been recognised as an issue of global concern, resulting in a range of initiatives to address this problem at global, regional and national scales. Previous IWC workshops had concluded that a significant role of the IWC should be to input cetacean-specific expertise into other fora undertaking work on this issue, and made specific recommendations for engagement with a range of organisations. IWC had made some significant progress on engagement including with the Food and Agriculture Organization of the United Nations (FAO) (e.g. regarding gear marking), and the UN.

Several global targets now set a framework for global work on marine debris including Sustainable Development Goal 14 and Target 14.1, and the Strategic Plan for Biodiversity 2011-2020 and Aichi Target 8 (*https://www.cbd.int/sp/*). There may be opportunities to strengthen this in development of the new post-2020 biodiversity framework.

Smith briefly summarised work in other organisations (see below).

3.7.1.1 The United Nations

Several United Nations General Assembly (UNGA) Resolutions relate to marine debris and ADLFG. In 2016, the Informal Consultative Process for Oceans and Law of the Sea under the United Nations Convention on the Law of the Sea (UNCLOS) looked at this issue in depth and the IWC contributed a summary of its work and recommendations as input to the UN Secretary General's report to this meeting.

The United Nations Environment Assembly (UNEA) has adopted several resolutions on marine debris. It recently extended the mandate of the *Ad Hoc* Open-Ended Expert Group on marine litter and microplastics (AHOEEG) until UNEA-5 in 2021 to increase coherence, coordination and synergies between existing mechanisms to better address the challenges posed by marine litter and microplastics.

The United Environment Programme (UNEP) convenes the Global Partnership on Marine Litter (GPML), supporting development of action plans (from international to local) and projects on clean up and removal, coordination and monitoring, education and awareness and post-disaster response.

3.7.1.2 IMO and MARPOL

The International Convention for the Prevention of Pollution (MARPOL) Annex V specifically prohibits the discharge of plastics from ships. In addition, it recognises that some sea areas require higher degrees of protection and can be designated as Special Areas under MARPOL. Dumping wastes at sea is also regulated by London Convention and its protocol.

The Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) has adopted the Action Plan to Address Marine Plastic Litter from Ships, which outlines a range of actions to be completed by 2025 on fishing gear, passively fished waste, port reception facilities, cost recovery systems and on-board waste management. The IWC has regularly attended IMO MEPC and keeps a watching brief on this issue.

The GESAMP Working Group on Marine Litter published its global assessment in 2015 and its new work programme covers a series of objectives including: developing guidelines on terminology and methodologies for the sampling and analysis of marine plastics and microplastics; assessing the occurrence and effects of nano-sized particles on marine organisms; and assessing the significance of plastics and microplastics as a vector for indigenous and non-indigenous organisms. The IWC may have the opportunity to field expert observers at future GESAMP meetings.

3.7.1.3 Chemicals conventions

Work under the Basel Convention includes Decision 13/17 to consider relevant options to further address marine plastic pollution. The Stockholm Convention on Persistent Organic Pollutants has a potential role related to greening the lifecycle of a range of plastic polymers. The most recent IWC Scientific Committee meeting made recommendations for IWC engagement with these Conventions with respect to chemical pollution and this could be extended to marine debris if useful.

3.7.1.4 Fisheries organisations and gear

At its Committee on Fisheries meeting in 2018, FAO adopted voluntary guidelines for marking of fishing gear which have potential to help address both ALDFG and live whale entanglements. Several Regional Fisheries Management Organisations (RFMOs) have also adopted resolutions on ALDFG and Fish Aggregating Devices (FADs). The General Fisheries Commission for the Mediterranean (GFCM) has developed specific recommendations based on the FAO gear marking guidelines. But a proposal from the EU on marine litter, including marking of fishing gear, put to the 94th meeting of the Inter-American Tropical Tuna Commission (IATTC) (July 2019) was not endorsed, suggesting that further advocacy might be needed within the RFMOs on this issue.

The Global Ghost Gear Initiative (GGGI) is a cross stakeholder alliance of fishing industry, private sector, NGOs, academia and governments focused on solving the problem of lost and abandoned fishing gear worldwide. In 2018, the GGGI launched the Best Practice Framework for the Management of Fishing Gear, a tool to assist actors throughout the seafood supply chain to embed measures to prevent, mitigate and cure the challenge of ALDFG in their operations. There are also outstanding IWC recommendations for closer cooperation with the GGGI.

3.7.1.5 The biodiversity related conventions

There are a range of relevant work programmes under the biodiversity-related Conventions. The Convention on the Conservation of Migratory Species of Wild Animals (CMS) has a resolution 12.20 on marine debris and work to take this forward has included outreach and communications to raise awareness of this issue, including through making plastic pollution the theme for the World Migratory Bird Day 2019, and engagement with other international bodies in order to address the issue at source. At the time of this workshop the Draft Decision for CMS COP13 *inter alia* directs the CMS Secretariat to further cooperate with other organisations working on this issue, including UNEP and the IWC, and requests the CMS Scientific Council to undertake further work on the impact of plastics on CMS-listed species that inhabit terrestrial and freshwater ecosystems. Cooperation with other organisations is currently strategically focused on engagement with UNEP and the process under UNEA, including encouraging CMS members to engage with the UNEA process and with the recently circulated UNEP questionnaire on marine debris.

Work under the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) and the Agreement for the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS) has included joint work on best practice guidance for cetacean necropsy and tissue sampling (see Item 4.4).

The Convention on Biological Diversity (CBD) has undertaken several activities on marine debris including development of voluntary practical guidance on means to prevent and mitigate impacts of marine debris on the oceans.

3.7.2 Discussion on IWC engagement with other organisations

The group thanked Smith for this presentation, noting that IWC engages with a range of other organisations and conventions directly and through membership of the Liaison Group of the Biodiversity related Conventions, so there are many opportunities for collaborative work.

The workshop noted efforts in other international organisations to address the issue of marine debris and stressed the importance of FAO and other relevant UN bodies continuing to develop and prioritise marine debris related actions. Recalling previous recommendations on this topic, the workshop re-emphasised the importance of IWC cooperation with other organisations on marine debris to promote synergies and avoid duplication of efforts. It encouraged the input of IWC expertise to appropriate fora including from research and data collection associated with its entanglement and strandings initiatives. In this context, the workshop discussed capacity of the Secretariat to engage with other IGOs on marine debris, noting resource and time constraints and the need for prioritisation of engagement towards where IWC input would be most feasible and useful. It suggested a roster of experts, drawn from the IWC community, might identify people willing to help represent the IWC at other meetings and in technical discussions and add value to Secretariat efforts.

Despite the growth in work in international bodies, the workshop noted there remained a major gap in national implementation of recommendations. Noting the projected acceleration in production of plastics, it stressed the need for enhanced efforts to address this at source. Participants thus encouraged IWC engagement with the UNEA process and its efforts to strengthen the global framework for dealing with marine debris, including at source. The workshop also discussed engagement with funding bodies (e.g. EU LIFE and similar programmes) including the potential for the IWC to offer support to marine debris projects put forward for funding by such bodies, as well as the opportunity to pursue fundraising for IWC collaborative efforts.

Participants raised the need for the IWC to lead by example and reduce its own use of plastic in its operations, including at meetings.

Recommendations

The workshop noted several upcoming opportunities to progress IWC recommendations on marine debris in other international processes including development of the post-2020 biodiversity framework, and the United Nations Environment Assembly (UNEA) in 2021. The workshop **encouraged** *the Secretariat to engage with the work of the Ad-Hoc Technical Expert Group established by UNEA to promote synergies between existing mechanisms.*

The workshop **recommended** *that a roster of marine debris experts be established from which the IWC Secretariat can request experts to represent the IWC at relevant technical meetings, and offer further advice as required to progress marine debris related recommendations.*

The workshop **recommended** *that the IWC should set an example and, as part of wider efforts to reduce its environmental footprint, have single use plastic-free meetings.*

The workshop **recommended** *that the IWC explores the potential to support or otherwise engage with projects funded under the EU LIFE programme and similar funding programmes that could support research into the effects of marine debris on cetaceans and the associated development and application of tangible actions.*

4. METHODOLOGIES

4.1 How to best collect and collate scattered information from cetaceans

4.1.1 Mapping the Mediterranean Litterscape

Pierantonio reported on efforts to map the Mediterranean Litterscape (Lambert *et al.*, 2020). Data on floating marine debris collected during aerial surveys across a large portion of the Mediterranean Sea, and in the framework of the ACCOBAMS Survey Initiative, were used to obtain density and abundance estimates of particles greater than 2cm and 30cm in size, respectively. Preliminary results suggest that highest densities of debris occur in the central basin, while numbers decrease in the eastern portion of the Mediterranean. When only considering items larger than 30cm, the total number of floating mega-debris was estimated at 2.9 million items, taking into account imperfect detection. Nonetheless, items larger than 30cm represent only one fourth of the complete load of anthropogenic debris (Suaria and Aliani, 2014). Therefore, when considering all floating items larger than 2cm, the overall abundance scales up to 11.5 million floating debris. These results will set the scene for identifying high vulnerability areas to plastic debris for marinefauna, and permitting the implementation of adequate strategies to thwart plastic pollution in the Mediterranean Sea and its impact on marine ecosystems.

Pierantonio also informed the workshop participants that the entire ACCOBAMS Survey Initiative (ASI) raw dataset, including data on floating macro-litter, is fully available upon request from the ACCOBAMS Secretariat and could be, therefore, used by the research and scientific communities for further analysis and modelling exercises to investigate the sources and accumulation patterns of marine floating debris in the Region.

4.1.2 Information from aerial surveys in Germany

Aerial surveys have been conducted by the Institute of Terrestrial and Aquatic Wildlife Research (Veterinary University of Hannover, Foundation) since 2002 to estimate harbour porpoise distribution and abundance in German waters (North and Baltic Seas). Data on floating marine debris were collected opportunistically during those flights and analysed for the very first time. This study showed that marine debris is ubiquitous with higher encounter rates in offshore waters. It furthermore showed how valuable aerial survey data are for gaining information on the distribution of floating debris, identifying overlaps with protected areas and looking at seasonal changes. Furthermore, a distinction can be made between industrial and household debris versus fishing related debris.

4.1.3 Discussion on aerial surveys and marine debris mapping

The workshop expressed thanks to ACCOBAMS for supporting this important survey work in the Mediterranean, noting that this data set was now available for further work or analysis. Discussion also confirmed that the Mediterranean data set is comparable with a similar study for all of the French territorial waters, and that data sharing was also planned with ongoing work to identify hotspot areas for marine debris (e.g. the Pelagos Sanctuary).

Participants stressed that abundance and density data relate only to the specific time of the survey and estimates must be looked at critically. Marine debris distribution can change dramatically over time, depending on currents and circulation, and hotspots of marine debris are not permanent. It is possible to come back to the same area a few days later and find it completely empty of debris. Thus, when using survey information for risk assessment, including assessment against feeding grounds of cetacean species, this is a really important point to note. Pierantonio confirmed that the next steps for the Mediterranean study would include the use of drift models to explore how debris move across the Mediterranean Sea in different seasons under different conditions of wind, currents, etc.

The workshop welcomed the approach applied and recommended the wider collection of data on floating marine debris during already existing aerial survey monitoring programmes. This will allow information to be gained on the distribution and abundance of floating marine debris in a cost-effective way over large-scales. Alongside existing programmes, the possibility of conducting dedicated aerial surveys to specifically monitor floating litter should be further explored.

Further consideration could also be given to combining aerial survey data on floating litter with other data sources, e.g. digital surveys, vessel-based fishery surveys, and particularly in areas where there is limited coverage and research effort. In particular, the workshop also discussed beach litter mappings, and the potential for comparisons of their results compared with those from floating debris research. It was also noted that beach clean-up activities have added value in raising awareness, supporting interaction between the public and policy makers. The workshop took note of and especially welcomed work under the Barcelona Convention which had launched an 'adopt the beach' project proving effective in terms of public engagement.

Recalling the previous day's discussions on microdebris, participants discussed using species as indicators of macrodebris, e.g. deep divers such as sperm whales and gray whales as bottom feeders as indicators of macrodebris on the seabed. Given migratory patterns, data from resident populations might be more useful. It was noted that some true skim feeders, e.g. right whales, may also be more susceptible to marine debris so should be monitored, though might not necessarily suitable as indicators.

The workshop also discussed whether/how the density of macroplastics might be used to estimate microplastics. There are some areas where it appears macrodebris can be a good predictor.

Recommendations

The workshop **recommended** *the collection of data on floating debris during aerial and boat-based surveys.*

The workshop **emphasised** *that beach clean ups are important initiatives for data collection and public awareness, whilst not directly addressing the problem at source, and welcomed the progress made on this inter alia under the Barcelona Convention.*

4.2 Global surveillance on marine debris

A wider discussion focused on data challenges and means to build up a global picture or repository of data on marine debris from strandings investigations. A potential role for the IWC in supporting global surveillance on marine debris was discussed, including through: (i) developing capacity of countries to respond to and investigate strandings through the IWC strandings initiative; (ii) improving information from IWC Scientific Committee progress reports; and (iii) some form of global database on marine debris. With regards to a global surveillance initiative, or database, participants suggested starting with necropsy data relevant to marine debris (rather than e.g. much wider records of marine debris observations or observed cetacean/marine debris interactions).

The workshop noted that the IWC, in partnership with NOAA, the University of Padua, IFAW, Seawatch and other organisations would be holding a workshop on strandings response harmonisation at the World Marine Mammal Conference (WMMC) on Saturday 7 December 2019. It asked Mazzariol to communicate the workshop's discussions to this event and encourage further thought on means of increasing global surveillance of marine debris.

Recommendations
The workshop **recommended** *that the IWC Scientific Committee consider development of a database of marine debris information from post-mortem examinations, taking into account the model provided by the IWC ship strikes database. This would contribute to global surveillance on marine debris and capture information as set out in the Evidence-based diagnostic assessment framework for cetacean necropsies on marine debris ingestion and common data collection developed by the workshop.*

Building on IWC Resolution 2018-3, the workshop **strongly encouraged** *countries to submit data on marine debris ingestion and entanglement in their national progress reports. In the case of a post-mortem investigation, this should specify the number of animals exhibiting marine debris interactions as a percentage of the total number of examined animals.*

The workshop **encouraged** *participants attending the upcoming workshop on Strandings Response Harmonisation, at WMMC on Saturday 7 December 2019, to explore the potential to increase global surveillance of marine debris.*

4.3 'Plastic Busters' - a methodology and approach for consolidating Mediterranean efforts against marine litter

Fossi provided information on 'Plastic Busters MPAs', an EU Interreg Med[4] funded project aiming to maintain biodiversity and preserve natural ecosystems in coastal and marine protected areas by consolidating Mediterranean efforts against marine litter. The project entails actions addressing the whole management cycle of marine litter, from monitoring and assessment, to prevention and mitigation. The project deploys the multidisciplinary strategy and common framework of action developed within the Plastic Busters initiative, led by the University of Siena and the Sustainable Development Solutions Network. This initiative frames the priority actions needed to tackle marine litter in the Mediterranean and was identified by the Union for the Mediterranean in 2016, gathering the political support of 43 Euro Mediterranean countries. Plastic Busters MPAs bring together 15 implementing partners and 17 associate partners from 7 Mediterranean countries, namely Albania, Croatia, France, Italy, Greece, Slovenia and Spain. Plastic Busters MPAs consolidate Mediterranean efforts against marine litter by: (i) assessing the impacts of marine litter on biodiversity in MPAs and identifying marine litter 'hotspot' areas; (ii) defining and testing tailor-made marine litter surveillance, prevention and mitigation measures in MPAs; and (iii) developing a common framework of marine litter actions for Interreg Mediterranean regions towards the conservation of biodiversity in Med MPAs.

One of the aims of this project is to realise a harmonised monitoring methodology to detect the impact of marine litter on Mediterranean ecosystems and particularly on marine biodiversity, including endangered species inhabiting pelagic and coastal MPAs (cetaceans, sea turtles, birds, endangered sharks, etc.). The final aim of the application of this approach will be to support MPA managers in their efforts to achieve the conservation goals set in their MPAs. Furthermore, these results will facilitate effective policymaking at local, national and regional levels with regards to the prevention, reduction and removal of marine litter in Mediterranean MPAs, within the framework of the EU MSFD and the Barcelona Convention Regional Plan for Marine Litter Management in the Mediterranean.

4.4 Post-mortem investigations

4.4.1 Overview of post-mortem investigations in the Netherlands

4.4.1.1 Marine mammals and marine derbis: an overview of the Dutch situation

IJsseldijk presented an overview of cetacean post-mortem investigations in the Netherlands. Since 2006, post-mortem examinations on a subsample of all stranded harbour porpoises have been conducted at the Faculty of Veterinary Medicine, Utrecht University (UU), by experienced veterinarians and biologists. The main aim of the research is to determine causes of death, especially the discrimination between natural and anthropogenic causes. The research is funded by the Dutch Government, due to the involvement of this species in several regional, international conventions (e.g. ASCOBANS, MSFD and Habitat Directives). In addition, samples for tissue banking and other research uses are collected.

One of the additional projects that the UU is involved in focusses on the presence of marine debris in stranded cetaceans. This is a collaboration with Bureau Waardenburg and Wageningen Marine Research. Collectively, it published the results of the examination of 654 harbour porpoise stomachs for the presence of marine debris in *AMBIO* in January 2018 (van Franeker *et al.*, 2018). This showed that the frequency of occurrence of plastic litter was 7% using only the overflow method, but this percentage increased to 15% using a 1mm sieve in addition to the overflow method[5]. They concluded that standardisation of methods is necessary, as proven by the study, but that in general harbour porpoises presented a low frequency of ingestion of minor numbers and masses of litter items. Post-mortem investigations did not reveal any cases of direct fatal plastic ingestion, but at least one case of fatal entanglement in fishing gear (non-bycatch; laryngeal

[4]*https://www.interreg-med.eu/.*

[5]Stomachs and intestinal contents of large whales were washed using a series of 1x1m sieves, with 1.0mm and 0.5mm mesh size. Obtained sieve fractions were machine-washed, following Bravo Rebolledo *et al.* (2013) to collect marine debris and hard prey remains. For dolphins an overflow method, following van Franeker *et al.* (2018) was used to collect hard prey remains and marine debris.

Table 1
Overview of investigated cetaceans in the Netherlands for the presence or absence of marine debris item in stomach and/or intestine (unpublished data).

Species	*N*=	Stomach	Intestine	Plastic in stomach	Plastic in intestine
Bottlenose dolphin	1	1	1	0	0
Common dolphin	6	5	4	0	0
Fin whale	7	2	1	0	0
Humpback whale	1	1	1	0	1
Long-finned pilot whale	4	4	4	0	0
Minke whale	4	4	4	0	0
Sowerby's beaked whale	5	4	4	0	1
Sperm whale	10	8	8	2	0
Striped dolphin	3	2	2	0	0
White-beaked dolphin	9	2	1	1	0

entanglement by a line with a fishing hook) was noted. Indirect effects of debris ingestion (e.g. links with nutritional condition, inflammation, infectious disease, etc.) have not yet been determined and require further investigation, which could be done retrospectively.

From ten other species, comprising 33 individuals (both baleen as well as toothed whales), gastrointestinal tracts were analysed. Plastic items were found in two sperm whales (Unger *et al.*, 2016), one beaked whale (Bravo Rebolledo *et al.*, 2018), one humpback whale and one white-beaked dolphin, but not in any other species (Table 1). No cases of direct fatal ingestion were determined. Standardised protocols are required in order to compare results between animals, species, regions and countries, with considerations among sample procedure started at the stranding event. This includes a best practise per species (e.g. which parts to sample from which species, depending on their size), logistics, environmental pollution (e.g. from items flying in during beach necropsies), as well as processing the samples in the lab.

The only information on marine debris in harbour seals in the Netherlands is collected by analysis of faecal samples (Bravo Rebolledo *et al.*, 2013), as a dedicated post-mortem programme for seals is lacking.

A recent plastic disaster occurred in January 2019, when the cargo ship MSC *Zoe* lost 342 containers north of the Netherlands which resulted in the spillage of tons of debris in the Natura2000 Wadden Sea, where there is a great abundance of seals. As of the date of this workshop 800,000kg of this debris were 'missing'. Monitoring of top predator species, including pinnipeds and porpoises, in addition to monitoring of seabirds and beach litter surveys are recommended in the long term in order to increase understanding on where plastic in the oceans accumulate and persists and what its effects are on the marine life.

The recommendation for further improvements in investigating marine debris impacts on cetaceans in the Netherlands are to: (1) increase the sample size of marine debris determination, including its absence, in all species that are stranded on the beaches, but especially the deep divers; (2) link with (histo)pathology, retrospectively this can be done for the cases in which marine debris ingestion has been observed; (3) expand the research to pinnipeds; (4) standardise protocols, taking into account the species involved and the logistics; and (5) develop an international database in order to work towards defining hotspot areas which could be of a similar design as the IWC ship-strike portal.

Studies on fulmar in the Netherlands

Bravo Rebolledo presented data from fulmar studies in the Netherlands. Plastic ingestion in northern fulmars has been monitored in the Netherlands since the early 1980s. Fulmars are purely offshore foragers that ingest all sorts of litter from the sea surface and normally do not regurgitate poorly degradable diet components like plastics. The monitoring uses fulmars that are found dead on the beach or accidentally killed, e.g. fisheries bycatch. North Sea governments aim at a long-term OSPAR Ecological Quality Objective (EcoQO) in which for at least 5 constructive years, the proportion of fulmars with more than 0.1 gram of plastic in the stomach remains under 10%. Over the 5-year period 2014-2018, EcoQO performance among 115 fulmars beached in the Netherlands was 43% (Van Franeker and Kühn, 2019). In this period Van Franeker and Kühn (2019) found ingested plastics in 93% of the fulmars, with an average over all birds of 24 particles per stomach, weighing 0.26g. Standard procedures for dissection and stomach analyses have been documented (in reports, scientific literature and formal OSPAR guidelines) and are used internationally.

4.4.2 Discussion on Netherlands studies

The workshop welcomed the Dutch studies and the efforts made to standardise approaches to necropsy and GIT investigations. It stressed the need for wider standardisation of approaches and discussed the specialisms involved in necropsy for marine debris. Initial observation of presence/absence of plastic (including as for the fulmar study) and the apparent presence/absence of lesions can be done first but determining health status of animal and cause of death (including, e.g. interpreting macroscopic lesions) is a task for an experienced veterinarian/pathologist. Samples needed to be taken in an appropriate way to include the apparently healthy part and the part with the pathology/legion. This had been discussed in detail during the development of the ACCOBAMS/ASCOBANS Best practice for cetacean post-mortem investigation and tissue sampling, and is further discussed below.

Bravo-Rebolledo confirmed that plastic ingested by fulmars of the Dutch coast has been decreasing slowly (Van Franeker and Kühn, 2019). This indicates that the marine litter situation of fulmars found on the Dutch coast is gradually improving. The same indication is not, however, evident in beach studies and further research would be required to fully establish a decline, identify which plastics are reducing and the measures that were introduced to achieve this and when. Furthermore, fulmars only feed at sea and are surface feeders, so these results are only an indication of floating debris, not of debris in the water column. Nonetheless, the workshop participants welcomed this good news story and hoped that further work could bring insights on what mitigation measures might have been a success. The workshop encouraged further dissemination of success stories.

The workshop noted anecdotal information on the MSC Zoe incident-including the huge loss of containers and the resultant follow up work to trace debris. It stressed the importance of monitoring such incidents and using them to learn more about marine debris, its distribution and impacts.

Recommendation
To follow up on the development, implementation and, in particular, on the effect of measures to reduce the risk of interaction of cetaceans with marine debris, the workshop **recommended** *that the Environmental Concerns subcommittee of the IWC Scientific Committee compiles a catalogue of successful mitigation measures, which the SC could then evaluate for best practice recommendations.*

4.4.3 Joint ACCOBAMS/ASCOBANS Best Practice on Cetacean Post-Mortem Investigation and Tissue Sampling

Mazzariol presented the Joint ACCOBAMS/ASCOBANS Best Practice on Cetacean Post-Mortem Investigation and Tissue Sampling, which can be downloaded from the following web page: *https://10.31219/osf.io/zh4ra*.

During the VIII ASCOBANS Meeting of the Parties (MoP) in 2016, the Advisory Committee (AC) and ASCOBANS Secretariat were requested to engage actively in the work on best practice guidelines for response to stranding events and in the establishment of an updated post-mortem protocol within the frameworks of the International Whaling Commission (IWC), ACCOBAMS and the European Cetacean Society (ECS) under Resolution 8.10. In the same year, ACCOBAMS endorsed the document on common best practices for a basic post-mortem examination of stranded cetacean (Resolution no. 6.22; VI MoP). ACCOBAMS also asked ASCOBANS, ECS and the IWC Scientific Committee (SC) to review the common definitions, common data collections and common post-mortem protocols during the triennium. In 2018, during the 24th ASCOBANS Advisory Committee and 12th ACCOBAMS Scientific Committee, a joint workshop was proposed to harmonise the existing initiatives. This meeting was held in Padua (Italy) in June 2019 and involved 24 experts from ASCOBANS and ACCOBAMS and also from Macaronesia, representing the MARCET project.

The aim of the Best Practice document was to update the protocol with the currently available techniques and methodologies agreed between all member countries of ACCOBAMS and ASCOBANS. It is hoped that this updated protocol can serve three overall aims: (i) to provide a reference document for veterinarians and biologists currently engaged in cetacean post-mortem investigations, summarising a recognised approach to stranding investigation across European networks; (ii) to highlight areas where harmonisation of data from existing networks could allow for analysis and inference to be made between networks, of particular relevance for the transboundary, mobile species; and (iii) to provide a start-up guide for researchers attempting to instigate new stranding monitoring programmes, particularly in regions of the world with limited resources for extensive, top-down surveillance programmes.

This document was not designed to replace existing protocols, particularly those of longstanding and well-established laboratories and stranding networks, but offers a post-mortem framework aiming for consistency across Europe when conducting examinations on dead cetaceans. By outlining current European best practices, it was assumed that there is sufficient time and resources to carry out a full post-mortem examination, although it is recognised this may not always be the case.

The quality of the information gathered is influenced by logistical capacity, e.g. carcass accessibility, available equipment/supplies and finances, and the skills, experience and capacity of the human resources. Nonetheless, it should be emphasised that following a precise and well-defined data collection procedure ensures the information collected during post-mortem investigations is of high quality. To be able to assess the cause of death and health status, a full post-mortem investigation with additional examinations as proposed below is deemed necessary. If a full investigation cannot be carried out for any reason, one should always attempt to collect the following data: species, sex, stranding location, stranding date and (approximate) body length to assess age class.

Common terms and definitions frequently used throughout the document, and general terminology used in stranding events and forensic human and veterinary medicine were harmonised and collected at the beginning (see Annex 6).

The document is structured using a tiered approach to carcass triage which allows investigations to be conducted at a number of levels, depending on the resources, facilities or experience of the stranding network. Whilst the 'gold standard' centres around a thorough and detailed post-mortem investigation conducted by well-resourced and experienced veterinary pathologists, it is recognised that this capacity is often the exception rather than the rule. The tiered approach offers a framework for data collection and interpretation appropriate to the resources available. In describing the tiers, information regarding who can do what and what should be assessed are reported.

- Tier One - External examination and stranding data collection.
- Tier Two - Post-mortem investigations and tissue sampling.
- Tier Three - Post-mortem examination with diagnostic aims.

The document describes the best practices for cetacean post-mortem investigations, and outlines basic best practice up to and including tier two. Guidance in cetacean post-mortem examinations or causes of death at tier three is outside the scope of the basic protocol. For this level, it is recommended that a veterinarian with specific training in pathology is involved in the examination, and principles and protocols according to professional bodies such as the European College of Veterinary Pathology (ECVP) are followed.

Furthermore, the decomposition code was revised to be adapted to post-mortem investigations only and a nutritional condition code was defined. The document includes tables summarising the possible investigations according to the decomposition code, tissues that should be collected and how to preserve them with special instructions.

4.4.4 Discussion on Joint ACCOBAMS/ASCOBANS Best Practice Guidance

The workshop welcomed this important contribution from ASCOBANS, ACCOBAMS and others and encouraged its use. It recognised that some countries will already have their own protocols but observed that they might find value in reviewing these for alignment with the ASCOBANS/ACCOBAMS document and integrating any additional guidance that is useful. The workshop noted the value of the tiered approach for different capacities and stressed that Tier 1 gives a useful starter for countries operating in low capacity and low technology environments. It encouraged that this best practice guidance should be presented to the IWC Scientific Committee for discussion and endorsement.

The discussion highlighted that though specific protocols for marine debris and bycatch investigations are useful, these should be components of protocols for establishing cause of death which remains the main aim of necropsy and is the main aim of the ASCOBANS/ACCOBAMS protocol.

The workshop furthermore stressed necropsy guidance as one important part of improving strandings response and surveillance for marine debris. Improvements are also needed in the organisation of strandings networks and strandings event management. There are important roles for a range of stakeholders, including governments and legislators in addition to technical specialists.

Recommendation
The workshop, noting the need for harmonisation to allow data to be compared globally, **strongly welcomed** *the European Best Practice on Cetacean Post-Mortem Investigation and Tissue Sampling and encouraged its wider use. The workshop commended this protocol to the IWC Scientific Committee for its consideration and potential endorsement.*

The workshop discussions brought forward much anecdotal information on marine debris types commonly seen in particular countries, e.g. synthetic raffia (used in agricultural construction) in the Canary Islands, plastic sheeting in the Adriatic and found in sperm whales (thought to be from discarded material from hothouses), and plastic bags in Greece. A preliminary review of literature considered during the workshop suggested the most commonly observed items were plastic bags, plastic bottles and food packages in general with some specific cases (such as those above) where particular items occur more frequently than others. The workshop noted other efforts to identify frequently occurring marine debris types, for example the 'top marine beach litter items' identified in Europe (Addamo *et al.*, 2017).

The workshop agreed that more efforts to identify commonly occurring debris types (including specific types more prevalent in particular locations) in addition to improved information on what is ingested by marine mammals, could help to identify particularly problematic marine debris types and thus priorities for improvement of waste disposal and recycling facilities and for addressing marine litter at source.

Recommendation
The workshop noted the emergence of some forms of debris as particularly prevalent globally, and that others can be identified as potentially problematic in some specific locations and **recommended** *these debris types should be addressed at source as a priority.*

4.5 Consideration of extent of cetacean entanglement in debris versus entanglement in active gear

4.5.1 Presentation

Mattila provided a brief overview and update on the difficulty of determining the origin of materials removed from entangled large whales, especially differentiating between actively fished gear and ALDFG. The importance of making this determination has been stressed at previous IWC marine debris and entanglement workshops, as incorrect assumptions about the source and origin of entanglements could funnel time, resources and political will in the wrong directions. Because many large whales destroy the gear that they become entangled in, and can drag the remnants for many weeks or months over thousands of kilometers, much of what is removed can look like debris, and is often classified as 'undetermined rope or net'. However, when identifying marks remain and the gear can be traced back to the owner, it has virtually always been actively fished gear. Currently, when there are no identifying marks, an attempt to differentiate between ALDFG and actively fished gear usually relies on unusual types or amount of fouling organisms, or on multiple gear types. However, even these can be misleading as a whale can drag gear through unusual habitats where it may pick up 'exotic' fouling organisms, and an entanglement in actively fished gear, if dragged long enough, could pick up multiple gear types as well as actual debris. So far, the only entanglement response network that has identified multiple entanglements in ALDFG is the network in Hawaii. Its determination of ALDFG as the origin of entanglement has varied annually between 5-16%. While many networks report 'unidentified rope or net', their affirmative determinations of ALDFG are extremely rare (Richardson *et al.*, 2019a).

The IWC currently coordinates a Global Whale Entanglement Response Network, which is made up of approximately 3,000 trained members representing about 25 country networks. The coordinators of these networks were recently polled about the extent to which they encounter entanglements in ALDFG (rarely, see above) and for ideas about how to differentiate. The need to identify better diagnostic fouling was reiterated, along with monitoring the rates of large whales becoming entangled in fishing areas that are closed to fishing, for some natural or management reason, during the whale's presence in that area. The latter idea assumes that any gear that a whale would encounter and become entangled in during such a closure would have to be ALDFG. An example of a 'natural closure', is the case of bowhead entanglement in Bering Sea crab gear, as telemetry tracking indicates that the whales stay in the sea ice during the winter where they could only encounter ALDFG lost in the ice (Citta *et al.*, 2013). Two examples of management closures shown were the seasonal lobster fishery closure in the Bay of Fundy and SW Nova Scotia, and the NARW closure of the snow crab fishery in the Gulf of St. Lawrence. However, in these examples it was noted that whales can easily roam in and out of the closure areas and could therefore be exposed to entanglement in active gear outside of the closed areas.

4.5.2 Discussion

In discussion, the group recognised that entanglement in fishing gear, both active and lost, is a threat to a range of marine species. The origin and impact vary according to species, population and habitat. For example, in most areas where data are available, large whales are primarily entangled in active gear, while lost gear may have a relatively larger impact on small cetaceans. But regardless of this variance, the benefits of sound fisheries management, that prevents entanglement in active gear, and facilitates the prevention, mitigation and clean-up of lost gear should be pursued in national, regional and international policy.

It was also recognised that differentiating between the origins of entanglements is important for focusing resources and management actions, and therefore it is helpful for ongoing research to provide tools that can assist in making these determinations for particular situations. But further research should not stall mitigation measures.

The workshop noted with interest the information from both the Bering Sea and North American crab fishery closures and the potential value of further research in 'closed areas' (to active fishing) in establishing impacts of ALDFG, whilst agreeing that movement of animals in and out of these areas might impact results.

The workshop agreed that further inquiry about diagnostic fouling may be valuable. It is recommended that inquiries be made with groups that are developing tools to track biotic fouling on marine debris (e.g. Plastisphere), in order to determine the utility of their methodology for determining if materials removed from entangled animals are from actively fished gear, or ALDFG.

Recommendations

The workshop **requested** *the Secretariat to establish contact with organisations developing tools to track biotic fouling on marine debris (e.g. Plastisphere) and report back to the IWC Scientific Committee on the utility of such methods to investigate materials removed from entangled animals.*

Given current knowledge, bowhead whales in the Bering Sea appear to be the species of large whale at the greatest risk to entanglement in ALDFG (Citta et al., 2013). Therefore, the workshop **encouraged** *the range states of the Bering Sea to engage stakeholders (e.g. Fisheries, subsistence whalers and others interested in the health of the Arctic) to investigate: (1) the removal and appropriate disposal of fishing gear that is lost in the ice, perhaps through a pilot project off Alaska; and (2) the use of gear that is less likely to entangle and less likely to be lost (e.g. remote release buoy lines). Furthermore, the group noted that, if these actions were successful and then expanded to an appropriate geographic area, this should benefit several populations of critically endangered large whales (e.g. North Pacific right whales, western gray whales).*

The workshop welcomed the plans of the Government of Canada to invest significant resources to remove ALDFG from North Atlantic right whale habitat in the Gulf of St. Lawrence. The workshop therefore **recommended** *that the IWC Secretariat invite Canada to provide an overview of this effort (e.g. underpinning data, methodology, anticipated outcomes), and other related mitigation measures, to the next meeting of the IWC Scientific Committee.*

5. HEALTH CONSEQUENCES OF MARINE DEBRIS FOR CETACEANS

5.1 Health consequences from ingestion

5.1.1 Review of latest evidence

Mazzariol gave a review of latest evidence of health consequences of ingestion of marine debris for cetaceans. Cetaceans can die after marine debris ingestion, due to gastric impaction/occlusion, perforation, or the associated lesions. Besides direct lethal effects, presence of plastic debris could affect marine mammals' health if they persist in the GIT, e.g. by reducing the space for food and, subsequently, reducing their fitness and nutritional condition. In addition, this may induce malnutrition, which is presented by a range of pathological changes (i.e. muscular and pancreatic atrophy, hepatic lipidosis, haemorrhages, etc.). Presence of foreign bodies could also cause inflammatory changes to the GIT and/or induce stress and pain. However, other indirect effects remain unclear, despite the concerns that have been raised by different studies on other taxa.

An investigation conducted on sheep and goats living in the Sahara Desert by Centelleghe *et al*. from the University of Padova (Mazzariol, pers. comm.) showed a direct relation between plastic ingestion and diseases. Here, sheep and goats eat plastic litter, which filled their forestomach. During a morbilliviral outbreak (Pest de Petite Ruminant Virus - PPRV) in Algeria in 2010, a direct relation was found between rumen repletion from the ingested plastic and sick animals with clear pathological findings associated to the viral outbreak.

An additional concern on the health effects of marine debris on cetaceans was related to the potential role of plastic debris as a carrier or vector of toxins and pathogens. This could respectively impair the immune function and change the (intestinal) microbiota. Recent studies conducted confirmed that polystyrene microfibers induced intestinal microbiome dysbiosis, hepatic metabolism disorders and changes in the gut barrier function.

5.1.2 Discussion

The workshop noted overall that more information is needed on the effects of macro and microdebris on cetaceans in order to determine the role of marine debris ingestion in causing mortality and to determine any risk of population level impacts. However, there are a growing number of reports showing ingestion of debris, in some cases relatively large quantities, and increasing documented evidence of associated pathology (Baulch and Perry, 2014a; IWC, 2014; Item 3.2.1 above). The complicated gut structure of cetaceans is such that it could facilitate impaction, and there have been some confirmed cases where marine debris has been established as cause of death (Baulch and Perry, 2014a; IWC, 2014). In addition, sublethal (chronic) impacts from marine debris ingestion have the potential to affect the overall health and welfare of the animal.

It was reiterated that the IWC has an interest in the threat from marine debris not only from a conservation but also a welfare perspective.

5.2 An evidence-based diagnostic assessment framework for cetacean necropsies on marine debris ingestion and common data collection

Following the discussion above, the group worked to develop an evidence based diagnostic framework for data collection on marine debris during necropsies (IWC/DEC19/MD/05). In presenting the framework, Mazzariol noted that interpreting post-mortem findings and evidence collected during a thorough necropsy, not limited to gross examination, needs specific skills and expertise. These data should be elaborated by skilled professionals to properly hypothesise the possible cause, mechanism and manner of death. A necropsy is a specialised medical procedure comprising of a thorough examination of a carcass by dissection with the aim to determine the likely cause of death. Sampling and testing should be complete and not be driven by any previous hypothesis or speculation; interpretation of evidences should be based on the best existing literature and protocols already published and/or used, ruling out any possible causes of death without bias. Even if it depends on the specific country's legal framework, post-mortem investigations with diagnostic aims should be conducted with the involvement of a veterinarian trained in animal pathology with an experience in marine mammal diseases.

Best practices and criteria associated with diagnoses of marine debris ingestion (IWC/DEC19/MD/05) is summarised in Annex 5. This set of findings constitute an evidence-based diagnostic assessment framework and could support the interpretation of data and observations collected during a thorough and complete necropsy by a veterinary pathologist and/or a veterinarian.

Recommendations

The workshop **recommended** *the adoption of the Evidence-based diagnostic assessment framework for cetacean necropsies on marine debris ingestion and common data collection by veterinary/biologists working in stranding networks during post-mortem examination of cetaceans in order to study the impact of marine debris ingestion on marine mammals.*

Considering the concern about the effects of ingested marine debris and the existing knowledge gaps on the effects that marine debris ingestion could have on the health of cetaceans, the workshop **encouraged** *collaborative and comparative studies on this, also noting potential links to human health studies.*

In particular, noting the potential role of marine debris in carrying pathogens and toxins, the workshop **strongly welcomed** *further studies on the effect of marine litter on the animals' microbiota and associated metabolic disorders, and the development of diagnostic approaches aimed at evaluating these effects.*

In this regard, the workshop recognised the activities of other IGOs and research institutions to improve understanding of the impact of microplastic ingestion in humans (e.g. World Health Organisation) and fish (e.g. Food and Agricultural Organisation of the United Nations) and **encouraged** *the sharing of information via the IWC Scientific Committee, e.g. through a presentation from WHO, FAO and other leading experts on the status of current knowledge in this field at the next possible meeting.*

6. CONSIDERATION OF SPECIFIC MITIGATION APPROACHES FOR CETACEANS

6.1 Addressing ghost nets

6.1.1 Overview of ALDFG issue

Dixon provided an overview of the issue of Abandoned, Lost and otherwise Discarded Fishing Gear (ALDFG). To the best available knowledge, approximately 640,000 tonnes of ALDFG gear enters the oceans every year, though this is considered to be an underestimate. By weight 70% of macroplastics are thought to be fisheries related and studies such as that from Lebreton *et al.* (2018) in the Pacific, point to over 50% concentration of marine debris originating from fisheries. A lot of fishing gear is underwater and therefore difficult to quantify in surveys or is washed up on beaches. Dixon also highlighted the research from CSIRO and Ocean Conservancy which indicates fishing gear is also the deadliest form of marine debris as it is designed to catch and kill, which does not stop once control of the gear has been lost. This is a significant risk for wildlife entanglement.

The main drivers of gear loss are direct (adverse weather, spatial pressures, gear conflict with other vessels and animals) or indirect (predominantly issues related to lack of disposal facilities), noting also that Illegal, Unreported and Unregulated Fishing (IUU) is considered to be a key driver of fishing gear dumping and loss but that this is an area requiring further research. Dixon suggested that understanding IUU hotspots where gear is frequently dumped due to enforcement issues or lost as a result of gear conflict may be useful as a focus for protecting cetaceans from entanglement.

Dixon described the progress made with the development and adoption of the FAO Voluntary Guidelines for the Marking of Fishing Gear, which were formally endorsed by the FAO Committee on Fisheries in July 2018. The intended benefits of implementation of the guidelines are wide ranging, from enabling better capacity control in fisheries to aiding in the detection of IUU fishing and ALDFG. The guidelines at present are voluntary, though FAO are conducting a series of capacity-building workshops in collaboration with the Global Ghost Gear Initiative and others in order to encourage countries and other fisheries stakeholders to implement the guidelines. In 2020 FAO are also partnering with IMO under the GloLitter project to continue scaling these efforts.

The workshop heard about the GGGI Best Practice Framework for the Management of Fishing Gear (BPF) which was formally launched in 2017 after an extensive stakeholder consultation. The BPF is another useful tool to support effective fisheries management and the reduction of ALDFG, providing a potential opportunity to benefit cetaceans. Dixon described the risk assessment approach to understanding which gear types pose the greatest risk as ALDFG and what their likelihood of loss is, noting that gillnets, then pots and traps and then FADs had been identified as the most high-risk gear types in the context of ALDFG.

The workshop also heard about the concepts of 'prevention, mitigation and cure', with the focus being on prevention of gear loss through measures such as gear marking, effective spatial management and improved port reception facilities as the preferred route. Dixon noted that several prevention and mitigation measures such as gear marking could be useful in identifying gear types and origins on entangled cetaceans, therefore encouraging the workshop to endorse gear marking.

Dixon described some of the recent policy developments in the European Union under the Single Use Plastics Directive, in particular the focus on scaling and replicating projects to facilitate the collection and recycling of fishing gear, therefore bringing it into the circular economy. Notably the EU is introducing an Extended Producer Responsibility (EPR) mechanism in 2024 which will enable improved gear design, management and disposal throughout the gear lifecycle. Dixon encouraged the workshop to take note of the EPR system as a potential policy approach to endorse to increase accountability with regards to the use and distribution of fishing gear.

In closing, Dixon introduced some potential areas for discussion as recommendations to IWC, notably referencing the possibility for IWC to support the call for a new legally-binding global governance framework to address plastic pollution; to further research links between IUU, ALDFG and cetacean entanglement in identified hotspot areas; to support policy approaches such as EPR and improved portside measures which aim to tackle producer responsibility and the circular economy of fishing gear; to support pilot projects in collaboration with FAO to implement the gear marking guidelines in areas of cetacean entanglement; and to highlight the potential usefulness of the GGGI Best Practice Framework.

6.1.2 Discussion

The workshop discussed the different degrees of risk (of becoming Ghost Gear) with different gear types, e.g. trap and pot gear will keep on fishing in perpetuity, whereas trawl/seine nets tend to ball up on the bottom and would not then pose the same risk. It was noted that means of identifying gear type when investigating entanglements are improving but that (as already discussed) there remain significant challenges in distinguishing between active gear and ALDFG.

Participants discussed provisions for shoreside disposal/recycling of unwanted gear, noting that there had been positive developments (including the EU Port Reception Facilities Directive) but that there was progress still to be made. It discussed legislative factors needing to be addressed for ghost gear mitigation, e.g. in some parts of the world (including some states in the USA), legally speaking, gear belongs to individuals even after it is lost and another party cannot have it on their boat without permission. It further noted the potential for ALDFG considerations (alongside active fishing, which is likely to remain the even bigger threat in most locations) to be integrated into fisheries certification schemes.

Finally, the workshop noted further potential for collaboration between the GGGI and IWC including in implementation of the GGGI Best Practice Framework.

Recommendations

The workshop ***recommended*** *that further research into links between ghost gear and cetacean entanglement be conducted, e.g. in hotspot gear loss areas, also exploring links with key drivers for gear loss (e.g. IUU). The workshop further noted the need to collaborate with the IWC Bycatch Mitigation Initiative (BMI) and the Entanglement Initiative.*

Recognising previous recommendations on engagement with the GGGI, the workshop ***encouraged*** *the IWC to consider the GGGI Best Practice Framework and recommended potentially undertaking pilot projects with GGGI on mitigation approaches to reduce impacts of ALDFG on cetaceans.*

The workshop ***encouraged*** *countries to implement policy approaches aimed at preventing and mitigating ALDFG, e.g. Extended Producer Responsibility and end-of-life gear management (e.g. circular economy, port reception facilities).*

The workshop ***encouraged*** *countries to support a global governance mechanism which would bring coordination and management for the full life cycle of plastics, including ALDFG, under one umbrella.*

The workshop ***welcomed*** *the introduction of the Port Reception Facilities Directive in the EU and efforts underway as part of the IMO Action Plan to Address Marine Plastic Litter from Ships to improve access and adequacy of port reception facilitates for end-of-life fishing gear and waste generated from ships. The workshop* ***encouraged*** *IWC members to implement or increase the capacity of existing convenient, cost-effective shoreside disposal/recycling infrastructure and logistics systems in order to enable responsible disposal of gear and other waste.*

The workshop ***recommended*** *that fisheries certification schemes should take into account impacts from bycatch and ALDFG.*

6.2 Addressing Fish Aggregation Devices (FADS)

6.2.1 Overview of the FAD issue

Mattila gave an overview of the Fish Aggregating Devices (FADs) issue. FADs are manmade structures that are placed (vertically) in the water column in order to encourage fish to gather and hide amongst the hanging materials, therefore aggregating harvestable fish, often in an otherwise low-density habitat (e.g. tropical or pelagic). Originally, FADs were made with floats made of bamboo or some other floating wood, with a vine or woven rope hanging below, to which items like palm fronds were attached. Today, they are often made of synthetic rope with debris or old netting attached loosely to the rope, topped by a float of some type, and a weight or anchor at the bottom. FADs can either be anchored in a permanent location, or can be set to drift in the open Ocean (dFADs).

The IWC Global Whale Entanglement Response Network has considered the entanglement risk that FADs pose to large whales since 2014, when a sperm whale female and calf (dead) were found entangled together in an artisanal FAD off the Island of Guadeloupe (Rinaldi and Rinaldi, 2014). The 2018 meeting of the GWERN (IWC/67/WKMWI/Rep/01) received further information about the increasing numbers and geographic scope of commercial FADs, along with reports of more large whale entanglements. Estimating the numbers of FADs, both commercial and artisanal, is difficult but a Pew report (PEW, 2015) estimated over 120,000 (commercial) FADs in international waters in 2013, with a rapidly increasing trend. Maufroy *et al.* (2018) estimated a loss rate of 8.8% for commercial drifting FADs.

For a number of reasons, there is growing concern about both the use of and loss of FADs. The International Seafood Sustainability Foundation (ISSF) has recently published a document (August 2019) with guidance for the construction and use of 'Non-Entangling and Biodegradable' FADs. At its next Congress (June 2020) the International Union for Conservation of Nature (IUCN) will consider a motion in support of non-entangling and biodegradable FADs, along with other management measures (e.g. limits per boat, etc).

It was also noted that FADs are not the only fishing gear used on the high seas that may pose a risk to cetaceans, whether tended or ALDFG. In particular, with regard to fishing effort on the high seas, long lines are estimated to be the most prevalent. Actively fished long lines are known to entangle large whales, and so abandoned, lost or discarded long lines would pose some risk as well.

6.2.2 FADs in the Mediterranean

Pierantonio summarised Sinopoli *et al.* (2020) which assessed the FAD situation in the Mediterranean Sea. This activity is widespread in southern Italy, Tunisia, Malta and Majorca (Spain). Sinopoli and colleagues estimated that every year, for at least 30 years, about 60,000 FADs have been placed at sea and in most cases are not recovered. In their study, they estimate that approximately 1.6 million FADs were abandoned in the Mediterranean Sea between 1961 and 2017. The largest fishing areas are off Malta (34,465km^2) and Tunisia (23,033km^2). The greatest numbers of abandoned plastic sheets (452,742) and concrete blocks (905,483) were estimated to be around Tunisia, while the greatest amount, in terms of length, of polyethylene cable (399,423km) was estimated to be around Sicily. The authors of the study discuss how the legislation on the use of Mediterranean FADs is still poor and does not address environmental issues and they emphasise that, overall, reducing the number of FADs and introducing new types of FADs equipped with specific technological systems appear to be the most suitable strategies to mitigate the impact of FADs on the environment and resources.

6.2.3 Discussion of draft IUCN motion on FADS

Following on from these presentations, the workshop discussed a draft IUCN motion on FADS to be proposed to the IUCN Congress, 11-19 June 2020. It welcomed IUCN engagement with this issue, expressed its hope that this motion would be supported and suggested that the motion could be strengthened by the additional of language on recent whale entanglements in FADS. It noted that there should be opportunities for online debate of this motion in the coming months.

Recommendations

The workshop **welcomed** *the draft of IUCN motion #28 for the IUCN World Conservation Congress to be held in June 2020, which seeks to promote more sustainable management of Fish Aggregating Devices (FADs). The workshop* **encouraged** *IUCN members to engage with the IUCN process to: (1) add wording that expresses concern about recent whale entanglements in FADs; and (2) support this motion when it comes to a vote.*

6.3 Identification of species/populations under particular threat of marine debris (i.e. hot-spots)

6.3.1 Overview from the literature

Nunny had reviewed the literature for the workshop and described the most relevant papers that show areas which could be considered hotspots where cetaceans are more likely to come into contact with marine debris. Identifying hotspots does not just mean noting areas where there are lots of plastics but also needs to consider the feeding habits and behaviour of the animals in that area.

Avila *et al.* (2018) reviewed publications highlighting threats to marine mammals and created risk maps. Almost all marine mammal species faced at least one threat. Although they did not create risk maps specifically for marine debris, this is included in the pollution map and the incidental catch and fishing gear interaction map which includes lost gear. Pollution hotspots were areas located along the coasts of industrialised nations with a few hotspots also being identified around northwest Africa and the Philippines whilst interactions with fishing gear were ubiquitous particularly in temperate waters though they are concentrated in coastal areas, enclosed seas and some areas of the Tropical Eastern Pacific and North Atlantic.

Modelling of hotspots for sea turtles by Schuyler *et al.* (2016) combined global marine plastic distributions based on ocean drifter data with sea turtle habitat maps to predict exposure levels to plastic pollution. The regions of highest risk to global sea turtle populations are off the east coasts of the USA, Australia and South Africa, the east Indian Ocean and southeast Asia.

Video transects were used to record the litter density in an area of 3,735,900m^2 of the seafloor in the Barents and Norwegian Seas (Buhl-Mortensen and Buhl-Mortensen, 2017). The mean density of items was 202 items/km^2 in the Barents Sea and 279 items/km^2 in the Norwegian Sea. The highest density recorded was >6,000 items/km^2 in a trough offshore alongside a fishing bank called Sveinsgrunnen. Fishery debris dominated the debris recorded. Litter density was higher than or similar to that recorded in other European waters.

Nøttestad *et al.* (2015) provide some distribution maps for cetaceans in the Norwegian Sea from three summer seasons which can be compared with the debris density maps from Buhl-Mortensen and Buhl-Mortensen (2017).

IMMAs (Important Marine Mammal Areas) which are being identified by the Marine Mammal Protected Areas Task Force (MMPATF) are available as maps (*https://www.marinemammalhabitat.org/imma-eatlas/*) which could be overlaid with the presence of marine debris to create hotspot maps where cetaceans could be particularly affected by debris.

The workshop thanked Nunny for providing this latest information.

6.3.2 Cetaceans and microplastics hotspots in the Mediterranean

Fossi gave a summary of work on marine debris hotspots in the Mediterranean. Monitoring of the impact of marine litter on cetacean species should include an understanding of likely exposure to marine litter in the area concerned. The Mediterranean Sea is one of the areas most affected by debris in the world: 115,000-1,050,000 particles/km^2 are estimated to float in the Mediterranean Sea (Fossi *et al.*, 2012; UNEP-MAP, 2015). Plastics and other polymer materials are the most common types of marine debris, representing some 80% of debris found on sea surface (Fossi *et al.*, 2017). As larger pieces of plastic debris fragment into smaller pieces, the abundance of microplastics in marine habitats increases. Despite the recent advances made within the framework of the Barcelona Convention Regional Plan for Marine Litter Management in the Mediterranean and the EU Marine Strategy Framework Directive (Descriptor 10), there is still a long way to go to tackle debris in the Mediterranean and reduce the risks posed to Mediterranean marine wildlife.

Recent studies suggest that debris, including microplastics and chemical additives (e.g. phthalates), tend to accumulate in pelagic areas in the Mediterranean (Panti *et al.*, 2015; Pedrotti *et al.*, 2016), indicating a potential overlap between debris accumulation areas and endangered species' feeding grounds (Fossi *et al.*, 2016; 2017). This fact highlights the potential risks posed to endangered, threatened and endemic species of Mediterranean biodiversity. In one of the most biodiverse areas of the Mediterranean Sea, the Pelagos Sanctuary, cetaceans coexist with high human pressure and are subject to a considerable amount of plastic debris, including microplastics (Collignon *et al.*, 2014; Fossi *et al.*, 2012).

Fossi and collaborators (Fossi *et al.*, 2017) investigated the possible overlap between microdebris, mesodebris (from 5 to 25mm) and macrodebris (>25mm) accumulation areas and the fin whale feeding grounds in the pelagic Specially Protected Area of Mediterranean Importance, the Pelagos Sanctuary. Models of ocean circulation and potential fin whale habitat were merged to compare debris accumulation with the presence of whales. Field data on the abundance of micro-, meso- and macrodebris, and on the presence of cetaceans were collected simultaneously. The resulting data were compared, as a multi-layer, with the simulated distribution of plastic concentration and the whale habitat model.

Field and model observations on marine debris distribution and accumulation areas overlapped the fin whale feeding habitat, paving the way for a risk assessment of fin whale exposure to microplastics at global level (Germanov *et al.*, 2018). The approaches used in this paper, and by Darmon *et al.* (2017) for sea turtles, predict where species will be the most affected by plastic debris, enabling the identification of sensitive areas for species specific ingestion to be defined, and providing a basis for the mapping of areas to be protected. Based on data or outputs from models on both macro- or microplastics, and species distribution, from plankton to large vertebrates, the same approach could be largely used to predict areas where the risk of ingestion occurs and possible consequences to biodiversity.

6.3.3 Discussion on marine debris hotspots

The workshop noted the potential threats posed by marine debris hotspots to cetacean species, particularly in convergent zones.

Mattila provided information on IWC collaboration with WWF and the IMMAs process, following on from a joint IWC-IUCN-ACCOBAMS workshop in 2019 to evaluate how the data and process used to identify IMMAs could be used to assist the IWC to identify areas of high risk for ship strikes. WWF is leading work to map the overlap between IMMAs and shipping and bycatch, which could potentially be extended to other threats.

IJsseldijk provided information on spatial risk analyses of marine debris exposure using predicted debris distributions and ranges for sea turtles (Schuyler *et al.*, 2016) and sea birds (Wilcox *et al.*, 2015). Participants expressed support for similar analyses for cetaceans.

Several participants described studies modelling the overlap between cetacean distributions and marine debris. Though noting such studies as useful, participants stressed that it is important to 'ground truth' modelling data with field studies wherever possible and the importance of taking into account sample sizes (where observations are small in number). Transience needed to be taken into account, with models accounting, if possible, for movements of hotspots with currents, etc.

Participants also discussed potential risks of marine debris to critically endangered species. In the case of the vaquita, for example, it had been observed that abandoned and lost fishing gear is adding to the threat already posed by active gear. Further work could potentially explore overlap between ranges of critically endangered species and marine debris hotspots, including those for ghost gear.

Dixon reported that the GGGI have undertaken some comprehensive efforts to build up a ghost gear database and collect and standardise all data globally. This is currently accessible through the GGGI.

Recommendations

Where suitable data exist, the workshop **recommended** *investigating co-occurrence of cetacean distribution with marine debris, for example through modelling exercises similar to those that have been done for seabirds and turtles. The workshop stressed the value of verifying modelling exercises using field data.*

The workshop **recommended** *that the IWC Secretariat adds marine debris mapping to its engagement with the IMMA process in order to identify potential high risk areas.*

Noting the potential threat of ghost gear to critically endangered species for which bycatch in active gear is the primary threat, the workshop identified in particular the vaquita (Phocoena sinus) as a species in a high risk that incidental mortality (bycatch) in gillnets will lead to its extinction. It therefore **strongly recommended** *the continuation of the removal of ghost nets in its distribution area.*

7. COMMUNICATIONS

7.1 Small group presentation

A small group presented on the issue of communications related to plastics pollution, focusing predominantly on consumer plastics rather than fisheries-related materials, which were covered elsewhere in the workshop. They highlighted the recent shift in public awareness on plastics pollution, giving examples of the 'Attenborough/Blue Planet Effect' and the viral images and videos of charismatic species interacting with marine debris as examples of tipping points in public awareness.

The presenters explained that as certain items have triggered awareness amongst the public, there has been a subsequent wave of product bans and community campaigns, e.g. to ban plastic straws locally. The group talked about how the activism and awareness has translated to a shift from companies and local municipalities to ban single use plastic items. They highlighted that campaigning can raise awareness, which can translate into industry and/or policy action, but questioned whether the most harmful/appropriate items are targeted through these actions. Often the 'easy wins' are the focus, rather than those causing the most harm in the marine environment. Also, misinformation, such as the lack of definitive degradation rates of various types of marine debris, was raised as an issue of concern in some campaign messaging.

The group talked about the statistics sometimes used in public awareness campaigning, e.g. 'more plastic than fish in the ocean by 2050' and the usefulness of these types of statistics. For campaigners, concrete numbers, when grounded in science, are helpful for communication, though some participants remained sceptical about sharing statistics derived from highly variable and time-dependent models. Discussion about the need for clear, impactful communications to make the topic relevant and accessible cautioned the need to be clear about these statements.

The presenters talked about the zero-waste movement and plastic bans as promoted approaches for targeting consumers. Zero-waste living is not accessible for everyone, so there is a need to be clear that plastics do have useful applications, and audiences in various geographies will require specified, considerate messaging, but single use plastics are not acceptable for those who have easily accessible alternatives. Stopping plastic production completely is not likely to be a message that resonates, but targeting measures upstream in the supply chain (e.g. through Extended Producer Responsibility) and restricting production could aid in addressing the challenges posed by this problem.

The group talked through tips for messaging and communication around behavioural change including:

- share the 'do' not the 'don't';
- focus on one action/location/initiative;
- show images of the desired behaviour;
- show positive progress, give hope;
- represent your audience; and
- caution against doom and gloom, facts first.

The presenters summarised that with regards to public-facing campaigning, there has been a big shift in progressive policy that is grounded in both the awareness and the presence of solid data on which to base policy decisions. The European Single Use Plastics Directive is a good example of this. Science, education and activism must come together to inform policy.

The presentation also touched on the importance of engaging industry in effective solutions to the plastic pollution crisis. The presenters talked about the role of 'brand auditing' in identifying the major polluters and highlighted the predicted increase in plastic production over the coming decades.

The group talked about industry targets and sustainability commitments, which have recently gained attention, e.g. commitments to increase recovery and recycling. It is notable that often these commitments are not focused on a restriction or reduction in production. In terms of assessing the role of industry in advocating around plastic policy, the presenters noted the presence of industry lobbying in key fora where scientists and NGOs are also engaging. Typically, a reluctance to commit to legally binding targets, taxes or other producer responsibility schemes and a focus on voluntary measures forms the basis of advocacy; however, it is critical for plastics industry representatives to be a voice in marine debris efforts, as solutions cannot be reached without their input.

The group discussed the importance of collaborating with a range of stakeholders to inform local, national, regional and global policy and identify clear communications approaches, in addition to engaging with behavioural and social scientists to promote long-term, effective system change.

7.2 Discussion

The workshop noted that, in part due to the successful awareness campaigns of a number of organisations, there has been a significant increase in awareness of the marine debris issue, but still a huge amount is needed to translate these campaigns into action, particularly for addressing the issue at source. Participants stressed the value of promoting positive solutions, i.e. what can be changed, or realistically achieved (and for the public, what actions individuals can take) rather than focusing on what should not be done.

It was noted that the wider public will act on things directly in their control, e.g. use of drinking straws and shopping bags, switching to multi use rather than single use items. On other things, e.g. awareness and influence of actions needed by the fishing industry and wider issues to address plastics at source, there is much lower awareness.

Participants noted some challenges in advocacy, particularly for larger, more bureaucratic organisations and where there are complexities in the science. Lessons could perhaps be learnt from recent effective environmental campaigns, including those of organisations such as Extinction Rebellion. Whilst their actions were not necessarily condoned by all workshop participants, they have been successful in side-stepping bureaucracy and engaging directly with public, particularly a youth audience impatient for action.

They further noted that marine debris and other environmental issues should be presented within the context of 'one health'. Challenges posed by marine debris affect the health of animals, ecosystems and people and should be represented in this context.

It is noted that the IWC should consider its own specific role in communicating on marine debris, with regards to other IGOs and the public as well as internally in communicating between its scientific and conservation committees and advocating its recommendations to member countries and other stakeholders (for which the new IWC database of recommendations will be useful). Messages and approaches will be different for different stakeholders. However, the discussions under this item highlighted some useful lessons for all organisations in communicating on this issue.

Recommendation

The workshop **recommended** *that when communicating on the issue of marine debris, stakeholders should: (i) take into account the audience; (ii) be accurate about the underpinning scientific information and its limitations; (iii) emphasise upstream solutions in addition to end of life measures; (iv) consider consulting communication professionals or social scientists; and (v) wherever possible, focus on positive, actionable messaging.*

8. CONCLUSIONS AND RECOMMENDATIONS

The workshop covered a wide range of issues related to: (i) the latest evidence on marine debris; (ii) methodologies for determining the extent of marine debris and its implications for cetacean conservation and welfare, including some detailed considerations for cetacean necropsy; and (iii) mitigation approaches for cetaceans. The conclusions and recommendations can be found highlighted in blue boxes under each agenda item.

9. ADOPTION OF THE REPORT

The Chair thanked all the participants for their hard work, high quality presentations and lively discussions during the workshop. The recommendations were reviewed and agreed during the workshop and the full report was adopted by correspondence on 24 April 2020. The Chair notes his thanks to Sarah Smith for acting as rapporteur and to Heidrun Frisch-Nwakanma for her assistance. He also thanks all the participants for taking part in what were stimulating and helpful discussions which should help not only the IWC take work forward on this topic but also help to address this global problem more robustly in the coming years.

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Annex 1

Agenda

1. Background
   - 1.1 Review of contributions and recommendations from previous IWC workshops and also recent work undertaken via CMS/ACCOBAMS/ASCOBANS, OSPAR and UNEP;
   - 1.2 Review of new key information since last workshop - to include information about whale entanglement in active and lost gear;
   - 1.2 New information about the 'microdebris' threat; and
   - 1.3 Consideration of lessons from other species (e.g. turtles and seabirds)
2. Methodologies
   - 2.1 Discussion of how to best collect and collate scattered information from cetaceans (identified as a key issue and opportunity for the IWC workstream
   - 2.2 Identification of 'best practice' in terms of protocols for data collection, to include
     - (a) Post-mortem investigations, including 'easy-to-collect' information from strandings and toxicology from plastic additives
     - (b) Categorisation of debris, including plastic types, microdebris and ghost gear
     - (c) Consideration of extent of cetacean entanglement in debris versus entanglement in active gear
3. Consideration of specific mitigation approaches for cetaceans
   - (a) Addressing 'ghost nets'
   - (b) Addressing Fishing Aggregation Devices (FADs)
   - (c) The role of litter streaming, clean-ups, recycling and biodegradables
   - (d) Identification of species/populations under particular threat of marine debris (i.e. hot-spots)
   - (e) Deep sea concerns
4. Research recommendations and identification of priorities.
   - (a) Addressed to the IWC
   - (b) Addressed to other bodies/more generally
   - (c) Networking opportunities
5. Policy recommendations
   - (a) Addressed to the IWC
   - (b) Addressed to other bodies/more generally
   - (c) Potential comment to World Marine Mammal Conference
   - (d) Other outreach
   - (e) Networking opportunities

Annex 2

List of Documents

IWC/DEC19/MD/

01. George, J.C., Sheffield, G. and Suydam, R. Working paper on E. Bering Sea bowhead entanglement [not for further distribution].
02. Smith, S. and Dixon, C. Review of recent Marine Debris work undertaken in other International Organisations.
03. Mazzariol, S., Povinelli, M., Corazzola, G., Marcer, F., Casalone, C., Grattarola, C., Mignone, W., Mancusi, C., Garibaldi, F., Baini, M., Panti, C. and Fossi, C. A novel meshes system prototype to examine the gastro-intestinal tract (GIT).
04. Mazzariol, S., Grattarola, C. and Casalone, C. An update on human induced mortality in the Italian waters (2015-2018): a focus on marine litter and ghost nets.
05. Mazzariol S., IJsseldijk L.L., Puig Lozano R., De La Fuente J. Evidence-based diagnostic assessment frameworks for cetacean necropsies on marine debris ingestion and common data collection.

Annex 3

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Annex 4

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Annex 5

Evidence-Based Diagnostic Assessment Frameworks for Cetacean Necropsies on Marine Debris Ingestion and Common Data Collection

S. Mazzariol[6], L.L. IJsseldijk[7], R. Puig Lozano[8] and J. De La Fuente[8]

This is a summary.

Interpreting post-mortem findings and evidences collected during a thorough necropsy, not limited to gross examination, needs specific skills and expertise. More in detail, these data should be elaborated by skilled professionals to properly hypothesise the possible cause, mechanism and manner of death.

A necropsy is a specialised medical procedure comprising of a thorough examination of a carcass by dissection with the aim to determine the likely cause of death. Sampling and testing should be complete and not be driven by any previous hypothesis or speculation; interpretation of evidences should be based on the best existing literature and protocols already published and/or used, ruling out any possible causes of death without bias. Even if it depends on the specific country's legal framework, post-mortem investigations with diagnostic aims should be conducted with the involvement of a veterinarian trained in animal pathology with an experience in marine mammal diseases.

In the present document, best practices and criteria associated with diagnoses of marine debris ingestion. These set of findings constitute an evidence-based diagnostic assessment framework and could support the interpretation of data and observations collected during a thorough and complete necropsy by a veterinary pathologist and/or a governmental veterinarian.

All the most relevant findings and diagnostic criteria reported in the most relevant literature will be summarised. The listed evidences should be interpreted with the results of the complete necropsy and all the other possible causes of death should be ruled out.

The ingestion of marine litter can occur in many cetacean species and the number of reports of foreign bodies found in the stomachs of stranded marine mammals is increasing. Despite these numbers, it should be noted that findings of plastic debris are not often deemed to be the main cause of stranding and are poorly reported in pathology literature. Recent papers published in the Canary Islands (Díaz-Delgado *et al.*, 2018; Puig-Lozano *et al.*, 2018) underline that only a few species seem to be lethally affected by plastic ingestion, with deep divers such as sperm whales and beaked whales more affected than others; young age and poor nutritional condition seems to be another relevant factor. With regards to the nutritional condition, it is not yet clear if it is a predisposing factor for the ingestion of marine litter, or a consequence thereof.

While, during necropsy, it is easy to state the possible ingestion of marine debris, it is more difficult to assess the impact it has on the animal's health.

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While entanglement could be hypothesised in tier 1 by reporting external evidences and poor body condition, marine debris ingestion could be assessed since tier 2: data and information collected could be useful to evaluate marine debris ingestion in the area from different species. In this case the following common information should be collected and evaluated:

Table 1

Data collection for tier 2 postmortem examination.

Data requested	To be filled by personnel
Species	name of the species
Gender	F/M
Age estimation	newborn/calf/juvenile/adult
DCC	1-5
Marine debris ingestion	Y/N
Type of object	Use INDICIT/MFSD
Size	surface, volume
Weight	g
Colours	describe different colors
Pictures	Y/N
Samples	according to Best practice document
Necropsy tier 3	Y/N
GIT associated pathology	from necropsy report
Cause of death	from necropsy report

In tier 3, the pathological findings summarised in Table 2 below could be observed, alone or associated with evidences of marine debris ingestion and they can support the interpretation of the pathologist in the assessment of the cause of death during the complete necropsy.

Table 2

Post-mortem findings associated to marine debris ingestion during necropsy (tier 3).

Moderate-severe presence of marine debris in the GIT could be consistent with:		
Post-mortem interpretation	Post-mortem findings	Notes
Incidental finding	Limited/moderate amount of marine debris without lesion associated with the foreign body	The volume and location of the debris should be evaluated.
Possible contribution to the cause of death and/or deterioration of health condition*	Partial repletion or obstruction with moderate-severe presence of lesion associated with the foreign body (e.g.: ulcerations, hyperkeratosis of the forestomach, gastritis and/or enteritis, haemorrages, etc.)	It is necessary to interpret in the general context of the postmortem study (necropsy and histopathology, as well as complementary analyzes if needed), and exclude other possible causes of death.
Probable cause of death	Traumatic perforation, severe impaction or complete obstruction of GIT with severe presence of lesion associated (e.g.: ischemia, necrosis, perforation, peritonitis, etc.)	

*Long-term pathological processes can cause or increase the possibility of presenting of other secondary processes like infectious diseases, parasitic infestation and/or signs of malnutrition or starvation (poor - very poor body condition, serous atrophy of fatty deposits, muscular atrophy, pancreatic acinar atrophy, etc.)

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Annex 6

Key Terms Used in Post-mortems

DISSECTION/PROSECTION: Medical and/or biological procedure to dismember the body of a deceased animal according to specific protocols in order to study its anatomical structure and/or to evaluate and sample specific organs and tissues.

NECROPSY/AUTOPSY/POST-MORTEM/POST-MORTEM EXAMINATION: Synonyms for a specialised medical procedure comprising of a thorough examination of a carcass by dissection to determine the cause, the mechanism and manner of death through the collection of evidence. In the case of wild animals this requires the involvement of a veterinary pathologist or a veterinarian with specific training in animal pathology, diseases and assessment of health.

POST-MORTEM INVESTIGATIONS: All studies and investigations carried out on an animal's carcass and/or samples taken after death, including those aimed to determine the cause of death.

HEALTH STATUS: Subjective assessment of diseases, conditions, or injuries that not only contributed to the proximal cause of death but which characterise the ante-mortem health status of the individual and the possible health status of cohort animals.

CAUSE OF DEATH/STRANDING: The disease, injury or abnormality that alone or in combination with other factors (environmental, other concurrent diseases, age, etc.) is responsible for initiating the sequence of functional disturbances that resulted in live stranding and death. In the case of an aquatic animal stranded on shore, the post-mortem investigation is aimed to determine the cause of stranding.

MECHANISM OF DEATH: The immediate physiologic derangement resulting in death. A particular mechanism of death can be produced by a variety of different causes of death.

Report of the South Asian River Dolphin Task Team Workshop

Kuala Lumpur, Malaysia, 19-21 July 2019

Report of the South Asian River Dolphin Task Team Workshop[1]

CHAIR'S SUMMARY

The threats to South Asian river dolphins (genus *Platanista*: the Ganges river dolphin (*Platanista gangetica gangetica*) and the Indus river dolphin (*P.g. minor*) are myriad. Habitat alteration, degradation and loss affects the entire range of the species across all four range states. Discussion and deliberations within the Scientific Committee (SC) led to the formation of a Task Team, in 2017, to assess emerging issues from across the species' range. The IWC creates task teams to provide timely advice on situations where populations of cetaceans are 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 Asian River Dolphin Task Team (AR-TT), convened by Sutaria and Kelkar, invited a group of river dolphin researchers to meet in an intersessional workshop to discuss progress towards achieving the AR-TT aims. A key objective of this workshop was to develop a trans-national plan that coordinated research efforts among range states and regions.

In particular, the workshop aimed to:

(a) identify information gaps and research priorities for South Asian river dolphin populations;
(b) identify research projects that require coordinated effort and sharing of expertise;
(c) identify key threats across the entire range of the species and any region, or country-specific threats; and
(d) communicate the results of the workshop to government agencies and other bodies concerned with river wildlife conservation.

The workshop was held between 19-21 July 2019 at the University of Nottingham, Kuala Lumpur, Malaysia, and was attended by members of the IWC SC and river dolphin experts from each range state – Bangladesh, India, Nepal and India. A review of the species' taxonomy indicate that two independent lines of evidence, morphological and mitochondrial, strongly suggest that the two subspecies currently recognised should be elevated to species status. The workshop supported the proposed taxonomic revision based on the evidence presented. Updates of population status were presented from each of the range states and it became apparent from the country updates that a substantial part of the dolphins' habitat (>80%) had been altered by river flow regulation measures or construction. Overall, mortality as a result of bycatch was recognised as the second greatest threat to river dolphins, following habitat fragmentation.

Five themes were discussed in detail: dams, hydro-climatic change and water availability; population surveys and ecological modelling approaches; dolphin bycatch; other types of interactions with fisheries; and human use of the animals (aquatic wildmeat) – all with the goal of identifying practical conservation solutions and emerging issues.

Following the deliberations of this workshop, the South Asian River Dolphin Task Team recommended that:

- By 2022, all range states identify key sections of national habitat that should be surveyed every five years, so that population trends can be monitored. Methodology should be replicated in each identified habitat but need not be standardised throughout the range, as different habitats require different methodological adaptations. This recommendation is targeted at the following:
    - Pakistan: WWF Pakistan, Punjab Wildlife Department, Sindh Wildlife Department and KPK Wildlife Department – co-ordinated through WWF Pakistan.
    - Nepal: Department of National Parks and Wildlife Conservation, Department of Forest and Soil Conservation, WWF Nepal, Institute of Forestry Pokhara and Hetauda Campus, University of Tribhuvan (co-ordinated by Shambhu Paudel and Usha Thakuri).
    - Bangladesh: Forestry Department and WCS.
    - India: India's Conservation Action Plan for Ganges dolphins, State Forest Departments.
- All existing survey methods in use for population estimation be reviewed, and a decision system prepared to guide monitoring agencies and conservationists to identify and implement statistically robust and optimal survey methods based on river conditions and available survey resources.
- Starting from 2020, surveys to establish population size be initiated as early as possible in the Padma, Jamuna and Meghna mainstems and tributary networks (excluding the Bangladesh Sundarbans), Bangladesh and the Budhi Gandak, Baghmati, Rapti and Mahananda, India.
- The review of Platanista taxonomy be completed and published.

[1]Presented to the IWC Scientific Committee as SC/68B/REP/04.

- As a priority, studies be conducted to better understand movements of dolphins across barrages in all countries and quantify the extent of population connectivity and impacts on dolphin populations in fragmented riverine habitats.
- Pingers be assessed as an effective tool, both to minimise bycatch and to reduce the risk of dolphins becoming strand in canals.
- A feasibility study be conducted to assess areas and methods to translocate Indus River dolphins (WWF-Pakistan) and to adapt existing marine mammal translocation initiatives specifically for river dolphins (co-ordinated by the Society for Marine Mammalogy and IUCN).
- As a priority and with data currently available, assess the level of dolphin bycatch throughout the species' range and evaluate its impact on local populations. From the outcomes of this assessment, provide recommendations for future monitoring and actions to mitigate impacts, ranging from technical changes to the revision of fisheries policies.
- Assessment be undertaken of the extent of targeted take and the use of dolphins for oil and as wildmeat, particularly in India and Bangladesh, by involving social and ecological scientists – as part of co-ordinated survey actions listed above.

In conclusion, the AR-TT members agreed to start working towards fulfilling these recommendations through compiling data sets, taking forward ideas for joint and collaborative work, and planning additional workshops to fill the identified information gaps and research needs for each country. The AR-TT agreed to report progress on its actions to the Task Team Steering Committee intersessionally.

1. INTRODUCTION

In 2016, the Scientific Committee (SC) of the International Whaling Commission (IWC) agreed that South Asian river dolphins (genus *Platanista*), currently recognised as two subspecies, the Ganges river dolphin (*Platanista gangetica gangetica*) and the Indus river dolphin (*P.g. minor*), required prompt and coordinated action to better protect the species from escalating anthropogenic threats throughout its range. At the 2017 SC meeting, a presentation on the Indian inland waterways development and river interlinking projects highlighted the likely have large-scale impacts on the habitat and distribution of Ganges river dolphin populations (Kelkar, 2017). Due to the complexities of water sharing between the four South Asian countries where river dolphins occur, it was also clear that the issue would not remain limited to India, but would have basin-level impacts across the Indus-Ganga-Brahmaputra (IGB) and associated basins. The IWC had considered these emerging issues as significant threats to be addressed through wider transnational collaborations between the four countries and thus had advised the formation of a Task Team to assess these impacts and changes. The IWC creates 'task teams' to provide timely advice on situations where populations of cetaceans are 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. Thus, the Asian River Dolphin Task Team (AR-TT) was formed in 2017 and Sutaria and Kelkar were nominated as co-Convenors. As a first action, an intersessional workshop was proposed, the key objective of which was to develop a trans-national plan that coordinated research efforts between range countries and regions.

In particular, the workshop aimed to:

(a) identify information gaps and research priorities for South Asian river dolphin populations;
(b) identify research projects that require coordinated effort and sharing of expertise;
(c) identify key threats across the entire range of the species and any region/country-specific threats; and
(d) communicate the results of these studies to government agencies and other bodies concerned with river wildlife conservation.

The workshop was convened at the University of Nottingham, Chulan Campus, Kuala Lumpur, Malaysia, from 19-21 July 2019. There were eight participants representing all four range states. The participants list is provided in Annex A. The workshop report was presented and endorsed at the 2020 IWC Scientific Committee Meeting (SC68B) Virtual Meetings.

1.1 Opening remarks

Fernando Trujillo welcomed the participants to the workshop and thanked the AR-TT for their on-going contribution to the work of the small cetacean (SM) sub-committee of the Scientific Committee of the IWC.

1.2 Election of Chair and appointment of Rapporteurs

Trujillo was elected as Chair. Porter and Sutaria were appointed as rapporteurs.

1.3 Adoption of Agenda

An addition was made to the agenda to include an update on *Platanista* taxonomy to be presented by Braulik. Duly revised, the adopted agenda is given as Annex B.

2. THE CURRENT STATUS OF RIVER DOLPHINS IN SOUTH ASIA: WORKSHOP VISION AND SCOPE

Detailed initial discussions on the purpose and outcomes of the meeting and workshop were critical, as multiple conservation plans and initiatives were being considered (e.g. CMS Concerted Actions (CA) for South Asian River Dolphins, WWF Global

River Dolphin Initiative, and IUCN revisions of Red List Assessments for both *Platanista*). Many national action plans are either in place, or being discussed, in each of the range countries. Some of the task team members are also involved in providing CA recommendations for CMS assessments at COP-13, India, in 2020. Thus, it was important for the AR-TT report to identify specific targets and recommend conservation actions that could complement and advance the outcomes of these parallel, multiple initiatives.

Sutaria provided the opening presentation in which she discussed the inception of the AR-TT and the urgent need for such a trans-national mechanism. Sutaria stated that the AR-TT would have to be sensitive to various aspects of power dynamics: between individuals, between NGOs, between scientists and conservationists, and between countries and their governments. These power dynamics, being strongly historical and culturally embedded, might become a significant hindrance to the conduct and application of effective cross-border science and conservation for Asian River dolphins.

Sutaria highlighted that the current pressures of infrastructure and economic development in the South Asian region is inevitably applying tremendous pressure on *Platanista* habitats. In this context, she wondered how the team, as a group of scientists and conservationists, would work in spaces impacted by geopolitics and intensive development aspirations. She suggested that to do so, team members would not only need to let go of agendas, identities, and work collaboratively, but also be realistic of the processes and scales they effectively can and cannot influence. She summarised the core scientific objectives of the meeting with the hope that population monitoring, hydrological studies, data analysis, and studies to assess impacts of threats, such as bycatch, barrages (and other hydro-infrastructure projects), pollution, etc., could be developed so that robust and comparable methods could be used regularly across the species' range. Sutaria also discussed how the teams might benefit from the exchange of each individuals experiences and could help mitigate proximate threats, both locally and regionally. She appealed to the workshop members to focus on 'small and beautiful ideas', with practical and timely outputs by next year.

In discussion, Arshad noted that science should lead to management outcomes and stressed that priority should be given to obtaining scientific information that is required by managers who have to deal with real-world challenges and conservation priorities. Alom opined that using the Task Team platform as a coordinating body was important especially in the context of transboundary conservation problems. The audience of this reports recommendations were clarified, and it was noted that any recommendations made could be directed at various parties, including the SC, the IWC Conservation Committee and various range states. Therefore, it was clarified that different recommendations could be directed to individual groups or entities. The impact of any recommendations was also discussed. Sutaria stated that there was value in formal letters from different organisations and international consortia that the four national governments were signatories to. This official medium of communication could have an impact at the highest levels of governments, as official responses from country officers can be solicited. The communication between different international bodies (e.g. IUCN, CMS, WWF) was also considered, as was the various groups' communication with governments. It was concluded that coordination between these various groups was desirable, and that SM of IWC would endeavour to highlight the workshop discussions within SC and the Conservation Committee, as well as with other international bodies.

There was concern that 'mixed messages' might result from multiple and parallel groups discussing similar issues, with the recognised need to avoid this outcome. It was noted that having one strong organisation, open to collaboration and data sharing, can significantly reduce the decentralisation of key issues and avoid confusion. The long-term and regular presence of such organisations can also assist in more effective communication, as has been demonstrated by the work of WWF in Pakistan and WCS in Bangladesh. It was highlighted that having multi-institutional systems with overlapping mandates and boundaries increases the complexity of conservation project and may create conflicts over collaboration and information sharing mechanisms (e.g. the numerous groups working on river dolphins in India). It was hoped that the AR-TT and the assistance of IWC could provide an over-arching platform to maintain coordination and cohesion with regards to Asian river dolphin priority research and conservation goals.

2.1 Update on proposed taxonomic revision

Braulik outlined the current taxonomic status of Asian river dolphin. Indus and Ganges river dolphins are currently classified as subspecies, *Platanista gangetica minor* and *Platanista gangetica gangetica*, within a mono-typic family (Braulik and Smith, 2017). Braulik *et al.* (2014b) studied mitochondrial genetics and compared sequences from the Indus and the Ganges rivers and ascertained that there were no shared haplotypes, that there were five fixed differences between rivers, and a Bayesian analysis of divergence suggested that the two populations had been isolated for around 550,000 years. This supports what is known of the riverine geology and historical river drainage patterns. A comparison of skeletal morphology demonstrated that the shape of the frontals, behind the nasals, can be used to consistently differentiate skulls of the two sub-species. Indus dolphins have, on average, five more teeth than the Ganges dolphin. And while the Ganges dolphin show sexual dimorphism (females being significantly larger than males), this is not the case for the Indus dolphin, although data from the Indus range is limited. A proposal that the two subspecies be elevated to species status is being prepared (Braulik *et al.*, In prep-a). Braulik highlighted that the taxonomic split is important for conservation, beyond the scientific importance. The workshop supported the proposed taxonomic revision based on the evidence presented.

2.2 Perspectives from South America

Trujillo presented an overview of his 32-year research and conservation efforts for the river dolphin species in South America (across Brazil, Colombia, Bolivia, Ecuador and Peru). Trujillo highlighted similarities and parallels between South America and Asia, in terms of habitat pressures, human population pressures, and impacts of hunting and bycatch on river dolphins in both regions.

Trujillo updated the workshop on the current status of *Inia* and *Sotalia* taxonomy. Current evidence indicates that the genus *Inia* taxon likely includes four species; *I. geoffrensis* (main Amazon), *I. araguianensis* (Araguian-Tocantins), *I. boliviensis* (Bolivia), and *I. humboldtiana* (Orinoco), however at present only *I. g. geoffrensis* and *I. g. boliviensis* are recognised by the Society of Marine Mammalogy (SMM), whose taxonomy committee is recognised as the authority of all marine mammal species. The genus *Sotalia* currently comprises one coastal and one riverine species, *S. guianensis* and *S. fluviatilis*, respectively.

Trujillo described the extent of human pressure in the Amazon basin. Importantly, he debunked the popular perception that the Amazon basin was a pristine and largely unaltered riverscape. The Amazon region hosts 34 million people, of which just over 10% are indigenous tribes. Hydropower dams along the Andes headwaters drastically interrupt natural flow regimes and sediment supply to the plains, affecting between 15% to 55% of river dolphin habitat in the region (Araujo and Wang, 2014; Pavanato *et al.*, 2016). Trujillo also highlighted severe threats from agrochemical pollution, oil spills, and artisanal gold mining. Gold mining, both legal and illegal, has resulted in high levels of mercury pollution and toxicity, in both fishes and river dolphins. Mercury levels in fishes and dolphins varied from 0.1 to 3.9mg/kg, noting 0.5mg/kg is the recognised ‘tolerable limit’. This is also a serious risk to human health.

Accidental bycatch and hunting of river dolphins in South America for aquatic wild meat varies across the region (IWC, 2020). In the 1970s, high bycatch in gillnets was recorded, but lately, threats from bycatch are coupled with targeted, illegal hunting of dolphins. Alarming estimates of dolphin mortality (*c*. 1,000 animals per year) were recently made for a small region of the Amazon River. In response, some countries have introduced a moratorium on fisheries that cause high bycatch and mortality, e.g. Brazil has declared a moratorium on Piracatinga fishing until 2020.

Trujillo detailed the ongoing range-wide effort to monitor populations of both *Inia* and *Sotalia*, using robust methodological approaches, utilising a combination of visual, acoustic and Unmanned Aerial Vehicle (UAV) surveys, to estimate population sizes and to map key habitats (Costa *et al.*, 2018; Oliveira *et al.*, 2017). Trujillo and others have coordinated surveys over 33,000km of river and across all five range states. Trujillo also highlighted the importance of obtaining population trends (Williams *et al.*, 2016), which are thought to indicate degrading freshwater habitats (Turvey *et al.*, 2012), while also monitoring dolphin health, seasonal and other movement patterns via satellite tagging studies, and social/foraging behaviors of river dolphins. The collective mission of these efforts has been to prioritise conservation actions in areas with the greatest known pressures.

In terms of conservation success, Trujillo has observed that South American river dolphin populations are better protected in and around Ramsar sites. He also highlighted the positive impacts of local fishing agreements and eco-tourism initiatives had had, in terms of reducing negative fishing impacts on South American river dolphin. He highlighted the utmost importance of coordinating trans-national efforts in the case of the Amazon, and the outcomes of coordination were summarised in a series of country-specific and regional action plans, including an IWC-CMP(s) or Conservation Management Plan(s), coordinated through the South American River Dolphin Initiative or SARDI (Trujillo *et al.*, 2010; Trujillo *et al.*, 2018).

The discussion that followed the talk mainly involved if, and how, similar coordination could be attempted within and across South Asian range countries of *Platanista* dolphins. Similarities and differences between the South American and South Asian situations were discussed. Participants reiterated the need to start by building technical capacity as well as communication platforms for similar coordinated surveys, situation-specific and priority-based studies, and sharing learning from different experiences.

2.3 Pakistan (Arshad)

Arshad thanked the long-term efforts of Braulik that have laid the foundation for the Indus dolphin research and conservation programme at WWF-Pakistan, and for the provincial governments of Punjab, Khyber-Pakhtunkhwa (KPK), and Sindh in Pakistan. Arshad also described the new WWF Global River Dolphin Initiative of WWF, and its Global River Dolphin Strategy or GRDS (2018-30, World Wildlife Fund [WWF], 2018) as being a major new effort towards river dolphin conservation in South America and Asia. In Pakistan, Arshad is in charge of implementing the recommendations of the GRDS for the Indus basin. He emphasised that the programme will be implemented under the ‘Freshwater Practice’ of WWF-Pakistan, to provide a holistic canvas for understanding the threats and implementing specific, targeted measures for river dolphins in relation to basin-scale water allocations for irrigation, power generation, and domestic use. The situation in Pakistan is very interesting from a management point of view: whereas the range of the Indus dolphin has shrunk by 80% from Anderson’s 1879 baseline (Braulik *et al.*, 2014a), the population densities in two sections of the Indus river, between the Taunsa and Guddu, and the Guddu and Sukkur barrages, have been showing an increasing trend (Hamera *et al.*, 2017). In the upper and lower sections of the Indus, and in its tributaries, Indus dolphins either persist in tiny populations or have been extirpated completely (the 5-11 strong population of Indus dolphins in the Beas River, India, is an exceptional case of an isolated remnant population of dolphins; (Braulik *et al.*, In prep-b; WWF-India, 2018).

Another significant issue is the high frequency of canal stranding of Indus dolphins in the Indus plains of Pakistan. Since 2000, nearly 150 dolphins have been 'rescued' from canals and released back to other sites on the river (Braulik *et al.*, 2015). Arshad showed data that indicated a nearly 90% success rate of rescue-release, i.e. 90% of the 150 individuals survived until release time. A 'dolphin ambulance' is run by WWF-Pakistan with the help of the Sindh Wildlife Department to respond to stranding cases and conduct rescue operations (Hamera *et al.*, 2017). Trujillo asked if any data on genetics, health, or other factors was being collected during these operations, because it was a great opportunity to do so. Trujillo suggested, based on his long-term data collection on Amazon river dolphins, that procedures for tissue sampling by skin-scraping and tail-bit collection will be helpful.

Satellite telemetry was also an obvious outcome of the discussion on stranded individuals captured by the dolphin ambulance. Toosy *et al.* (2009) had actually tagged a male Indus dolphin, which was tracked for 15-20 days. This dolphin moved upstream and downstream of the Sukkur barrage through the gates, when the gates were opened and the water levelled out. Telemetry studies were recommended by Arshad and other participants to understand movements of dolphins across barrages, as well as between the river and canals. Braulik said that Indus and Ganges dolphins needed customised tags and telemetry devices, due to their tiny surfacing times and the lack of a clear dorsal fin for anchoring tags. Porter suggested that customised tags can be developed on the lines of how technologies are being specifically developed for Irrawaddy dolphins in different habitats.

Arshad and Braulik also said that to deal with the peculiar issue of increase in dolphin densities and abundances in a shrinking range, assessing efforts for 'Conservation Translocations' is a priority. For this, WWF-Pakistan was interested in conducting a feasibility assessment of river stretches in the Upper Indus, to evaluate the habitat quality, prey availability, water availability, social indicators and the levels of all threats would be reviewed to assess whether translocated dolphins would be likely to survive well enough for small populations to be re-established (Braulik *et al.*, 2015; 2018; Khan, 2013). The idea is that, as a pilot effort, stranded dolphins rescued from canals, or from areas with extremely high densities (>10 dolphins per km) could be released in the sections with lower density. Arshad and Braulik also highlighted that consensus needs to be built between provincial governments prior to translocating animals from one province to the other. Translocations may be an important intervention in Pakistan in the near future. Discussions are in the early stages at present and unequivocal support is still wanting from all concerned authorities who will design and implement translocation programmes. Braulik identified the IUCN Guidelines on 'Reintroduction and Conservation Translocations' as a good starting point to prepare procedures for the rescue, captive maintenance, and relocation of Indus dolphins in Pakistan's context (Braulik *et al.*, 2018). At present, a draft concept note has been completed on the matter and is likely to be discussed with provincial departments in charge of permissions and clearances in Pakistan.

Arshad presented a graphic map from Braulik *et al.* (2014a) that highlighted the 'time since last sighting' of Indus dolphins in each of the river sections. The rapporteurs asked if a similar graphic could be prepared for all populations of the Ganges dolphins as well. To this, Kelkar replied that this was being undertaken for the IUCN Red List Assessment for Ganges dolphins, which is currently on-going.

Other important points highlighted by Arshad included the creation and maintenance of protected area networks for Indus dolphins (including the Indus Dolphin Reserve in Sindh, multiple Ramsar sites in the Indus river-floodplains, and potential new areas), legislative changes in fisheries policy, and the creation of a program for comprehensive ecologically informed water management that could ensure 'Conservation Assured River Dolphin Standards (CARDS)'. Arshad also identified themes of work in the Indus basin, from which funds had been secured also for monitoring and conservation efforts for Indus dolphins in Pakistan (which have included programmes on food security, livelihoods, water resources and climate change, and human development). He also flagged the issue of microplastic pollution in Indus dolphins based on a study recently conducted by a student at the Punjab University. An examined dolphin had 2,653 microplastic pieces, highlighting the grave extent of this problem.

Trujillo wanted to know if the WWF GRDS goal of doubling river dolphin populations in Pakistan would be realistic. Arshad replied that the more important aspect of this goal would be to increase the range of the Indus dolphin at least to some areas where it historically occurred (Anderson, 1879). He said that currently, all eggs were only in one or two baskets (the Taunsa-Guddu and Guddu-Sukkur populations on the Indus mentioned earlier). To ensure the rise of dolphin populations in more viable habitats, the number of baskets had to be increased by translocating adult dolphins to allow more areas to support populations, as explained before.

Kelkar asked for more detailed information on the 'revision of fisheries policy' that was emphasised by Arshad in his presentation. Arshad said that different fishing regimes exist on different stretches of the Indus. In Punjab province, fishing is commercial and intensive, and conducted under a system of leasing out river stretches to private contractors for fishing over one to a few years. In Sindh, however, the fishing is effectively an 'open-access' regime – whereby fishers can purchase fishing licenses very cheaply (PKR 100 for one license for a year). This led to a significant rise in the number of fishers, activity of fishing gears, and intensity of fishing. Such subsidised licensing systems needed a critical review in order to make them more sustainable and socially just. Contractual fishing systems (as in the Punjab province) were likely to be exploitative of fishermen, while effectively open-access systems (as in Sindh) might lead to overfishing as well as conflicts. In response to Trujillo's query about the influence fish traders hold on the fishery (as in South America), Arshad replied that traders indeed hold sway on how specific areas of rivers under contracts are fished. Both regimes have had impacts on Indus dolphins in terms of accidental bycatch, but hunting had reduced substantially as a result of extensive awareness campaigns and monitoring by provincial wildlife departments and WWF-Pakistan. As the Indus dolphin populations had been increasing both under the contract regime and the open-access system, at present it is not easy to establish a causal relationship between the institutional regimes and negative interactions of dolphins with fisheries.

Finally, Arshad identified that alternative livelihood systems to support fishing communities without increasing their impact and dependence on river fishing was important. This was attempted by WWF-Pakistan for about 3,000 families under a UKAID Global Poverty Action Fund (GPAF) programme.

2.4 Nepal (Thakuri/Paudel)

Thakuri gave an overview of the major threats and the current status of research and conservation efforts for Ganges river dolphins in Nepal. The species is protected in Nepal under the National Park and Wildlife Conservation Act (1973). River dolphins used to occur in four rivers of Nepal (Mahakali, Karnali-Mohana, Narayani, Koshi) but are now found only in three rivers (they are extinct from the Mahakali). The total population size in the three rivers may not be more than 28 animals (Paudel *et al.*, 2015). Dolphins have been extirpated from some upper segments of the Karnali, Narayani and Sapta Koshi recently, indicating a range contraction (Khanala *et al.*, 2016). Barrages on the India-Nepal border and irrigation intakes (e.g. Upper Karnali Hydropower dam, Rani Jamuna Kulariya Irrigation Intake) remain important threats and continue to affect river dolphin habitats in these rivers (Smith *et al.*, 1994). Four cases of mortality due to entanglement/targeted killing were recorded from the Karnali and Sapta Koshi. One animal was found trapped in the gates of the Koshi barrage. This level of mortality can be highly significant for the small persisting populations. In the Sapta Koshi, dolphins with broken snouts and injury marks have also been recently observed, which could indicate potential conflicts between artisanal fisheries and river dolphins. Thakuri highlighted that there is stronger need for government engagement with the issue of river dolphin conservation. This applies not only to the Nepal Government, but also to trans-boundary management of barrages for ecological river flows between India and Nepal. India and Nepal have had bilateral water sharing treaties from the 1960s and the operation of the barrages is controlled by the clauses of the treaties. Although Nepal is geographically the upstream nation, India had built the border barrages in the 1960s. Based on water demand, India gets the larger share of water between the two nations.

Insufficient research and conservation funding for river biodiversity in Nepal were also cited as constraints, and the preparation of a conservation action plan for Nepal, including plans for sustainable fisheries management was recommended (Paudel *et al.*, 2016).

It emerged during the discussions that although transboundary biodiversity conservation and wildlife management plans exist between India and Nepal (Government of Nepal, 2018) for charismatic terrestrial megafauna (rhinos and tigers), a similar effort was wanting for Ganges river dolphins. Current research in Nepal is in the early stages but acoustic research and attempts at photo-identification based population size estimation are underway. Kelkar requested Thakuri to update the audience on the status of the large hydropower projects on the Karnali and other rivers. Thakuri responded that the second phase of construction of the Rani Jamara Kulariya Irrigation Intake and Upper Karnali hydropower project was on-going. It is deemed that once completed, these projects on the Karnali River might have significant impacts on river flows downstream. Kelkar also hinted at prospects for a biodiversity component that could be under discussion in the context of water sharing treaties and MoUs between Nepal and India.

Trujillo asked about the methods used to assess population size and whether the known numbers were believable, with a measure of uncertainty known. This would be important because Nepal's populations, in terms of numbers, might be at the highest risk. Braulik's comment was that if we compared the current population sizes with those recorded by Smith *et al.* (1994), it would appear that there has been no major change in population size. Probably there were never large populations of dolphins in Nepal, as the river stretches are not big enough to support an abundance of dolphins. The Karnali, for example, has numerous whitewater rapids, deep pools, and fast-flowing riffles, and the remaining river habitats might at best be marginal habitats for river dolphins (Khanala *et al.*, 2016). These rivers probably represent the most upstream extents of suitable habitat for *Platanista*. Kelkar agreed and also pointed out that the three rivers had interesting similarities and differences in hydrology and the nature of flow regulation by barrages. The extent of suitable river dolphin habitat upstream of these barrages and within Nepal varies, and the remnant population sizes could be related to the differential extent of floodplain. He said that this situation merited a study to understand what barrage operations might affect habitat availability for the small populations in Nepal. A map was also shown with the locations of the barrages on the three rivers.

Trujillo suggested that measurements of suitable habitat area in Nepal that might remain untransformed by dams and other human interventions would be a useful effort to undertake. Braulik added that studies to confirm whether river dolphins move through the barrages on the India-Nepal border will be critical, for their implications of regular movement are for local population connectivity and dynamics. In Nepal, the restricted lengths of their floodplain river stretches, above which mountainous areas and gorges begin, might naturally limit river dolphin habitat. The river flows in Nepal's plains are currently 'near-natural', altered only at minor levels by a few hydropower projects on mountain tributaries.

With regards to the issue of estimating dietary overlap between fishing catches and river dolphins, Alom opined that unless stomach content analyses were carried out, the estimate of dietary overlap would not be robust.

2.5 Bangladesh (Alom)

Alom summarised the extensive science, conservation, and outreach work being done by the Wildlife Conservation Society-Bangladesh (Alom *et al.*, 2014; Mansur *et al.*, 2014a; WCS and BCDP, 2014a; 2014b; 2014c), in the Bangladesh Sundarbans with the Forest Department, Ministry of Environment and Forests, Bangladesh (Forest Department *et al.*, 2015). Alom focussed on conservation interventions for *Platanista* in particular, with: (1) three river dolphin sanctuaries along deep pools in identified key habitats of the Sundarbans; (2) community engagement and outreach to reduce fishery impacts on river dolphins, especially accidental entanglement in fishing gears, and also occasional targeted killing; and (3) insights from fisheries monitoring and bycatch mortality reporting in the Bangladesh Sundarbans (Mansur *et al.*, 2014b). He stressed that fishing impacts were the primary conservation concern for Bangladesh's river dolphins by direct and indirect impacts.

In Bangladesh, between February 2007 and August 2019, 118 deaths of Ganges river dolphins were recorded by a cetacean mortality monitoring network maintained by the Wildlife Conservation Society (WCS). Most of these deaths (66.9%) occurred in waterways of the Sundarbans mangrove forest where a large portion of WCS activities are concentrated. This means that reporting rates are probably higher in this area compared to the river stretches upstream. The cause of death was known for more than half of the deaths (60 animals) of which 81.7% were due to entanglement in fishing gears. Dolphins were beaten to death (probably in retaliation for depredation) for 8.3%, hunted by harpoon for 5.0%, and fatally injured in boat collisions for 5.0% of the remaining mortalities, with known cause of death. Of the total number of fishing related mortalities when the gear type was known (41), 80.5% were in gillnets, 12.2% in set bag nets, and 7.3% were in long lines (WCS, unpublished data). The large percentage of dolphins killed in gillnets with large mesh-sizes in Bangladesh is consistent with what is known about the vulnerability of Ganges dolphins to this fishing gear in other areas of their distribution. This points to gillnets as a major threat that could drive the species to extinction in the absence of urgent interventions.

The use of SMART technology in patrolling and monitoring river stretches has been a key feature of increased effectiveness in fisheries monitoring and prevention of illegal fishing. Coupled with vast outreach efforts by WCS in fishing villages (Alom, 2015; Mansur *et al.*, 2014a), SMART patrols have led to both enforcement of fishing bans and no-go areas (e.g. over 4,300 gillnets and 1,140 small boats have been seized), as well as awareness among fishing communities. Outreach efforts have involved boat-based and land-based 'dolphin fairs', development of playing stations and interactive materials, and field-kits for fishers with manuals in the Bengali language for fishers and wildlife managers (equipped with fisheries seasonal calendars and information brochures on legal and illegal practices, mesh-size, species, and seasonal restrictions on fishing in particular areas). Alom expressed that securing sustainable financing mechanisms for developing community engagements has been a challenge, but so far there has been a fair measure of success in this regard (Iyer *et al.*, 2019).

Sutaria and Arshad asked Alom if the outreach materials they had prepared (and demonstrated by Alom in his talk) could also be made available to teams in other countries, to adapt, replicate, and use for educational activities. Alom replied that the materials were developed by the WCS Program with the purpose of wider dissemination and conservation outreach, and they were happy to share the materials.

Kelkar asked Alom to identify some measures of success, i.e. the effectiveness of the river dolphin sanctuaries in reducing gillnet entanglements, which was their objective. Alom responded that due to outreach efforts, reporting rates of bycatch or mortality cases had increased significantly, which he regarded as a measure of success. Fishers are not only keen to report on mortality cases, they also now realise that it is likely to provide them with economic and cultural benefits (e.g. by becoming conservation stakeholders rather than being viewed as antagonistic to dolphins). Increasingly, fishers have been learning that society values river dolphins for their intrinsic 'beauty' and their conservation is hence a must.

Braulik remarked that the Bangladesh work had been going on for a long time and involved the inspiring efforts of many people. She wanted to know how the small hotspot areas protected as dolphin sanctuaries worked as community-led reserves. Alom said that the entire Sundarbans region includes a Ramsar site, and is a World Heritage Site and thus are protected, while the local sanctuaries had the specific objective of reducing dolphin entanglements (Smith *et al.*, 2010a). Braulik also submitted that the major existing data gap on Ganges river dolphin population size was now from the rivers of northern Bangladesh (Padma, Jamuna, Meghna, and their tributary-distributary networks), and asked if WCS-Bangladesh was planning to survey this region, to arrive at a country-level population estimate for Bangladesh. Alom said that no proper or systematic surveys had been conducted in the rivers of northern Bangladesh so far, except for anecdotal information and occurrence records (Baki *et al.*, 2017; Rashid *et al.*, 2015) that confirmed only the presence of dolphins. To put in place a survey of the entire river network in Bangladesh would be challenging, but needs to be attempted soon. Alom said that WCS could partner with other local NGOs and the government's environment departments to complete extensive surveys.

Arshad suggested that different activities conducted with fishing communities could involve options such as signing conservation agreements with industries that are promising labour and other employment opportunities to local rural fishing communities. It might be possible to argue that, because new jobs are becoming available in part due to conservation engagements, industries could be requested to support dolphin conservation programs in the long term.

2.6 India (Kelkar)

Kelkar provided a country update on India's Ganges river dolphin populations, describing existing and emerging threats. There are numerous teams from different institutions (including state-level forest/environment departments, university groups, government and non-governmental research institutes, NGOs and non-profits, etc.) involved in dedicated, long-term surveys of Ganges dolphin populations and threats in India. According to Kelkar, individual state-level environment and forest departments in India were best placed to bring all the different teams together and allow coordination. Apart from them, the Wildlife Institute of India's River Dolphin Recovery project (2016-21, Bihar, West Bengal, Assam) and WWF-India (for the states of Punjab and Uttar Pradesh) were thought to be important nodal organisations that could facilitate coordinated surveys in the future (see point 1 in the Recommendations of this report).

As a result of multiple teams working mostly independent of each other, different survey methods have been used in different areas. So far there has been no agreement on standardising methodology across the range, and most groups used single-observer, downstream survey methods that provide the bare minimum of 'direct counts', based on Smith *et al.* (2000). Kelkar took stock of the different methods in use across the species' range. He also described their own independent-observer double-observer survey methodology (used in the Ganga in Bihar, India), from small, basic country-boats with wooden platforms and shades built from bamboo poles and thatching materials. Improvisation of survey platforms from available materials was discussed further. Double-observer survey methods involving both visual observers, visual + acoustic observers, independent-, tracking-, and tandem observers were all discussed (Akamatsu *et al.*, 2013; Braulik *et al.*, 2012a; Kelkar *et al.*, 2010; Richman *et al.*, 2014; Smith *et al.*, 2006).

Braulik responded to Trujillo's question about whether there was a need for standardising methodology, saying that it was not easy, or perhaps even desirable, given the diversity of hydrological contexts across the numerous rivers of the region. Braulik emphasised that although the best methods need to be chosen given the river conditions (navigability, depth, geomorphology etc.) and resources available (skilled observers, boats, funds), it is not always possible. She said that ideally, if direct counts could be augmented by additional information (dive times, sightability models, etc.), then correction factors and estimators of bias (detection and availability) could be derived. These estimators could be used to upgrade the inferences that could be drawn from direct counts, with the necessary caveats. Direct counts might also be useful for basic comparisons of present studies with historical data.

Trujillo, Braulik, and Sutaria suggested that it would be good to review all methods for their effectiveness in population size and trend estimation. At present, apart from single-observer downstream counts, different types of double-observer surveys and upstream single-observer surveys are also in use. In some cases, bank-based surveys or interview surveys have also been used to detect occurrence of dolphins (Richman, 2014; Sinha *et al.*, 2010b; Turvey *et al.*, 2013). Based on the available design-based and model-based methods in use, if a decision system could be developed for teams to decide what survey would be most ideal for them to use, given their study area and available resources that could be a valuable document for reference. Porter and Trujillo suggested that the team try to compile a working paper on this issue, for the upcoming IWC/SC meeting in 2020.

Kelkar gave an overview of the population sizes and trends known from different rivers across the Ganga and Brahmaputra basins in India. Kelkar, Braulik, and other co-authors are working on the IUCN Red List Assessment for Ganges dolphins this year, and have synthesised this information already. In the Assessment, they are following a method similar to Braulik *et al.* (2014b) used for Indus dolphins to estimate range reduction of Ganges dolphins. From this estimate, an approximate range reduction of 20% in the Ganga River and 35% in the Yamuna River. The northern tributaries of the Ganga (Ghaghara, Gandak, Kosi) have also witnessed minor range reductions (<10%) in this time. Dolphins might have been extirpated from the Ramganga, a major northern tributary of the Ganga (Sinha *et al.*, 2010b). Canal strandings of Ganges dolphins are also being reported from the Ghaghara-Sharda canal networks over the last few years (Prajapati, 2018). The Brahmaputra was the river with the least range reduction (probably <5%). Ganges dolphins appear to have been extirpated from all southern tributaries of the Ganga and Yamuna, except for the Chambal River (Singh *et al.*, 2014; Sinha and Kannan, 2014). Most of these rivers have multiple dams, and dry-season flows have been reduced to almost zero. These rivers originate in the Indian peninsula and are not snowmelt-fed (see summary of discussion theme 1 for more details). However, in three major northern tributaries of the Ganga (Ghaghara, Gandak, Kosi), dolphin populations appear to be significant (>150 animals at least). The Mahananda, another major tributary remains unsurveyed (except for a small stretch), along with the Rapti, Budhi Gandak, and Bagmati rivers. Choudhury *et al.* (2019) reported the local extinction of a 10-15 strong dolphin population from 2000 onwards in the Barak River, Assam, India.

Kelkar also highlighted the collective learning from long-term research and conservation work at Bihar, India, in which he is involved. Kelkar represented the basic and applied research efforts of their informal and collaborative effort by researchers from various institutions. He spoke about three arenas of their research: (1) on the effectiveness of protected areas for Ganges dolphins (Kelkar, 2015); (2) on the interactions between water availability and fisheries bycatch risk to dolphins; and (3) acoustic studies to assess impacts of underwater noise from vessel traffic on river dolphins. In his presentation, Kelkar highlighted three broad findings of interest. It was found that large-scale hydrological changes had stronger impacts on river dolphin densities and persistence as compared to local fishing impacts. Kelkar also said that this result was likely because their study area was located in the middle Ganga River, where annual discharge was much higher compared to upstream reaches. Dolphin densities were also found to be very similar within the river stretch of the Vikramshila Gangetic Dolphin Sanctuary and stretches upstream and downstream (see (Choudhary *et al.*, 2006; Kelkar, 2015) for details).

India has plans to commercially develop inland waterways on about 100 of its rivers, which include most rivers of the Ganga and Brahmaputra plains. It is predicted that rapidly increasing vessel traffic and dredging for waterways development and maintenance might negatively impact Ganges river dolphins. Kelkar also shared the main findings of a recent study by their team. The study (Dey, 2018) showed that underwater noise resulting from increased vessel traffic was found to severely impact Ganges river dolphins in terms of elevated metabolic costs from altered acoustic activity and frequency levels.

Kelkar said that there was a need to ask large-scale and crosscutting research questions in order to understand and respond to various conservation threats to river dolphins in an adaptive manner. He provided some examples where comparative research across different basins with certain similar variables (e.g. barrage effects, dolphin populations in link canals, etc.) could provide vital specific as well as general insights. He also said that closely observing hydro-climatic change in the Indus-Ganga-Brahmaputra and associated basins will be critical to make predictions about emerging threats.

2.7 Country review discussions

From the country updates, it became apparent that a substantial part (in the region of approximately 80-90%) of the habitat of Ganges and Indus dolphins was altered by some level of river flow regulation by dams and barrages (Reeves and Smith, 1999; Smith *et al.*, 2000). The rivers of Nepal and the Brahmaputra probably had the least level of flow regulation, but it was not entirely absent if one included hydropower projects on headwater tributaries of each of the rivers. Braulik and Kelkar reminded the team that the estimate of affected habitat could vary based on what criteria are used for the extent of flow regulation. For instance, a recent multi-author study in the journal *Nature*, on ‘mapping the world’s free-flowing rivers’ (Grill *et al.*, 2019) included only high storage dams (but not barrages) in their definition of flow regulation. This meant that many rivers in the Gangetic plains (especially northern tributaries like the Ghaghara, Gandak, Kosi, etc.) were considered ‘free-flowing’ in spite of having barrages. Bycatch mortality was the second major threat common across countries.

3. DISCUSSIONS

3.1 Theme 1. Dams, hydro-climatic change and water availability for South Asian river dolphins

Across the range of *Platanista* dolphins, adequate water availability is critical for maintenance of habitat (deep pools) and longitudinal connectivity along the river during the dry season. How much water dolphins need to persist in regulated rivers is a very important aspect of river dolphin conservation. In this discussion, the team shared scenarios known to them about ‘minimum flows’ and ‘ecological flows’. Most of the range of the Indus and Ganges dolphin is strongly influenced by barrage and dam operations, which decide how much downstream as well as upstream habitat is available for dolphins. The Indus and Ganga basins are the most flow-regulated, while the Brahmaputra is the least. Among the countries, Pakistan and India have the highest levels of flow regulation, and Nepal has the lowest. In most of the region, studies on ecological flow measurements and assessments are important. It was agreed that e-flow assessments have to be specific to the context and history of each of the dams and barrages.

For comparative studies, it is important to have common metrics for evaluating river dolphin responses (in terms of population densities and spatial distribution) to river discharge. Kelkar introduced some remotely sensed hydrological datasets available online for free use under the creative commons, which could be used across major rivers for discharge measurements. This would make estimates of flow comparable across rivers, as biases or measurement errors are already known for these datasets. It is easy to ground-truth the satellite-based data from direct field measurements or from published data sources for river discharge.

A future exercise could be to assess river dolphin densities and distribution in response to discharge values across the range. This can help identify temporal and spatial trends emerged over the last 20 years, from which most systematic monitoring data are available for different rivers.

Pakistan provides freely accessible daily data on barrage discharge online. In India, Bangladesh and Nepal, river discharge data appear to be available upon request. India is perhaps the only country that assigns ‘classified information’ status to river flow data across the Indus, Ganga, and Brahmaputra river basins, perhaps due to the implications for trans-boundary water sharing with its neighbours. As a result, data is available only to Indian researchers upon special request.

Arshad spoke about imminent discussions on environmental water management (by IWMI, IUCN, and WWF) in Pakistan to commit and ensure flows through the Indus Delta of between 5 million acre-feet per year (4,055m^3/s) or 25 million acre-feet (20,275m3/s) in 5 years to the sea. He believed that Pakistan could use these estimates to test their importance for ecology and help improve baselines and estimate flows for Indus dolphins in particular. The Prime Minister of Pakistan heads the National Water Council and it would be a good idea to discuss e-flows as a key part of agenda items. Managing water utility in irrigation is a very high priority for Pakistan.

In India, e-flow studies are on-going in some rivers for assessing how barrage operations might translate into adequate discharge to maintain dolphin habitat and sustain populations downstream (in terms of river depth, longitudinal connectivity, flow velocity, and channel geomorphology). Kelkar shared that such studies were underway in the Upper Ganga, Gandak, and Kosi rivers at present. Depth requirements have already been studied in some detail for the alluvial rivers in India, as well as in Nepal and Bangladesh (Bashir *et al.*, 2012; Choudhury *et al.*, 2012; Kelkar *et al.*, 2010). However, detailed e-flow studies are still needed. For Bangladesh, the downstream impacts of barrages on the India-Bangladesh border (e.g. Farakka: Gain and Giupponi (2014) and for Nepal, the upstream effects of barrages on the India-Nepal border need to be studied (Smith *et al.*, 1998; Smith *et al.*, 1994).

Braulik said that in general, water availability and connectivity improve from west to east if one travels from the Indus to the Brahmaputra and the Ganga-Brahmaputra delta and the Sundarbans. In the Indus, upper Ganga, and Ghaghara basins, dolphins were found stranded in canals quite regularly. Kelkar said that the southern tributaries of the Ganga have always been more water-stressed than the northern tributaries, as the former do not receive glacial melt and dry-season base flows are strongly influenced by groundwater extraction. The northern alluvial tributaries had much shallower groundwater aquifers and led to greater recharge of river base-flows in the dry season.

The discussion between the participants on new, upcoming dams and hydropower projects underscored the importance of producing a map showing all rivers with dolphin populations, and all dams and barrages that affected historical and current dolphin distribution and densities, to update information in Sinha *et al.* (2000), Smith *et al.* (2000), Braulik and Smith (2017). Trujillo said that recommendations on the need to study ecological flows needed to be very specific. Alom and Kelkar said that while at present, the Brahmaputra basin had the relatively least flow regulation, upcoming controversial dam projects on the India-Bangladesh border needed a close watch.

Due to the current development of inland waterways in India, and its recent extension through India-Nepal and India-Bangladesh bilateral MoUs (Anon., 2018), there might be trade-offs and implications for water sharing between these countries. Waterways could potentially even lead to greater seasonal water availability in some river stretches. However, the other impacts of waterways (from dredging, increase in river pollution, port construction, river channel modifications, etc.) could increase and likely undo or even suppress any possible positive effects of flow availability.

Braulik suggested the importance of research to assess river dolphin movements across barrages within and between countries. She said it will be important to conduct studies across different barrages to see what operations might allow for dolphin movements through barrages both in the flood and dry-season (Braulik *et al.*, 2012b). In Pakistan, Braulik and Arshad will try to bring together engineers, biologists, and statisticians in a workshop to discuss the concept and come up with some technical options to monitor movement through canals, and also potential mitigation measures to avoid issues like canal strandings, such as bubble curtains on canal gates, for example. In this context, Braulik also said that it would worth testing if pingers could deter dolphins from entering canals. Alom and Kelkar responded that pinger trials conducted in Bangladesh (Smith, 2013) and India did not yield very encouraging results, but more research and field trials were still needed.

Participants discussed whether it would be feasible to rejuvenate rivers where dolphins had become locally extinct, with the aim of reintroducing dolphins to these areas. Ecological flow management was not important not only for quantity of river flows, but also their quality. Water chemistry monitoring and measurements have been done in many rivers, but the data needed to be compiled together in the context of ecological flows. This was similar to the status of floodplain and flood management plans that existed in all countries, but specific links with river dolphin habitat maintenance needed more studies. Kelkar had mentioned in his presentation that they found a positive response of river dolphin densities to flood strength and extent in Bihar, India, showing that dolphins will respond in terms of spatial distribution to riverine productivity, which could be maintained by near-natural regimes of flooding.

Actions

(1) A map of all dams and barrages in the historical and current range of dolphins.
(2) Comparative studies on ecological flows across regulated rivers with common hydrological datasets.

3.2 Theme 2. Population surveys and ecological modelling approaches

The outcomes of the discussion on survey methodology during Kelkar's presentation can be summarised as: (1) at present, multiple different methods are in use across different rivers, some of which might not be able to present very clear and statistically meaningful trends; (2) there is a need to develop a working paper that provides a comparative summary and decision framework on the best methods to use, according to river conditions and survey resources available; (3) the priority is to fill existing gaps in population size and distribution across the range; and (4) continue monitoring of trends where possible, and try to estimate correct trends where disparate survey methods exist but long-term survey data are available. These activities will help in the ultimate aim of getting range-wide estimates that can be monitored over the coming years with coordinated surveys within each of the four countries.

The Wildlife Institute of India coordinated large-scale, multi-team surveys in the states of Bihar, West Bengal, and Assam, 2017-18 (Wildlife Institute of India, 2018; Wildlife Institute of India (WII-GACMC), 2017). The Bihar Forest Department coordinated surveys across Bihar in 2018 and WWF-India, along with the Uttar Pradesh Forest Department surveyed the rivers of Uttar Pradesh in 2013-14 (Behera *et al.*, 2014). These two efforts led to a major upgrading of country-wide population estimates for India. After these efforts, the only rivers with potential dolphin populations left to be surveyed are the Mahananda, Budhi Gandak, and Bagmati in Bihar, and the Rapti in Uttar Pradesh. These rivers could be surveyed by early 2020. Surveys carried out by the Wildlife Institute of India and others in the Indian Sundarbans in 2014-16 found almost no river dolphins (communication by Sutaria and Kelkar with Dr. Q. Qureshi in 2019; (Manjrekar and Prabhu, 2016). Other reports have found only 1-2 dolphins in 200 to 300km of survey effort in the Indian Sundarbans. These low numbers could be due to the low freshwater flows into the Indian Sundarbans as compared to the Bangladesh Sundarbans. Information from which trends could be estimated, is available from a few stretches such as: (1) the Ganga from Munger to Farakka; (2) the Gandak River; (3) the Kosi River; (4) the Ganga from Bijnor to Narora; (5) the Beas River in Punjab (the only Indus dolphin population in India); (6) the Chambal River; (7) the Brahmaputra River in India (Wakid, 2009); and (8) the Farakka Feeder Canal.

A list of the main teams working in different rivers of India is as follows:

(1) WWF-India (Beas River, Upper Ganga, Yamuna, etc.);
(2) Turtle Survival Alliance (Ghaghara River);
(3) Uttar Pradesh Forest Department (Ghaghara, Ganga, and other rivers of the state);
(4) Rajasthan, Uttar Pradesh, and Madhya Pradesh Forest Departments (Chambal River);
(5) Wildlife Trust of India (Gandak and Ghaghra rivers in Bihar);
(6) Patna University and Zoological Survey of India (Ganga in Bihar up to Munger);
(7) T.M. Bhagalpur University, Ashoka Trust for Research in Ecology and the Environment (ATREE), and Wildlife Institute of India (Ganga from Munger to Farakka, Gandak, Kosi, and Mahananda Rivers);
(8) Wildlife Institute of India (rivers of West Bengal and Assam, especially the Brahmaputra, Hooghly, Subansiri, Kulsi, Farakka Feeder Canal, etc.); and
(9) Silchar University (Barak River).

In Bangladesh, trends between 2002 and 2012 for the Bangladesh Sundarbans need to be assessed. Alom said that at present, the data from these large-scale surveys, collected by the captains of tourism vessels (Alom *et al.*, 2014; Smith *et al.*, 2010b). From the surveys in Southeastern Bangladesh made in 1999-2000 and 2013-14, dolphin populations might be stable in the Karnaphuli-Sangu basins (Richman, 2014; Smith *et al.*, 2001). Rivers in north Bangladesh have not been surveyed yet, and this region remains the biggest gap for population surveys. It was suggested that interview surveys could be used as a first step to identify key areas to distribute survey effort and plan large-scale surveys. Alom said he could start work on a concept note for planning and execution of surveys in the rivers of northern Bangladesh.

In Pakistan, four full surveys of the Indus have been carried out over twenty years: 2001, 2006, 2011/12, 2017/18. These surveys have indicated an unambiguous trend of an increase in the population of Indus dolphins from 1,200 to almost 2,000 dolphins in the Indus. Excluding the 5-11 animals found in the Beas River in India, the dolphins in Pakistan are restricted to four sub-populations between five barrages on the Indus River, of which one sub-population is very small and persists in marginal habitat.

In Nepal, population sizes have been estimated and also monitored for the three river sections where Ganges dolphins persist. From a review of available information it is apparent that river dolphins have persisted at small populations in these rivers over the last 30 years. There have been some declines in the range and local population sizes from some of these rivers. The on-going IUCN Red List Assessments for Ganges and Indus dolphins will summarise available information on population size and trends as of 2019.

A recommendation from the discussion was that coordinated surveys are conducted at least at five-year intervals in each country, and population trends estimated for all rivers, where they are lacking. This will need to be coupled with the development of guidelines for choosing optimal survey methods for different rivers. Braulik said that population and threat monitoring surveys will lead to more knowledge on the ecological resilience of *Platanista* dolphins and their ability to adapt to changing conditions. Studies in this direction will be of help in assessing the vulnerability of South Asian river dolphins to emerging threats in changing social and ecological contexts (Smith and Reeves, 2012).

3.3 Theme 3. River dolphin bycatch, interactions with fisheries, and human utilisation

Estimates of river dolphin bycatch remain wanting across the range of *Platanista*, but the occurrence of bycatch events is not uncommon, especially across India and Bangladesh. Bangladesh has the most rigorous monitoring programme for bycatch mortality of Ganges river dolphins (Mansur *et al.*, 2014b), with data collected with high reporting rates (about 80% of actual events reported) across the Sundarbans region. Nepal also has some recent reports of bycatch. In Pakistan, data on fishing intensity in different stretches of the Indus are available, but no systematic assessments of bycatch mortality from entanglement in gillnets exist. In India it is known that bycatch is frequent in areas with high intensity, especially in the dry-season. It is likely that bycatch cases almost never, or rarely, get reported during the monsoon floods, because accessing many river-floodplain areas can become very difficult. Systematic reporting of bycatch has been done in a few areas, but rates might be significantly under-reported. Gillnets with larger mesh-sizes are observed to be the main gears causing entanglements.

In Bangladesh, 118 Ganges river dolphin deaths were recorded by a cetacean mortality monitoring network maintained by the Wildlife Conservation Society (WCS) between February 2007 and August 2019. Of these, over 80% were due to fishing mortality, of which most deaths were in gillnets (see Item 2.6 [Bangladesh country update] for details). WCS-Bangladesh has also collected systematic data from carcasses, including skin samples, stomach contents, etc. A database of fish otoliths from dolphin stomachs is also being compiled to assess dolphin diet and its overlap with fishery targets. The intensive efforts of WCS for mitigation of bycatch and hunting reduction have been through a combination of rapid response to bycatch or mortality events, and education outreach programs. The use of SMART patrolling by range officers of forest departments has proved successful in improving bycatch monitoring and sightings of dolphins as well. Outreach programs that have actively involved fishers have also likely led to reductions in targeted killing. Some notable examples of outreach program involve distribution of field kits and manuals to fishers to avoid illegal gear usage, bycatch-prone gears, and fishing in closed areas. Educational outreach programs such as the boat-and land-based dolphin fairs, or the Shushuk Mela, have seen great success in this regard.

To test their potential for bycatch mitigation, field trials of pingers were also conducted in Bangladesh to estimate dolphin displacement based on theodolite tracking (Smith, 2013). The results were not published but it was suggested that the pingers were not effective.

In India, based on a fairly consistent bycatch reporting network between 2001 and 2013, Kelkar and others estimated mortality of 6-12 animals per year for a population of 170-190 dolphins in 65km of the Vikramshila Gangetic Dolphin Sanctuary in Bihar, India (Kelkar, 2015). These results are not published yet, and are likely to be underestimates. At present, there is no systematic bycatch monitoring programs in almost any river stretch, and records are available on an opportunistic basis only. Kelkar suggested that there were social implications to the monitoring of bycatch, especially in terms of the delicate relationship between conservationists and impoverished fishing communities (Choudhary *et al.*, 2015; Kelkar, 2018), who needed to be involved in conservation even as their fishing activities caused bycatch mortality. Mortality is expected to be fairly high in India's rivers.

In terms of aquatic wild meat (products used) from Ganges river dolphin, most of the bycaught animals are likely to be used for oil (non-targeted salvage and non-targeted deliberate usage). Dolphin oil is used as bait for catching the Ailiid catfish *Clupisoma garua*) in India and Bangladesh, countries to which the use of dolphin oil appears specific (Mohan *et al.*, 1999; Mohan and Kunhi, 1996). Alternatives from fish oils have been proposed instead of dolphin oil (Sinha, 2002) but their use and application has been very limited.

Targeted killing of dolphins is known only from India and Bangladesh, in the present day. There has been a near-total stop to dolphin hunting in Pakistan, although hunting was regular until the 1970s and may have persisted in to the 1990s in some areas. No targeted killing was known from Nepal at any time.

In India, targeted killing appears to be significant in the states of West Bengal, Assam, and Bihar, as per decreasing order of threat. Researchers of the Wildlife Institute of India (Wildlife Institute of India, 2018) estimated that dolphin hunting and oil extraction was rampant and regular along the Ganga River on the India-Bangladesh border (Murshidabad district, downstream of the Farakka barrage). Their interview surveys found that even school children had detailed knowledge of processing dolphin carcasses to obtain oil. In India and Bangladesh, dolphin meat was not usually eaten, except by the poorest and socially marginalised minority fishing people. In Bangladesh, Hindu fishers and some indigenous tribes were known to eat dolphin meat if fresh and opportunistically landed. In India, so-called low-caste Hindu and Muslim fishers were known to use the meat. In contrast, Muslims in Bangladesh and Pakistan regarded the dolphin meat as *haraam* (kosher) and did not consume it. There could be diverse religious and cultural factors influencing dolphin meat consumption by fishers across the region. Other uses were also reported: (1) to relieve rheumatic pain or as an aphrodisiac (Bangladesh and India); (2) to mix oil with fish food for livestock (Khulna, Bangladesh); (3) to deter wild herbivores from raiding crops (Gandak River, India); and (4) for lighting earthen lamps (a practice now very rare in India).

In Nepal, an active network of local informants is present who report bycatch cases to research teams. There are fines of USD 40 to 70 enforced by Nepal's wildlife department, if anyone is caught with a dolphin carcass. Between 2010 and now, 4-5 bycatch mortalities have been reported, which is nearly 20% of the total population of Nepal's dolphins.

WWF-Pakistan maintains a database of mortality records using a standard protocol, although reporting is *adhoc* and the level of detail is low. Annual mortality is 3-5 dolphins per year. They are also compiling a database of fishing gear with all relevant details.

The participants felt that it would be a worthwhile exercise to characterise fishing nets and gears with common definitions to be used across the range of *Platanista*. Given the remarkable diversity of nomenclature, technical details, and specialisation of fishing gears used across the four countries, this would be a challenging but exciting task. Once such a gear dataset was available (as developed in Bangladesh and some sites in India), it was recommended that fishing gear use information be mapped to estimate spatial risk of bycatch for dolphins. Sutaria suggested that disentanglement and release response protocols needed to be spread among fishers and ecologists working in the field, so that mortality could be reduced in case of entanglement. Also, there is a need to streamline sample collection, data storage, and necropsy procedures from carcasses recovered. At present, very little data is being collected from India, in the event of finding carcasses.

3.4 Theme 4: Identifying practical conservation solutions

Arshad provided insights from WWF-Pakistan's long-term efforts on Indus dolphin conservation in Pakistan, and also shared some ideas about the dimensions in which the task team's effort could have most impact. Arshad spoke from the viewpoint of how managers could successfully engage both with scientists and policy makers to effect change at the ground level. He summarised the existing gaps in applied research for conservation, and also synthesised learning from examples of involving communities, lobbying, management of habitats and populations, and outreach in conservation programmes. Arshad suggested that the efforts of Bangladesh in conservation outreach, bycatch response, and threat mitigation needed wider replication and adaptation in the other countries. He expressed interest in potential collaborations between Pakistan and Bangladesh on extending outreach programs. Such collaborations could continue and strengthen capacity building of technical teams across the region.

Translocation and rescue of canal-stranded dolphins were clearly important priorities for Pakistan. There was a need to strengthen data collection on dolphin health, sample collection for genetic and eco-toxicological studies, tagging and telemetry studies, etc. Studies on fish prey abundance, water chemistry, eco-toxicology, use of emerging technologies for dolphin surveys (e.g. drones), and economic valuation studies of conservation options (including ecotourism) would be most important in fulfilling these objectives. Engaging with fisheries policy and fishing communities in the designation of conservation areas and fisheries development was also key across the range. Arshad and Kelkar also mentioned that socio-cultural and anthropological research on fisher communities in the four countries might be valuable to understand the cultural and historical factors that continue to remain relevant in spurring conservation action. They shared the example of the Kehal community in Pakistan and possibly related fisher groups in Bihar, who still exert a significant impact on riverine wildlife through targeted hunting.

This session concluded with a discussion on how to secure funding for long-term, sustainable conservation and monitoring efforts. Braulik said that to do so, it is important to raise the scope of our conservation targets to larger issues of the social and environmental impacts of dams and infrastructure development, than just restricting to wildlife or dolphins. She gave the example of the recent protests against dams on the Mekong River, which approached the problem at a higher level. This way, conservationists might be able to not only secure funding and continuity, but also link conservation objectives with larger and conjoined objectives of ecological security, climate change adaptation, and human wellbeing.

Trujillo asked whether a review of the effectiveness of all protected areas and Ramsar sites along the distribution of Ganges and Indus dolphins would be possible. A map overlaying existing protected areas and Ramsar sites (or other conservation areas) could be a useful outcome of such a review.

In the four countries, there are not more than ten river PAs and Ramsar sites in the dolphins' range. The Indus Dolphin Reserve in Pakistan, and the Chambal River in India, might be examples where some degree of protection might have helped dolphins persist at increasing or at least stable population sizes (Behera *et al.*, 2014; Singh *et al.*, 2014). However, most PAs were paper parks, and the team members agreed that more were not needed unless metrics for monitoring became more encouraging for the existing areas. With or without formal protected areas, interventions to reduce fishing impacts (bycatch), sustainable fishing, pollution reduction, ensuring ecological flows etc. would have much bigger impact. Trujillo mentioned that PS funding mechanisms could be one way to finding funds for these objectives. He also asked how different organisations, research teams, and governments could be brought together in such connected programs. Arshad replied that organisations had to feed off each others' strengths within such larger programs, as one organisation would not be solely equipped to do everything from field work and research to policy change and lobbying.

Alternative incomes to floodplain dwelling people, including fishing communities, were another issue in the discussion. In Pakistan's Sindh province, the degree of dependence of people on fishing had increased after getting licenses became very easy in 2011. This might have constrained the success of community development programmes and initiatives in ensuring that the provision of benefits resulted in better management of fisheries and lower impacts on biodiversity.

3.5 Theme review, emerging issues, and conclusions

Under emerging issues, the biggest threats to river ecosystems in all countries were linked to basin-scale and intensive infrastructure development in South Asia. National waterways development projects and river interlinking plans in India were important challenges to freshwater availability for endangered dolphins in the near future. Waterways development has targeted almost all major rivers with significant dolphin populations in India. The consequences of such developments would be seen not only within India but on Nepal, Bangladesh, and Pakistan as well, because of their implications for trans-boundary water sharing across barrages. In India, studies are already showing negative impacts of increased underwater noise from vessel engines and propeller cavitation noise on Ganges river dolphins. Direct injury from propeller cuts has not been estimated. But deaths of dolphins due to propeller cuts are known from India (Hooghly River [Mallick, 2016], Ganga River near Patna) and Bangladesh (propeller hits accounted for less than 5% of recorded mortalities and was rare, but are not absent). In the wake of strong impacts of climate change on the IGB region, especially through increasing glacial melt and decreasing monsoon rainfall, severe reduction in dry-season flows are expected. There are important differences too. The annual flow of the Indus receives almost 50% of its discharge from glacial melt, which is more than twice that of the Ganga or Brahmaputra basin. Thus, the Indus might be the most affected by immediate climate change impacts, including recurring droughts. In Pakistan, the CPEC (China-Pakistan Economic Corridor) is likely to increase the number of dams on the upper Indus further, causing potentially destructive impacts on downstream dolphin populations. Nepal also deals with the issue of increasing glacial melt and a push for hydropower development, while Bangladesh might face increased upstream-downstream water inequities and the impacts of sea-level rise in the Sundarbans (Smith *et al.*, 2008; Smith *et al.*, 1998). These issues make it necessary for existing conservation actions and initiatives to expand the scope of research as well as policy engagement to study future impacts.

When asked in a rapid-fire round what different countries would prioritise given infinite funds the following answers emerged. Bangladesh would conduct country-level population abundance estimation and monitoring if they got infinite funds, and will strengthen the existing efforts in education and outreach, protected area networks, management plans, and monitoring of dolphin mortalities. Pakistan would focus on a translocation programme, while continuing to streamline population management in protected areas and revised fisheries policies. Pakistan would also strengthen its efforts on dolphin mortality monitoring, outreach and education, community livelihoods, and collect baseline data on prey and habitat availability for dolphins. They would also engage university students more actively in dolphin and fisheries research.

Nepal would focus on the formulation of a national Conservation Action Plan and fisheries management plan, while also working on awareness building, alternative livelihoods, and studies on assessing ecological flows to improve dolphin population numbers in the nation. India would develop knowledge on ecological flow studies across riverscapes in the Ganga and Brahmaputra basins, and initiate concerted bycatch monitoring, as both were high priority issues for the region. Making population monitoring frameworks more systematic and robust across different data collection teams would be another objective. Notably, the main priorities differed across all countries, as seen from the responses. But the above responses highlighted the importance of strengthening bycatch monitoring efforts and ecological flow assessments in all countries.

4. WORK PLAN

On day 3 of the meeting, the task team discussed and finalised recommendations that would form the crux of the report of the meeting. The report will be presented at SC68B in 2020. Until then, it was agreed that Task Team members would start working towards these recommendations through compiling data sets, taking forward ideas for joint and collaborative work, and also planning towards workshops based on the discussions on information gaps and research needs for different countries.

5. RECOMMENDATIONS

The IWC South Asian River Dolphin Task Team **recommends** the following.

- That by 2022, all range states identify key sections of national habitat that should be surveyed every five years, so that population trends can be monitored. Methodology should be replicated in each identified habitat but need not be standardised throughout the range, as different habitats require different methodological adaptations. This recommendation is targeted at the following:
  - Pakistan: WWF Pakistan, Punjab Wildlife Department, Sindh Wildlife Department and KPK Wildlife Department – co-ordinated through WWF Pakistan.
  - Nepal: Department of National Parks and Wildlife Conservation, Department of Forest and Soil Conservation, WWF Nepal, Institute of Forestry Pokhara and Hetauda Campus, University of Tribhuvan (co-ordinated by Shambhu Paudel and Usha Thakuri).
  - Bangladesh: Forestry Department and WCS.

- India: already a recommendation in India's Conservation Action Plan for Ganges Dolphins (Sinha *et al.*, 2010a) and should be co-ordinated through State Forest Departments, who will identify teams best suited for river stretch-specific surveys (based on experience and available expertise).

- That all existing survey methods in use for population estimation be reviewed, and a decision system prepared to guide monitoring agencies and conservationists to identify and implement statistically robust and optimal survey methods based on river conditions and survey resources available with them.
- That, starting from 2020, surveys to establish population size be initiated at the earliest in the Padma, Jamuna, Meghna main stems and tributary networks (excluding the Bangladesh Sundarbans), Bangladesh and the Budhi Gandak, Baghmati, Rapti and Mahananda, India.
- That the current review of the taxonomy of *Platanista* is completed and published.
- That, as a priority, studies be conducted to fully understand movements of dolphins across barrages in all countries and quantify the extent of population connectivity and impacts on dolphin populations in fragmented riverine habitats.
- That pingers be assessed as an effective tool to minimise bycatch and to reduce the risk of dolphins stranding in canals
- That a feasibility study be conducted to assess areas and methods to translocate Indus River dolphins (WWF-Pakistan) and to adapt existing marine mammal translocation initiatives specifically for river dolphins (co-ordinated by SMM and IUCN).
- That as a priority and with data currently available, assess the level of dolphin bycatch throughout the species' range and evaluate its impact on local populations. From the outcomes of this assessment, provide recommendations for future monitoring and actions to mitigate negative impacts, ranging from technical changes to the revision of fisheries policies.
- To assess the extent of targeted take and the use of dolphins for oil and as wildmeat, particularly in India and Bangladesh by involving social and ecological scientists, as part of co-ordinated survey actions listed above.

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Annex A

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Annex B

Agenda

1. Introduction
   1.1 Opening remarks
   1.2 Election of Chair and appointment of Rapporteurs
   1.3 Adoption of Agenda
2. The current status of river dolphins in south Asia: workshop vision and scope
   2.1 Update on proposed taxonomic revision
   2.2 Perspectives from South America
   2.3 Maintaining the increasing population of Indus river dolphins in Pakistan: a conservation challenge
   2.4 Nepal: An overview of threats to river dolphins
   2.5 Bangladesh: Improving conservation prospects for river dolphins through effective and sustained community engagement
   2.6 Ganges river dolphins in India: current research needs for conservation applications
   2.7 Country review and conclusions
3. Discussion topics
   3.1 Theme 1. Dams, hydro-climatic change and water availability for south Asian river dolphins
   3.2 Theme 2. Population surveys and ecological modelling approaches
   3.3 Theme 3. River dolphin bycatch, interactions with fisheries, and human utilisation
   3.4 Theme 4: Identifying practical conservation solutions
   3.5 Theme review and conclusions
4. Emerging issues
5. Work plan

Report of the *Sotalia guianensis* Pre-Assessment Workshop: Main Results and Status of Current Knowledge

São Paulo, Brazil, 26-28 November 2019

Report of the *Sotalia guianensis* Pre-Assessment Workshop: Main Results and Status of Current Knowledge[1]

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1. CHAIRS SUMMARY

In 2014, a Resolution was approved by the IWC for establishing new, specific *Terms of Reference* to consolidate the Scientific Committee's mandate on small cetaceans within its broader working program. This program opens the possibility of periodic reviews about the current knowledge and threats, as well as the possibility to implement *Conservation Plans for Endangered Species* within the scope of the IWC when appropriate. The first *Conservation and Management Plan* for a small cetacean was proposed for the franciscana dolphin (*Pontoporia blainvillei*) and **endorsed** by the Commission in 2016. In recent years, the Scientific Committee has worked to better understand the extent of multiple disturbances on small cetaceans - habitat degradation, incidental and intentional catches (for human consumption, bait, trade and traditional use) - to mitigate these threats. This task force resulted in a series of workshops to enable local research groups to collect, share and analyse data aiming to paint a clearer broad picture of the conservation status of these species.

River and estuarine dolphins in South America have been of great concern by the Small Cetacean Sub-committee (SM). During the IWC/67b Scientific Committee Meeting, held in Bled in 2018, Slovenia, the sub-committee on small cetaceans listed the Guiana dolphin (*Sotalia guianensis*) as a priority species for an evaluation of its conservation status in the upcoming years (2019/20 – presented at the meeting as SC/67b/SM/WP/12). The Guiana dolphin is restricted to coastal areas, including estuaries and bays in western tropical South America, from Nicaragua in Central America to Santa Catarina state in southern Brazil (Flores and Da Silva, 2009). Due to its exclusive coastal habits, the distribution of Guiana dolphins overlaps with densely human coastal populations, raising concerns on the status of various populations (Avila *et al.*, 2018). It is important to clarify that although the taxonomy of this genus has been controversial, some of the main questions, regarding the taxonomic identification of *Sotalia* dolphins in the Maracaibo Lake and in the Orinoco River, have been recently confirmed to be *Sotalia guianensis* (Caballero *et al.*, 2018; Caballero *et al.*, 2010).

The Guiana dolphin was previously listed by IUCN Red List as 'Data deficient' (DD) because the data available on abundance, trends, and mortality levels or rates were considered inadequate for assigning it to a single Red List category at the time (Secchi, 2012). However, the current assessment classified the species as 'Near threatened' (NT) (Secchi *et al.*, 2018), approaching criterion A2d+3d+4d. Regional assessments classified the species in different categories depending on the country and availability of data on each population (details in the section 'Management and Conservation actions').

In 2006, the SM reviewed the status of the *Sotalia* genus, as part of a review of the small cetaceans of the Caribbean and the western tropical Atlantic. Since then, not only the taxonomy of the genus has been clarified, but also new data on the dolphin populations from the Orinoco River, French Guiana and Maracaibo Lake has been collected and analysed. While bycatch in artisanal gillnets is a major threat to Guiana dolphin populations, other threats such as intentional captures for bait, habitat loss, high contaminant load, and diseases (MeCV, herpesvirus, skin diseases of unknown aetiology), are emerging factors depleting some Guiana dolphin populations. For example, recently a high mortality event in the populations of Sepetiba and Ilha Grande bays in southeastern Brazil has been associated with morbillivirus (Groch *et al.*, 2018). Also, deliberate capture of Guiana dolphins for human consumption has been recorded in Maracaibo Lake (Yurasi Briceño, pers. comm.; Barrios-Garrido *et al.* (2015) where the population is exposed to pollutants, particularly from oil spills (Espinoza-Rodríguez *et al.*, 2019). Throughout its distribution, Guiana dolphins are facing habitat degradation and loss due to anthropogenic activities, such as high boat traffic and their high noise levels, eutrophication due to run-off and pollution from agriculture, mining and industrial activities to name but a few (Barrios-Garrido *et al.*, 2016; Crespo *et al.*, 2010; Secchi *et al.*, 2018). Given these threats, an assessment of population structure and viability, temporal trends in abundance and in space use, and estimative of population connectivity are urgently needed to guide discussions by the SM sub-committee, regarding the sub-committee priority agenda focusing on riverine and estuarine dolphins from South America (IWC, 2019).

A pre-assessment of the status of knowledge about *Sotalia guianensis* was proposed, due to the difficulty in obtaining summarised data in a timely manner during IWC annual Scientific Committee meetings, since much information is scattered in grey literature in local research groups along the wide distribution range of the species. The pre-assessment plan included holding two intersessional workshops following SC68B and probably SC69A. Dr. Camila Domit volunteered to lead the organisation of these workshops in partnership with Centro Nacional de Pesquisa e Conservação de Mamíferos Aquáticos do Instituto Chico Mendes de Conservação a Biodiversidade (CMA/ICMBio), Brazil. The first Guiana Dolphin (GD) Pre-Assessment Workshop was held in the city of Lima in October 2018, during the SOLAMAC meeting. The attendance was limited and composed mainly of researchers from south/southeastern Brazil, in addition to one researcher from Colombia. They mapped resident populations of Guiana dolphins and the ongoing research efforts, as well as they listed the research teams working with the species along its distribution that would be relevant to conduct the review. The group also delineated a participative strategy to compile the knowledge about Guiana dolphins supporting a future assessment. Because the species distribution is transboundary, covering an extensive coastal area, and there are many experts focusing on this species, the group decided to develop an online questionnaire to circulate for all institutions, research teams and individuals identified. A total of 35 experts answered the questionnaire (see Annex B for their contact details), including their opinions for prioritising locations and scientific researches in supporting improvements in conservation actions. The results are summarised in the 'Expert elicitation' section of this report.

The Second Intersessional Workshop for Pre-Assessing the Status of Knowledge of Guiana Dolphins had two goals. The first was gathering and analysing information collected by the online questionnaire; the second, was compiling the available information on a series of population, biological and ecological parameters, as well as about threats, along the species distribution. Supported by the compiled knowledge, the participants collaborated to delineate conservation measures and research needs both in national and international contexts.

The second Workshop was held in Santos, São Paulo, from 26-28 November 2019, at the Instituto Chico Mendes de Conservação da Biodiversidade/Centro Nacional de Pesquisa e Conservação de Mamíferos Aquáticos (ICMBIO/CMA). The Workshop was divided into five sessions, following the priority topics listed by the IWC for the conservation of the species:

(1) population structure;
(2) abundance and population trends;
(3) biological parameters;
(4) threats and its potential effects; and
(5) management and conservation.

A list of experts relevant to the aims of the Workshop from each country were identified during the SC/67b and the Guiana Dolphin Workshop held in Peru during the 2018 SOLAMAC meeting, and in consultation with the Scientific Committee (SC) Vice-Chair, and co-Chairs of SM. There were 13 experts on Guiana dolphin research from three countries (Brazil, Colombia and Venezuela) and another 20 participants to the Workshop. Information gathered from the literature review, ongoing projects and the expert elicitation via online questionnaire were used by the group of Point of Contact (POCs) and other co-authors to compile and present the best up-to-date information on the species. The participants list is given as Annex A and the Agenda is given as Annex C.

2. MEETING OPENING

2.1 Opening remarks

The Workshop was held 26-28 November 2019 in São Paulo, Brazil. Filardi, on behalf of Luna, the chief of the 'Centro Nacional de Pesquisa e Conservação de Mamíferos Aquáticos' (CMA), part of the ICMBIO, an agency of the Brazilian Ministry of Environment, welcomed participants and thanked IWC and ICMBio for hosting the Workshop. Domit welcomed participants and provided a brief overview on the IWC structure and assessments workflow. She also mentioned the working paper proposing an assessment for *Sotalia guianensis* presented during the IWC Conservation and Scientific Committee in May 2018 (Bled, Slovenia), which included the steps required to develop such assessment and outlined the aims of the current Workshop.

2.2 Appointment of Rapporteurs

Fruet and Torres-Florez were appointed as rapporteurs. Duff (Secretariat) assisted with references.

2.3 Available documents

The documents developed by POCs available to the Workshop were included in the report and summarised on recommendations and conclusion.

3. WORKSHOP AIMS AND OBJECTIVES

3.1 Overview

River and estuarine dolphins in South America have been of great concern to the SM sub-committee. During the SC/67b Scientific Committee meeting, held in Bled, Slovenia in 2018, the sub-committee on small cetaceans had listed the Guiana dolphin (*Sotalia guianensis*) as a priority species for an evaluation of its conservation status in the upcoming years (2019/20). Due to a large amount of scattered data, ongoing research, and grey literature, the SM sub-committee proposed an intersessional process to document the current knowledge on the Guiana dolphin and inform the review of the status of the species to be conducted by the Scientific Committee in the upcoming Annual Meetings. It was agreed by the participants that the intersessional process should include, in principle, two meetings to fulfil this aim. A Steering Group (SG) was established to ensure progress on this topic between SC meetings. The SG is tasked with articulation with researchers and stakeholders to plan and run the workshops. The first of which took place in Lima, Perú, in 2018, when it mapped the main Guiana dolphin populations being studied and research effort and the groups of scientists working with the species. This second Workshop focuses on compiling the available data on population structure, abundance and trends, population parameters, threats and conservation policy, and identify research gaps and priorities.

3.2 Workshop aims

(1) Review the information available on Guiana dolphin (focusing on population structure, biological parameters, abundance estimates, and management and conservation actions).
(2) Integrate and consolidate the current knowledge on Guiana dolphin.
(3) Prepare a report with recommendations for presentation at the SC68B meeting.

4. REVIEW OF INFORMATION ON THE GUIANA DOLPHIN

In 2010, the *Latin American Journal of Aquatic Mammals* published a special issue regarding *Sotalia* genus[2]. These articles served as a baseline information and were updated during this pre-assessment Workshop. Some critical points about the species taxonomy and population structure have been addressed along the last ten years and opened an opportunity for better assessing the conservation status of Guiana dolphins.

The POCs provided presentations with an overview of the current knowledge on Guiana dolphin: Caballero (Colombia) and Cunha (Brazil) for population structure; Briceño (Venezuela) for management and conservation actions; Azevedo (Brazil) for abundance and density estimate; and Cremer (Brazil) for biological parameters. The POCs presentations were discussed in regional groups during the Workshop. The participants had the opportunity to include extra data, and the results and recommendation of each topic were discussed by the plenary. A summary of the information presented and discussed is provided in Items 4.1 to 4.5 below.

4.1 Distribution and population structure

Guiana dolphins (*Sotalia guianensis*) inhabit the coastal waters of the Caribbean Sea and the Atlantic Ocean of Central and South America. The species distribution range from Florianópolis, southern Brazil (27°35'S) in the south to the Caribbean Sea and along the coast of Central America to central Honduras at La Mosquitia, 14°00'N, 83°20'W (Da Silva *et al.*, 2010; Fig. 1). Although to date the species is thought to occur along this entire range, Guiana dolphins usually form discrete populations (Borobia *et al.*, 1991; Da Silva *et al.*, 2010; Flores and Da Silva, 2009), in which individuals typically display relatively small home ranges (Flores and Bazzalo, 2004; Oshima and Santos, 2016; Santos and Rosso, 2008).

Cunha, Farro and Caballero (scientific paper submitted for SC68B; SC/68B/SDDNA/06rev1) reviewed the available population genetic data for the species, including published and unpublished studies, and presented the results at the Guiana dolphin pre-assessment Workshop. Twelve studies have been carried out along the distribution of the species, using two molecular markers: the mitochondrial control region and microsatellites. Five macro-scale studies focused either on the northern part of the distribution (Caballero *et al.*, 2010; 2018) or on its southern portion (Cunha *et al.*, 2005; 2007; SC/68B/SDDNA/06rev1). Moreover, several genetic studies with large sampling at regional level also indicated fine-scale population structure. Combining all evidences, Cunha *et al.* proposed the delimitation of 12 Management Units (MUs) for Guiana dolphin across its distribution. The authors also listed ongoing genetic studies that will confirm or refine the available information, all expected to be concluded in 2021.

Thus, based on the presented analyses, the participants of the Workshop **agreed** that for the time being, the genetic population structure with 12 MU should be adopted by the group and guide discussions on the other priorities topics (e.g. population abundance and trends, biological parameters, threats, and management and conservation actions). These MUs will be hereafter named as proposed by Cunha, Farro and Caballero: CCOL, VEML, VEOR, FRGU, BRNO, BRNE1, BRNE2, BRNE3, BRNE4, BRSE1, BRSE2, BRS/SE (SC/68B/SDDNA/06rev1; Fig. 1). The Workshop participants discussed and **recognised** that in the absence of samples from the northern range of distribution (Panama, Costa Rica, Nicaragua), and to be as parsimonious as possible, the populations from these areas should be considered panmictic within the CCOL MU (northeastern management unit analysed so far). Trinidad and Tobago might be part of the Orinoco Management unit (FOR), due to its closeness to the mouth of the river, however, this region still has an important gap in knowledge that should be addressed in the near future. It is important to note that information to delineate these MUs is not equally complete, or representative for each of these (in terms of number of samples and molecular analysis), and additional research is needed for particular MUs in different subjects (Fig. 2).

Despite the delineation of these MUs, the Workshop participants **recognised** the need to establish as **priorities** for further studies to better understand the population substructure within the distribution of the species, and areas that are still not sampled.

Priorities in terms of management unit definition for the species are summarised as follows.

- DNA samples from Sucre State (Venezuela) where there seems to be established a resident population (proposed to be conducted during the next 24 months).
- DNA samples from Panama, Costa Rica, Nicaragua and Trinidad and Tobago (proposed to be conducted in 36 months).
- DNA samples from those places where population abundance data and/or biology parameters already exist (proposed to be conducted during the next 36 months).
- Analyses of all data using a genomics approach (e.g. Radseq), joint research initiative being conducted by Cunha and Caballero (proposed to be conducted during the next 24 months).

Other lines of evidence that could support these proposed delineations for management units were discussed during the pre-assessment Workshop. These include body morphology, levels of pollutants and ecotoxicology, bioacoustics, residence patterns, movements between populations, reproduction and life history parameters, and trophic levels and

[2]*http://lajamjournal.org/index.php/lajam/issue/view/20/showToc.*

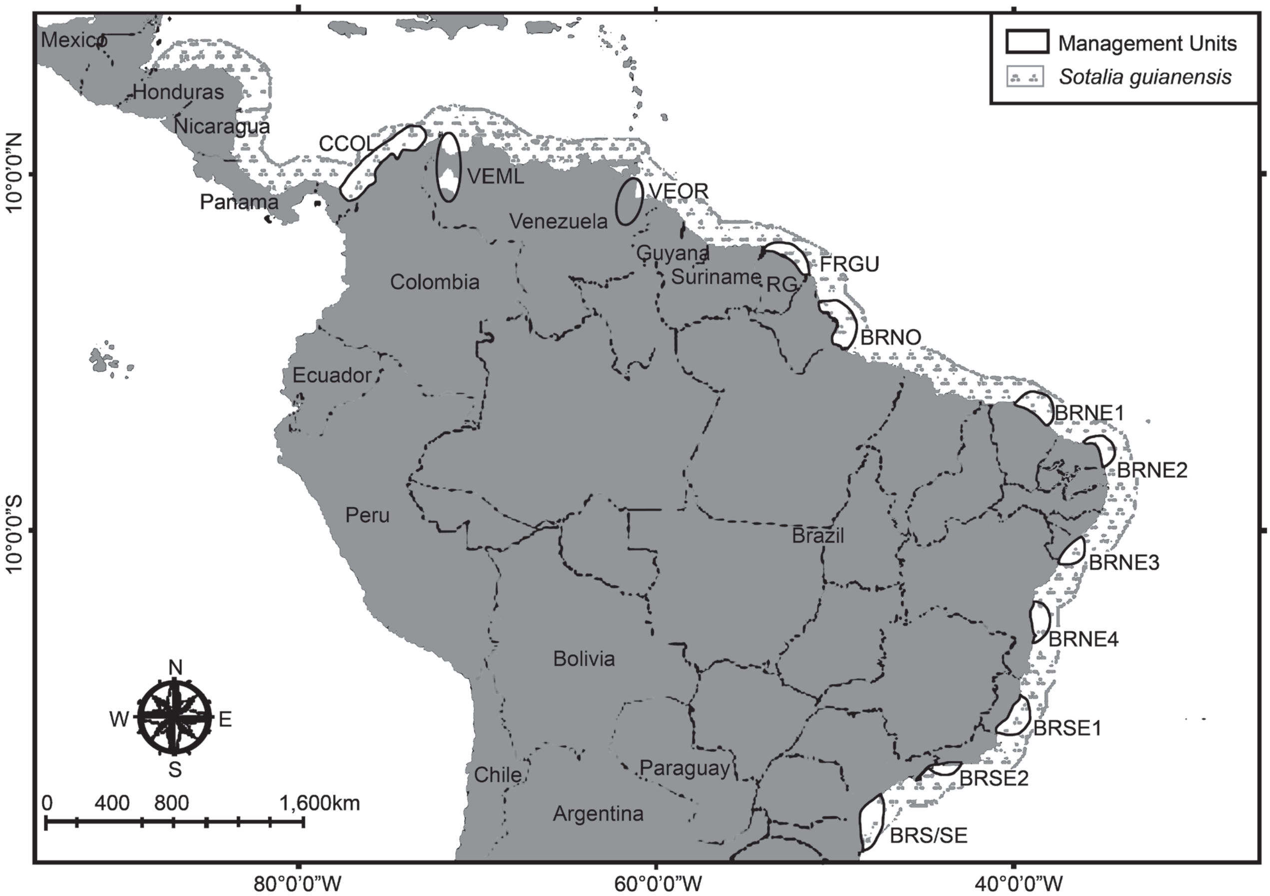

Fig. 1. Population limits according to genetic studies, identifying 12 management units (MU), named as proposed by Cunha *et al.*: CCOL, VEML, VEOR, FRGU, BRNO, BRNE1, BRNE2, BRNE3, BRNE4, BRSE1, BRSE2, BRS/SE.

feeding habitats as informed by stable isotopes analyses (SC/68B/SDDNA/06rev1). Notwithstanding, these other lines of evidence should be taken with caution to omit studies that did not compare areas, but instead characterised a single area or a Management Unit. It is important to notice that differences exist regarding the number and geographic coverage of these studies, with a high number of studies focused in southern and southeastern Brazil (e.g. on acoustics, pollutants, morphology, etc.), decreasing in number for north and northeastern Brazil and with little representation and coverage for other countries, particularly the northern limit of the range, including Nicaragua, Costa Rica and potentially Honduras. A summary of studies and information available from these other lines of evidence is represented in Fig. 3.

Additionally, an ongoing regional effort led by Melos-Santos and May-Collado uses acoustic data to identify the drivers of geographical variation on *Sotalia* whistle repertoires (Deecke and Janik, 2006). The effort has resulted in an acoustic database from 1998 to 2017 comprising 16 different sites throughout the distribution of both *Sotalia* species, namely: Costa Rica coast, Lake Maracaibo and Gulf of Venezuela (Venezuela Coast), French Guiana coast, the coast of Pará state (northern Brazil), the Tocantins River (Pará state, northern Brazil) Japurá and Solimões Rivers (Central Amazon, Amazonas State, northern Brazil), Juruá River (Amazonas State, northern Brazil), Colombian Amazon, Peruvian Amazon, Napo River (Ecuadorian Amazon), the coast of Rio Grande do Norte State (northeastern Brazil), Sepetiba Bay (coast of Rio de Janeiro state, southeastern Brazil), Ilha Grande Bay (coast of Rio de Janeiro state, southeastern Brazil), Cananéia Estuary (São Paulo state, southeastern Brazil), Paranaguá Estuarine Complex (Paraná state, southern Brazil) and Babitonga Bay (Santa Catarina, southern Brazil). The preliminary results from this ongoing analysis indicate that both (freshwater and coastal) Guiana dolphin species have rich whistle repertoires, but also suggest that *Sotalia* dolphin from the Tocantins river has a repertoire of their own. The taxonomic identity of Tocantins Guiana dolphins remains uncertain. Furthermore, a non-metric multidimensional scaling (NMDS) analysis suggests that the whistle repertoire of coastal dolphins from Costa Rica, Venezuela, French Guiana, and Ilha Grande Bay is significantly distinct from each other. In the case of Costa Rica this could be due to high geographical isolation as one of the northernmost Guiana dolphin populations. Interestingly, the populations of the Brazilian coast grouped close to each other indicating similar repertoire and connectivity between these populations.

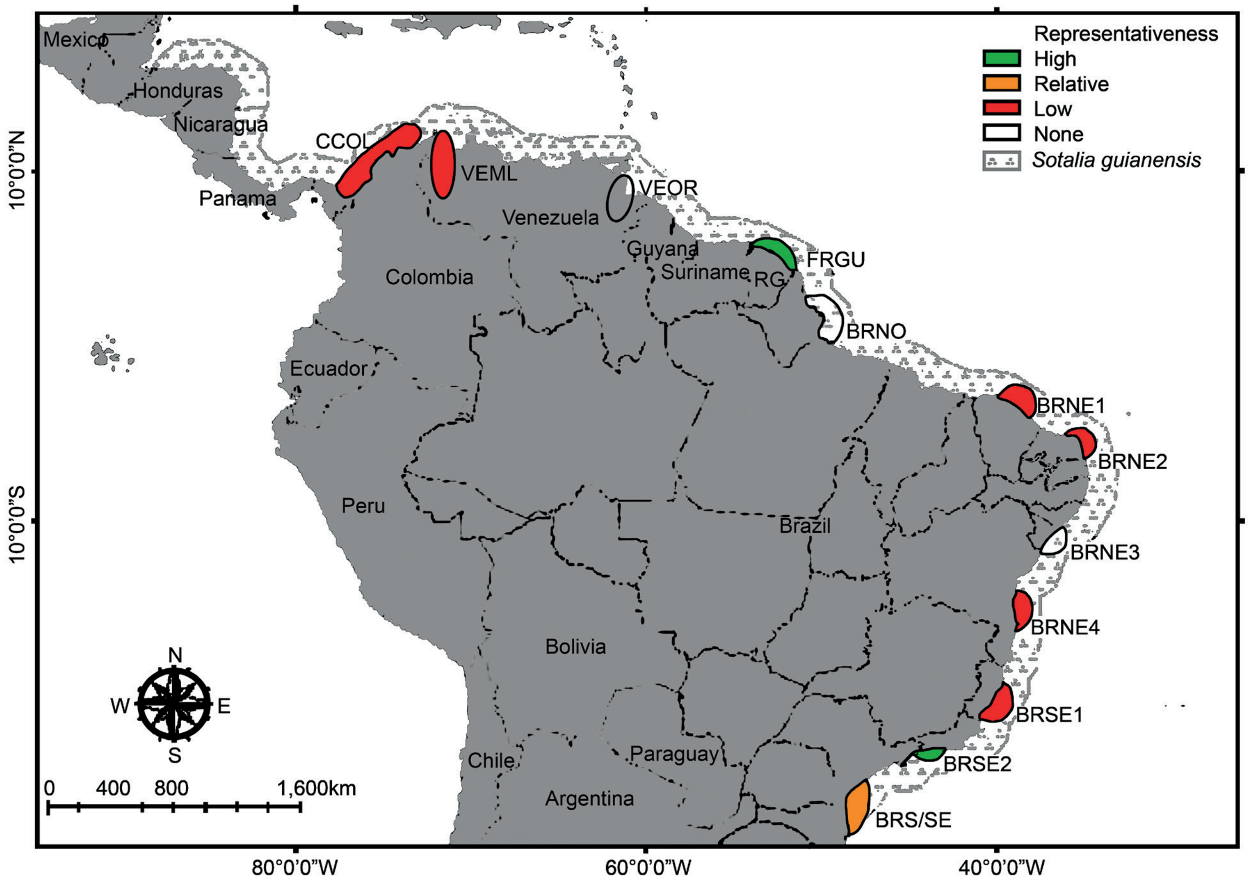

Fig. 2. Data representativeness supporting the proposed management units (MU) for Guiana dolphins along the species distribution area.

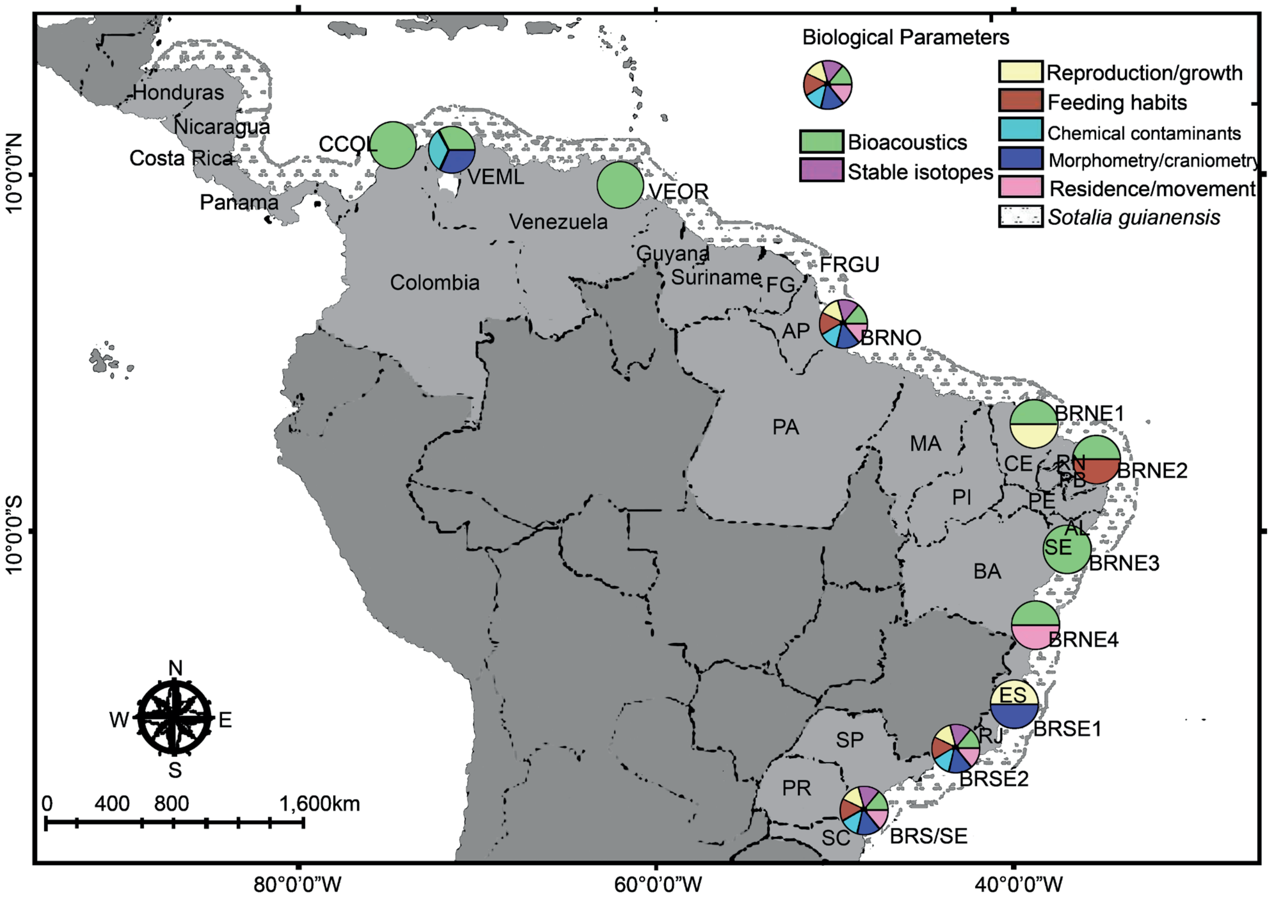

Fig. 3. Studies and information available from other scientific lines of evidence supporting population structure of Guiana dolphin.

4.2 Abundance and trends

Our knowledge on abundance and density estimates of Guiana dolphins is relatively scarce along its distribution. Santos *et al.* (2010) compiled ~20 documents on abundance and/or density estimates conducted in Brazil from 1989 to 2008, carried out in seven sheltered areas. The authors also reported one study in Nicaragua and another in Colombia. The two major shortcomings identified by this early review were: (i) the short-term sampling of the studies; and (ii) concentration in specific areas of the south (S) and southeast (SE) of Brazil. Santos *et al.* (2010) also identified mark-recapture and distance sampling (linear-transects; Buckland *et al.*, 2004) as the two principal methods used to estimate density estimate and/or abundance for Guiana dolphin.

To update the information about abundance and density of Guiana dolphin, this report summarises all data available in *adhoc* articles, theses and dissertations published between 2000 and 2019 (see Table 1). The compiled knowledge is plotted following the Management Units (Fig. 4) defined during the Workshop (see above). A total of 36 studies on population abundance or density estimation of Guiana dolphin were listed. Overall, a similar pattern was found as that described by Santos *et al.* (2010), where most of the studies were conducted with local populations in estuaries and bays of southern (S) and southeastern (SE) Brazil, covering small sampling areas. In northeast of Brazil, a lower number of abundance estimates are available, while for north of Brazil this information is scarce. In French Guiana, two recent studies estimate Guiana dolphin abundance in the whole EEZ. In Venezuela, Colombia, Costa Rica/Panama and Nicaragua efforts for abundance estimation were employed for few localised areas. No abundance survey effort has been conducted in Surinam, Guyana, Trinidad and Tobago and Honduras. This compilation reveals two main troubles to understanding Guiana dolphin abundance: the low amount of research over the years and the absence of efforts on medium/large geographical scales (except for French Guiana). The effort conducted in the last 20 years can be summarised as follows.

(1) Brazil: 24 studies at 14 sites. Efforts, estimated area covered: 12,700km^2. Of this total 9,300km^2 were conducted in BRSE1 on 2019.
(2) French Guiana: two studies in whole EEZ. Efforts, estimated area covered: 62,000km^2.
(3) Surinam: No effort.
(4) Guyana: No effort.
(5) Venezuela: four studies in three sites. Efforts, estimated area covered: 1,100km^2.
(6) Trinidad and Tobago: No effort.
(7) Colombia: two studies in Golfo de Morrosquilo. Efforts, estimated area covered: 310km^2.
(8) Costa Rica/Panama: one study. Efforts, estimated area covered: 10km^2.
(9) Nicaragua: No effort during the last 20 years. Edwards and Schnell (2001) conducted the last sampling in 1998.
(10) Honduras: No effort.

Data on trends in abundance are rare. The only two studies we found were conducted with two local populations: (i) Azevedo *et al.* (2017) reported that Guiana dolphin population in Guanabara Bay, Rio de Janeiro state (BRSE1) is declining drastically; and (ii) Cantor *et al.* (2012) pointed out a stable population at Cavarelas River Estuary, Bahia state (BRNE4).

Summary by management units

Brazil

BRS/SE

This MU is one of the most studied and has been monitored continuously since the end of the 1990s. Abundance is available for three sites/populations: Babitonga Bay, and Paranaguá and Cananéia Estuarine Complexes. Guiana dolphin abundances in some sites from BRS/SE have been estimated in hundreds or thousands of individuals: between 2001-03, Cremer (2007) estimated between 147-365 individuals in Babitonga Bay (Santa Catarina State) using distance sampling. Seven years later (2010-11), Schulze (2012) estimated that there were 174-252 individuals in the same area using a mark-recapture approach. In Paranaguá Estuarine Complex (Paraná State), Miranda (2017) conducted distance sampling surveys between 2012-13 and estimated a population size of 1,371-2,393 individuals. In Cananéia Estuarine Complex (São Paulo State), a recent mark-recapture study estimated around 392-438 individuals (Mello *et al.*, 2019). Coastal areas outside those estuarine zone/bays have not been assessed yet for abundance/density estimates, totalling about 400km of survey gap along the coastline within the species distributional range in this MU.

BRSE2

Monitoring of some populations in this MU has been conducted since the late 1980s, particularly in three sites: Ilha Grande Bay, Sepetiba Bay and Guanabara Bay, all three located in Rio de Janeiro State. Guanabara Bay abundance (37- 40 individuals; Azevedo *et al.*, 2017) contrasts with Sepetiba Bay (588-1,004 individuals; Flach (2015) and Ilha Grande Bay (602-1,296; Souza, 2013). Similar to BRS/SE, BRSE2 populations using bays and estuaries contrast in size, but most are large, numbering thousands of individuals. However, studies in open coastal waters are still lacking for abundance/density estimates. In this MU, unsampled coastal areas represent more than 400km of coastline within the species distributional range.

BRSE1

There are only two studies conducted in two different coastal areas along this MU: Cepile, 2008; 81-141 individuals, and Mamede, 2015; 59-78 individuals. However, since 2019, aerial surveys have been conducted along Espírito Santo coast covering a large geographical area, as part of the impact assessment of the Mariana environmental disaster. In this survey, abundance/density was estimated for the whole BRSE1: summer 2019 393-1,256 and winter 2019 137-840 (RRDM – Rede Rio Doce Mar – FEST, 2019).

BRNE4, BRNE3, BRNE2, BRNE1

There are few studies on these MUs: sampling areas are small and there are only five studies about abundance/density along 3,000km of Guiana dolphin distribution. Very low abundances were estimated for one location in BRNE4 (28-48; Melo, 2018) and for another in BRNE1 (26-64; Meirelles, 2013). In BRNE2 there is only one study available (Paro, 2010) and in BRNE3 no effort has been conducted yet.

BRNO

No effort has been conducted in this MU.

French Guiana

FRGU

Guiana dolphin abundance/density was estimated in the FRGU by two recent studies. Mannocci *et al.* (2012) and Laran *et al.* (2019) conducted aerial surveys in the EEZ coastal waters from French Guiana and estimated 2,076 and 1,764 Guiana dolphins in the area, respectively.

Surinam and Guyana

FRGU

No effort has been conducted in these countries.

Venezuela

VEOR

Two studies were conducted in the Orinoco River by line-transectss. Abundance estimates point out to thousands of individuals: Gomez-Salazar *et al.* (2012) estimated 2,205 and Herrera (2013) estimated 4,451 Guiana dolphins. This MU seems well studied, but it represents only the Orinoco River and the whole coast from this MU to VEML (1,500km of coastline) has not been sampled. Therefore, information about abundance/density estimates cover a small extension of Venezuela coast.

VEML

This MU has been poorly studied in its total area for abundance/density of Guiana dolphins. Two studies were conducted at Maracaibo Lake (a total area about 13,000km^2), but only 900km^2 were sampled (Briceño *et al.*, 2017). At the Gulf of Venezuela two other studies estimated abundance/density in about 6km^2 (Carrasquero, 2010; Espinoza-Rodríguez *et al.*, 2019).

Trinidad and Tobago

No effort has been conducted in this country.

Colombia and northern areas

CCOL

Two mark-recapture studies were conducted in the Gulf of Morrosquilo. Abundance estimates point to hundreds of individuals (118-426; Dussán-Duque, 2013), but the sampling area was small and covered about 300km^2. This MU seems under sampled and is the only site sampled along the Colombia coast. As a consequence, information about abundance/density estimates covered a small extension of the CCOL.

There is currently one PhD thesis study ongoing in Uraba Gulf, which one of its objectives is to estimate abundance of Guiana dolphin in this region (Trujillo and Rosso-Londoño, pers. comm.).

Costa Rica/Panama

Efforts are incipient. Only one study covered 10km^2 (Gamboa-Poveda, 2009).

Nicaragua and Honduras

No effort has been conducted in these countries.

Research priorities and recommendations

The literature review stresses out some critical gaps regarding population abundance estimates and trends.

- Sampling effort must be extended along coastal areas, where abundance data are lacking for most MUs and where opportunistic sightings and strandings usually record Guiana dolphins. Aerial surveys seem to be adequate for this purpose (Mannocci *et al.*, 2012; Laran *et al.*, 2019) and can be complementary to effort already applied in sheltered waters.

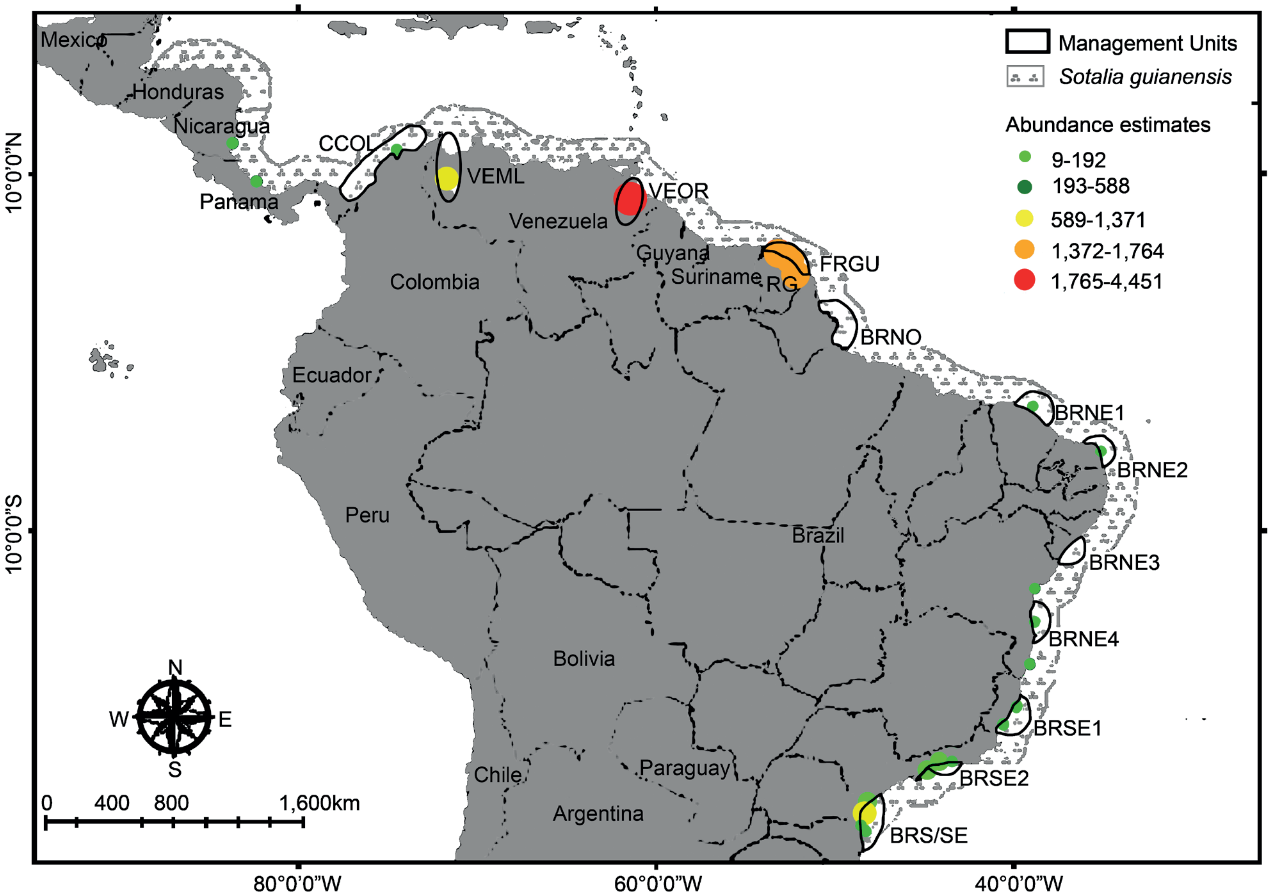

Fig. 4. Map of management units defined during the SG Workshop (2019) and their respective abundance/density estimates of Guiana dolphin (*Sotalia guianensis*), obtained from studies conducted between 2000 and 2019.

- In the sites in which continuous monitoring has been conducted, as in Guanabara, Ilha Grande and Sepetiba Bay (Rio de Janeiro state), Cananéia Estuarine Complex (São Paulo state), Paranaguá Estuarine Complex (Paraná state) and Babitonga Bay (Santa Catarina state), in southern and southeastern Brazil, it is highly recommended to assess trends in abundance/densities.
- Comparable methods and appropriate correction factors should be used to estimate abundance in areas where previous estimates are available.
- Improve the protocol for abundance estimation methodologies and to obtain estimates of trends in abundance, encouraging new technics for this purpose (e.g. passive acoustic monitoring, Unmanned Aircraft Systems – UAS, etc.).
- Foster international cooperation and conducted an integrated workshop to enhance the scientific approach concatenating protocols for data collection and analysis in abundance estimates.

4.3 Biological parameters

General characteristics

This report provides a summary of information on life history and population parameters available for the Guiana dolphin, particularly related to body size, age and reproduction (see Table 2). We compiled the information available from peer-reviewed scientific articles, masters and doctoral theses as well as working papers presented during the Workshop. Personal communications and unpublished data provided by specialists during the meeting were also included to complement this report.

Information about biological parameters for the Guiana dolphins is available mainly for the southern part of its distribution, in southeastern and southern Brazil (Table 2; Fig. 5). However, even in these areas, the information is still elementary, fragmented and, in some cases, based on reduced sample sizes. Most information listed here originated from stranding data (see below), but for some local population, information from long-term mark-recapture studies are also available, particularly regarding the estimation of reproductive output and survival rates.

Table 1

Summary of abundance/density estimates of Guiana dolphin (*Sotalia guianensis*) from 2000 to 2019. Management Units were defined during the *Sotalia guianensis* pre-assessment Workshop (2019). Methods: Mark-recapture (1) and Line-transect (2).

Management Unit	Area (km^2)	Period	Estimates	Source
BRS/SE - Brazil				
Babitonga Bay (SC)[2]	160	2001-03	147-365	Cremer (2007)
Babitonga Bay (SC)[1]	160	2010-11	174-252	Schulze (2012)
Guaratuba Bay (PR)[2]	40	2002-03	0.15/km^2	Filla (2004)
Antonina Bay (PR)[2]	28	2003-04	23.1 ind/km^2	Japp (2004)
Paranaguá Estuarine Complex (PR)[2]	600	2012-13	1,371-2,393	Miranda (2017)
Cananéia Estuarine Complex (SP)[1]	125	2000-03	290-360	Santos and Zerbini (2006)
Cananéia Estuarine Complex (SP)[2]	106	2001	0.15/km^2	Bisi (2001)
Cananéia Estuarine Complex (SP)[1]	132	2007	697-730	Pacífico (2008)
Cananéia Estuarine Complex (SP)[1]	132	2016	392-438	Mello *et al.* (2019)
BRSE2 - Brazil				
Ilha Grande Bay (RJ) [1]	550	2005-09	602-1,296	Souza (2013)
Ilha Grande Bay(RJ) [1]	550	2007-10	1,232-1,389	Espécie (2011)
Ilha Grande Bay (RJ)[1]	550	2007-13	482-757	Espécie (2015)
Sepetiba Bay (RJ) [2]	526	2002-03	739-2,196	Flach *et al.* (2008)
Sepetiba Bay (RJ) [1]	145	2006-07	1,004-1,117	Nery *et al.* (2008)
Sepetiba Bay (RJ) [1]	520	2012	588-1,004	Flach (2015)
Guanabara Bay (RJ) [1]	280	2015	37-40	Azevedo *et al.* (2017)
BRSE1 - Brazil				
Benevente Bay (ES) [1]	---	2014	59-78	Mamede (2015)
Regência (ES) [1]	235	2007	81-141	Cepile (2008)
Espírito Santo state (costal zone)	3,319	Summer 2019	393-1,256	RRDM – Rede Rio Doce Mar – FEST (2019)
Espírito Santo state (costal zone)	9,305	Winter 2019	137-840	RRDR as above
BRNE4 - Brazil				
Canavieiras Estuarine Complex (BA) [1]	---	2016-17	28-48	Melo (2018)
Ilhéus (BA) [2]	30	2014-15	133-343	Rosa (2016)
Caravelas River Estuary (BA) [1]	700	2009	83-182	Cantor *et al.* (2012)
BRNE3 - Brazil				
No effort	---	---	---	-
BRNE2 - Brazil				
Southern Coast of RN State [1]	22.3	2008-09	192-297	Paro (2010)
BRNE1 - Brazil				
Fortaleza city (CE) [1]	16	2009-11	26-64	Meirelles (2013)
BRNO - Brazil				
No effort	---	---	---	-
FRGU - French Guiana				
EEZ, coastal stratum [2]	39,409	2008	2,076	Mannocci *et al.* (2012)
EEZ, coastal stratum [2]	61,465	2017	1,764	Laran *et al.* (2019)
Surinam				
---	---	---	---	-
Guyana				
---	---	---	---	-
VEOR - Venezuela				
Orinoco River [2]	5,078	2006-07	2,205	Gomez-Salazar *et al.* (2012)
Orinoco River [2]		2008, 2012-13	4,451	Herrera-Trujillo (pers. comm.)
VEML - Venezuela				
Zapara Is. Southern Gulf of Venezuela[1]	6.33	2008-09	5.62 ind/km^2	Carrasquero (2010)
Barranquitas, Maracaibo Lake System[1]	249.2	2011-12	1.66 ind/km^2	Delgado-Ortega (2012)
Maracaibo Lake System[2]	900	2017	1.25 ind/km^2	Briceño *et al.* (2017)
Zapara Is. Southern Gulf of Venezuela[1]	6.33	2009-11	150-573	Espinoza-Rodríguez *et al.* (2019)
Trinidad and Tobago				
---	---	---	---	-
CCOL – Colombia				
Golfo de Morrosquilo [1]	310	2002-06	70-90	Dussán-Duque *et al.* (2006)
Golfo de Morrosquilo [1]	310	2009-10	118-426	Dussán-Duque (2013)
Costa Rica/Panama [1]				
Coastal region	10	2003-05	81-100	Gamboa-Poveda (2009)
Nicaragua				
---	---	---	---	-
Honduras				
---	---	---	---	-

Guiana dolphin can reach up to 230cm in total length and weight 150kg (PMP-BS[3]). The maximum estimated age was 33yr (Lima *et al.*, 2017). The species is not sexually dimorphic, but slight variation in maximum total lengths and sexual maturity was observed within and between some regions. Male maximum total length varied between 179cm, in northeastern Brazil (Meirelles *et al.*, 2010), and 230cm in south Brazil (PMP-BS[1]). Female maximum total length varied between 174.5cm in Espírito Santo, southeastern Brazil (Ramos *et al.*, 2010), and 230cm in south Brazil (PMP-BS[1]). Sexual maturity is reached between 170-180cm in males and 160-169cm in females, and age of sexual maturity was estimated between 6-7 yr in males and 5-7yr in females (Ramos *et al.*, 2010; Rosas and Monteiro-Filho, 2002). Seasonality in testicular activity was not detected, but adult males have large testes, estimated in 3.3% of the total body weight (Rosas and Monteiro-Filho, 2002). Both ovaries are functional (Rosas and Monteiro-Filho, 2002) but a slight variation is recorded for birth periods. Births on the Rio de Janeiro coast, southeastern Brazil, occurs from spring to autumn, with a peak during the autumn (Ramos *et al.*, 2010). On the Paraná coast, southern Brazil, no defined seasonality was recorded (Rosas and Monteiro-Filho, 2002). Lactation period, estimated between 8.7 and 9.4 months, was estimated only for Paraná (Rosas and Monteiro-Filho, 2002). Reproductive senescence was detected for females older than 25 years (Rosas and Monteiro-Filho, 2002). Information provided by relative size and histological inspection of tastes, and reinforced by behaviour analysis of wild populations, indicate that the species has a promiscuous mating system (Rosas and Monteiro-Filho, 2002; Santos and Rosso, 2008).

Research priorities and recommendations

The literature review stresses some critical gaps regarding biological parameters.

- Studies addressing aspects of reproduction and growth should be carried out, particularly for populations in the north and northeast of Brazil (BRNO, BRNE1-4), and in Central America (regions where there is no information).
- Considering the high degree of dependence of the populations of the south and southeast regions in Brazil on the environments of bays and estuaries, where the anthropogenic pressure is intensive, efforts must be made to obtain survival estimates for the different populations.
- Information on reproductive biology and growth needs to be updated and/or carried out for the entire southern and southeastern regions of Brazil, mainly for estimation of age and length at sexual maturity, annual pregnancy rate and calving interval.

4.4 Threats

Multiple activities are potentially sources of impacts on various Guiana dolphin local populaitons within the defined Management Units. These activities were listed and discussed by expert researchers during the intersessional Workshop held during the Latin American Society of Aquatic Mammals (RT) meeting in Peru, 2018. The survey resulted in 11 anthropogenic activities to which Guiana dolphins are exposed: fishing activities (gill, trawl and longline) (PI); development of coastal infrastructure (DI); port activities (including dredging (DRMultiple activities are potentially sources of impacts on various Guiana dolphin local populations within the defined Management Units. These activities were listed and discussed by expert researchers during the intersessional Workshop), underwater explosions (EX), vessel traffic (TE), environmental disasters (AA); mining (M); oil exploration (PG); aquaculture/fish farming (MA); industrial activities (IN); agricultural activities (AG); nautical activities (AN); and nautical tourism (TU) (Fig. 5). This list was used as a basis for the assessment of impacts and threats by Workshop participants, which evaluated the existing studies that addressed the impacts and their potential effects on dolphins considering the study areas, but also the management units proposed (see Annex E).

Human-induced mortality

Mortality Rates and Strandings Events

In 1994, the Scientific Committee of the International Whaling Commission (IWC) urged that steps should be taken by member states to reduce incidental mortality of genus *Sotalia*, while at the same time establishing better systems of recording and monitoring take levels (IWC, 1995). Since then, anthropogenic activities and habitat loss have increased probably faster than the scientific knowledge about their effects on population conservation status and health.

At the moment, there are estimates of total mortality rates only for specific populations such as Cananéia Estuarine Complex (BRS/SE; Mello *et al.*, 2019), Guanabara Bay (BRSE2; Azevedo *et al.*, 2017) and Caravelas River (BRNE4; Cantor *et al.*, 2012) in Brazil, and Gulf of Morrosquillo, Colombia (Dussán-Duque, 2013). More detailed information and studies come from southeastern Brazil. While the Caravelas, Cananéia and Gulf of Morrosquillo mark-recapture studies estimated relatively high survival rates (0.88, 0.86 and 0.95, respectively), in Guanabara Bay it was much lower (from 0.427 to 0.551, depending on the period). In the latter, it was observed a fast decline in the population, probably related to mortality and not related to emigration (Azevedo *et al.*, 2017). Guanabara Bay is a human-densely region and is environmentally degraded, with different threats potentially contributing to this decline in the Guiana dolphin population.

[3]The PMP-BS is an intense beach monitoring program that has been underway since 2015 along the coasts of São Paulo, Paraná and Santa Catarina, including the southern limit of the Guiana dolphin distribution. All data collected is available at *http://simba.petrobras.com.br*.

Table 2

Summary of the current knowledge on biological parameters of Guiana dolphin (*Sotalia guianensis*).

Area	Parameter		References
Venezuela			
Maracaibo Lake (VEML)			
	Maximum length	Male: 200cm	
		Female: 222cm	
	Maximum age	31 years	
Brazil - Northeastern			
Ceará State (BRNE1)			
	Maximum length	Males: 210cm	Meirelles *et al.* (2010)
		Females: 208cm	
		Males: 189cm	Spinelli (2017)
		Females: 208cm	
	Reproduction	Female length of sexual maturity: 165-208cm	Spinelli (2017)
		Male length of sexual maturity: 164-189cm	
		Length at birth: 97cm	
	Survival (Macuripe)	2009-11: Adult survival=0.88 (95% CI: 0.69-0.96)	Meirelles (2013)
Rio Grande do Norte State (BRNE2)			
	Maximum length	Male: 200cm	
		Female: 197cm	
		Male: 200cm	
		Female 196cm	
		Male: 220cm	
		Female: 194cm	
	Length at physical maturity	Male: 200cm	
		Male: 200cm	
		Female: 194.2-196cm	
		Male: 220cm	
		Female 194cm	
Bahia State (BRNE4)			
	Survival rate	CJS=0.88 ± 0.07 SE, 95% CI=0.67-0.96	Cantor *et al.* (2012)
		RD=0.89 ± 0.03 SE, 95% CI=0.82-0.94	
Brazil - Southeastern			
Espírito Santo (BRSE1)			
	Maximum age	20 years	Carvalho *et al.* (2012)
		33 years	Lima *et al.* (2017)
	Maximum length	Male: 222cm	Ramos *et al.* (2010)
		Female: 184.5cm	
	Age at asymptotic length	6 years	Ramos *et al.* (2010)
	Asymptotic length	Males: 176cm	Lima *et al.* (2017)
		Females: 191cm	
	Length at physical maturity	187.5cm	Carvalho *et al.* (2012)
	Reproduction	Length at birth: 92.96-122cm (Mean=103.3cm)	Carvalho *et al.* (2012)
		Age at female sexual maturity: 7 years	Lima *et al.* (2017)
		Age at male sexual maturity: 8 years	
		Length of female sexual maturity: 191cm (SD=7.12)	
		Length of male sexual maturity: 190.2cm (SD=158.75)	
Rio de Janeiro – (BRSE1)			
	Maximum age	30 years	Arruda Ramos *et al.* (2000); Di Beneditto and Ramos (2004)
	Maximum length	Males: 200cm	Ramos *et al.* (2010)
		Females: 198cm	Ramos *et al.* (2010)
	Age at asymptotic length	6 years	Ramos *et al.* (2010)
	Asymptotic length	Males: 191.7cm	Arruda Ramos *et al.* (2000)
		Females: 191.7cm	
	Age at physical maturity	Males: 7 years	Arruda Ramos *et al.* (2000)
		Females: 7 years	
	Length at physical maturity	Males: 185cm	Arruda Ramos *et al.* (2000)
		Females: 185cm	
	Reproduction	Gestation period: 11.6 months	Arruda Ramos *et al.* (2000)
		Length at birth: 97-106cm	
		86-117.5cm	Di Beneditto and Ramos (2004);
		Age at female sexual maturity: 6 years	Arruda Ramos *et al.* (2000)
		Age at male sexual maturity: 6 years	
		Length at female sexual maturity: 160cm	
		Length at male sexual maturity: 180cm	

Cont.

Area	Parameter		References
Rio de Janeiro – (BRSE2)			
	Maximum length	Males: 210cm Females: 198cm	Ramos *et al.* (2010)
	Age at asymptotic length	6 years	Ramos *et al.* (2010)
	Survival	Calf survival=0.75 (SE=0.02) Juvenile survival=0.89 (SE=0.02) Adult survival=0.89 (SE=0.02)	Flach, unpublished data
		2007-10=0,97 (SE=0.01)	Espécie (2011)
	Reproduction	Calving interval: 2-3 years Fecundity: 0.20 (min: 0.17-max: 0.25)	Flach, unpublished data
Brazil - Guanabara Bay (BRSE2)			
	Survival rate	2000-05=0.43 (95% CI 0.28-0.59) 2005-10=0.55 (95% CI 0.40-0.70) 2010-15=0.55 (95% CI 0.37–0.72)	Azevedo *et al.* (2017)
Brazil - São Paulo – North (BRS/SE)			
	Maximum length	Males: 200cm Females: 200cm	Ramos *et al.* (2010)
	Age at asymptotic length	6 years	Ramos *et al.* (2010)
Brazil - São Paulo – South (BRS/SE)			
	Maximum age	29 years	Santos *et al.* (2003)
	Maximum length	Male: 200cm Female: 200cm	Santos *et al.* (2003)
	Age at asymptotic length	7 years	Santos *et al.* (2003)
	Asymptotic length	179.8cm	Santos *et al.* (2003)
	Reproduction	Length at birth: 97.8cm	Santos *et al.* (2003)
		Calving interval: 2-3 years	Santos *et al.* (2001)
	Survival	2015-16: 0.86 (SE=0.06)	Mello (2016)
Brazil - São Paulo (BRS/SE)			
	Maximum age	Male: 9.7 years Female: 9 years	PMP/BS
	Maximum length	Male: 230cm Female: 206cm	PMP/BS
	Reproduction	Female age at sexual maturity: 6.5 years Male age at sexual maturity: 7.3 years Female length at sexual maturity: 165-208cm Male length at sexual maturity: 164-189cm	Santos Neto (2017)
Brazil - South *Paraná (BRS/SE)*			
	Maximum age	Male: 30 years Female: 24 years	PMP/BS
	Maximum length	Male: 208cm Female: 197cm	PMP/BS
	Maximum age	30 years	Rosas *et al.* (2003)
	Asymptotic length	Males <5 years: 159.6cm Males >5 years: 186.4cm Females: 177.3cm	Rosas *et al.* (2003)
	Maximum weight	121kg	Rosas and Monteiro-Filho (2002)
	Reproduction	Reproductive cycle: 2 years Senescence: females older than 25 years Gestation period: 11.6 months Length at birth: 89.1 to 95cm (92.2 ± 2.7cm) Lactation period: 8.7 months Age at female sexual maturity: between 5 and 8 years Age at male sexual maturity: 7 years Length at female sexual maturity: between 164 to 169cm Length at male sexual maturity: between 170 and 175cm	Rosas and Monteiro-Filho (2002)
Santa Catarina (BRS/SE)			
	Maximum age	Male: 25 years Female: 25 years	PMP/BS
	Maximum length	Male: 212cm Female: 230cm	PMP/BS

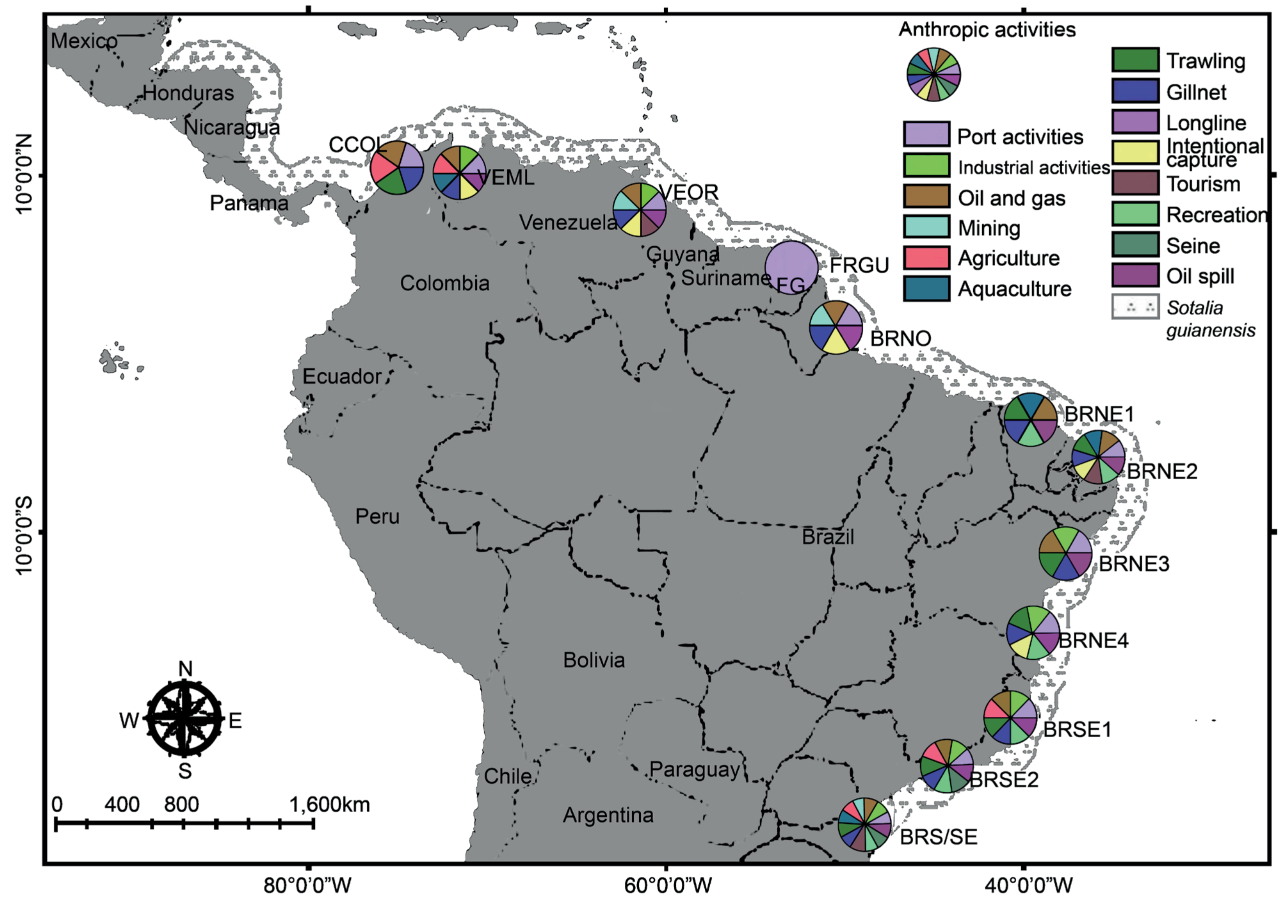

Fig. 5. Map of anthropogenic activities potentially impacting Guiana dolphins identified for each management unit during the Workshop in 2019 (map based on Annex E).

However, even in the absence of direct estimates of injuries caused by human activities, suggestive marks of trauma have been observed on live animals (Azevedo *et al.*, 2009; Flach, 2015; Nery *et al.*, 2008) and stranded individuals. Information collected from stranding programmes between 2015 and 2019, recorded 832 Guiana dolphin carcasses during daily beaching monitoring, along approximately 1,500km of the southeast and south Brazilian coast (data available at: *http://simba.petrobras.com.br*). Considering only fresh or in early decomposition carcasses (*n*=328), signs of fishery interactions were seen in 42% (*n*=138) of them, but in some areas signs of fishery interactions were observed in almost 75% of the carcasses (see Fig. 6).

Other negative interactions, such as vessel collision, marine debris ingestion and aggression are rare, but also recorded during necropsy (details provided in specific topics below). Additionally, juvenile/calves stranded more frequently (~50%) than adults (33%) or undetermined individuals (17%), and this proportion is similar for animals with (juveniles=55.8%; adults=33.3%) or without (juveniles=45.4%; adults=31.9%) suggestive marks of fishing interaction.

Bycatch

Fisheries bycatch of marine mammals are regulated throughout the Guiana dolphin distribution, but are poorly monitored. Therefore, impacts of bycatch on these populations are not well understood. The lack of data on fishing effort, particularly for small-scale fisheries, bycatch rates, and which Guiana dolphin population are affected remain as critical barriers for assessing risks from individual fisheries or cumulative impacts from fisheries that overlap with the population distribution.

Nevertheless, the high number of Guiana dolphins found stranded along the coast and information from the literature inform the species is one of the most commonly caught small cetaceans in Brazilian coastal gillnet fisheries (Di Beneditto, 2003; Emin-Lima *et al.*, 2008; Lodi and Capistrano, 1990; Meirelles *et al.*, 2010; Siciliano, 1994; Sidou, 2008). The same impact was reported for other regions in South and Central America (Vidal *et al.*, 1994). For example, in Colombia, at least six mortality events related with entanglement in nets are reported yearly for the last five years (Trujillo, pers. comm.). Although gillnets appear to be the most important fisheries in terms of threats, interactions also include incidental mortality in other types of nets, artisanal longline fisheries, the use of dynamite in fishing operations, direct catches for meat consumption and bait, and competition with fisheries for fishing resources (Crespo *et al.*, 2010; Delgado-Ortega,

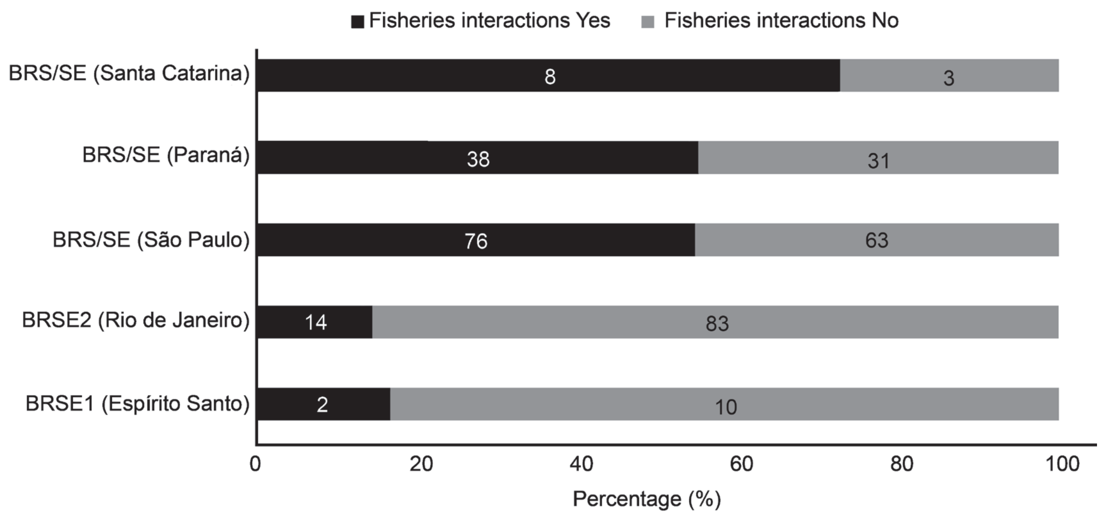

Fig. 6. Guiana dolphin carcasses with or without suggestive marks of fishery interactions detected during necropsies. The analysed individuals were found stranded along the Brazilian states of Espirito Santo, Rio de Janeiro, São Paulo, Paraná and Santa Catarina. The number within columns indicates the absolute number of dolphins. Only fresh and early decomposition stages were considered (codes 2 and 3, *sensu* Geraci and Lounsbury, 2005).

2012; Di Beneditto *et al.*, 1998; Loch *et al.*, 2009; Lodi and Capistrano, 1990; Monteiro-Neto *et al.*, 2000; Nery *et al.*, 2008; Pinheiro and Cremer, 2003; Rosas *et al.*, 2010). The review contributions in understanding Guiana dolphin bycatch are summarised by management units in Table 3.

In general, few initiatives and experiments have been carried out on Guiana dolphins to mitigate fisheries interactions. Crespo *et al.* (2010) cited just one experimental test with pingers carried out in Iracema Beach, Fortaleza, Brazil, from 1996 to 1998 (Monteiro-Neto *et al.*, 2004). Experiments with functional, dummy and control trials were tested in a sheltered area where dolphin groups were monitored. The results suggested that functional pingers affect dolphin distribution, but side effects in population parameters and its prey were not cited.

Summarised by management units

BRS/SE

In the central coastal area of São Paulo state, Guiana dolphins represented 5.4% of the incidental capture records during the over 20 years of monitoring artisanal fishing (Bertozzi *et al*., unpublished data). On the southern area in the same state, in Cananéia Estuarine Complex, fisheries interactions were observed between 2004 and 2007 and Guiana dolphins represented 11.5% of no-target species captured. On the coast of Paraná state, the monitoring of fisheries recorded the incidental capture of 45 Guiana dolphins between 1997 and 1999 (Rosas, 2000).

BRSE1

In the region of Atafona, north of Rio de Janeiro state, Guiana dolphin has historically represented one of the species most vulnerable to fishing activities. Between 1987-88 Lodi and Capistrano (1990) recorded the incidental capture of 33 specimens; later, between 1989 and 1996, Di Beneditto *et al.* (1998) registered 78 individual incidental captures. Between 2001 and 2002, monitoring of 374 sets of gillnets resulted in the bycatch of 20 individuals (Di Beneditto, 2003).

BRNE (1-4)

In the northeast of Brazil, an ethnobiology study carried out in Pernambuco state showed that 44% of the fishermen confirmed that have incidental capture individual of Guiana dolphins, but the mortality rate and the threat to the population are still unknown (Araújo, 2008). For Ceará state (BRNE1) mortality due to incidental captures was estimated at 4 to 11 individuals per year (Monteiro-Neto *et al.*, 2000). In Rio Grande do Norte state (BRNE2) the mortality recorded for small-scale fisheries was 29 individuals over three years (Attademo, 2007).

BRNO

The mortality of Guiana dolphin by interactions with small-scale fisheries was evaluated in Pará, from August 2006 to May 2007, and 166 Guiana dolphins were captured; an average of 5.35 dolphins per fishing sets (Emin-Lima *et al.*, 2008). This number is larger than for other regions of Brazil.

Additionally, Guiana dolphin can be severely injured, due to trauma related to net entanglements resulting in partial or complete amputations and deformations. Remains of nylon gillnets were found around the body of Guiana dolphins (Azevedo *et al.*, 2009; Domiciano *et al.*, 2016). As cited by Rosas *et al.* (2010) this might result in severe injuries and traumas, high-stress levels and secondary mortality, which goes unaccounted for in Guiana dolphins (Van Bressem *et al.*, 2007).

Bycatch and intentional captures – Venezuela cases

Historically in Maracaibo Lake there has been a use of Guiana dolphin when it is incidentally captured. The meat is used for human consumption or as bait for shark fishing (Barrios-Garrido *et al.*, 2015; Ramírez, 2005; Sánchez and Briceño, 2017). In the last four years, there has been an increase in beached individuals of Guiana dolphins in Lake Maracaibo with signs of anthropogenic injuries, such as suggestive marks of fisheries interactions. The bycatch rates were estimated per region (North, Center and South of the Lake Maracaibo) for 3 to 5 months (Briceño *et al.*, unpublished data; see Table 3). Recently, direct hunting has been reported: between July 2019 and January 2020, about 100 individuals were captured for consumption and these data have been collected through interviews conducted at the main fishing ports and with local informants. In a single hunting event in the north of the lake in January 2020, 17 animals were killed and consumed, including pregnant females (Briceño, pers. comm.). Considering the data collected between 2016 and 2020, an estimated bycatch and directed hunting mortality is estimated at almost 180 individuals/year, one of the highest rates in the species entire distribution (Briceño *et al*., unpublished data; Sánchez and Briceño, 2017).

Environmental concerns

Chemical Contaminants

Guiana dolphin is a marine ecosystem sentinel (Moura *et al.*, 2013) as the species is particularly sensitive to environmental changes and the spatially and temporally pollution signals of the environment might be detected throughout their life parameters. Guiana dolphins are exposed to a range of human-induced impacts that include persistent environmental pollution and emerging diseases. Its coastal distribution, high residency and site fidelity, high trophic level and long lifespan (about 30 years) complicate the exposition to these pollutants and disturbances (Bisi *et al.*, 2012; de Freitas Azevedo *et al.*, 2004). For instance, Guiana dolphin can present high concentrations of xenobiotics with potential for bioaccumulation and biomagnification (e.g. mercury and persistent organic compounds). These processes have been reported for populations in the south and southeastern Brazil (Kajiwara *et al.*, 2004; Lailson-Brito *et al.*, 2010; 2012; Yogui *et al.*, 2003). Many of these contaminants can lead to harmful effects on the health conditions, such as altering hormonal cycles and acting as an immunosuppressant. Although the Guiana dolphin is the most studied delphinid in the coast of Brazil regarding bioaccumulation of contaminants, the vast majority of investigations were carried out in the southeastern region, and no available studies were found on Guiana dolphin populations from other countries along its distribution.

Trace Elements

Most studies published regarding trace element levels in Guiana dolphins were carried out in the southeastern region of Brazil, mainly along the coast of Rio de Janeiro State (Bisi *et al.*, 2012; Carvalho *et al.*, 2008; Kunito *et al.*, 2004; Lailson-Brito *et al.*, 2012; see Table 4). In other regions, studies are still scarce (Monteiro-Neto *et al.*, 2003; Moura *et al.*, 2012a).

The highest concentrations of mercury have been reported in specimens from Rio de Janeiro, with values ranging from 0.17 to 132 $\mu g.g^{-1}$ wet weight (w.w) in liver tissue (Lailson-Brito *et al.*, 2012; Lemos *et al.*, 2013). The population of Guanabara Bay had the highest mean concentration, 19.9 µg.g-1 w.w. (Lailson-Brito *et al.*, 2012). This study found a positive correlation between mercury concentrations and the total length, probably because of the accumulation of this trace element over the life of the Guiana dolphin, a pattern widely reported in studies with marine mammals throughout the world (Lailson-Brito *et al.*, 2012). In the south/southeast region of Brazil, there is a single study which analysed individuals collected from the south coast of São Paulo State to the north coast of Paraná State, that reported similar values to those reported in Guanabara Bay, varying between 1.4 and 380$\mu g.g^{-1}$ dry weight (d.w.; 0.35 to 95$\mu g.g^{-1}$ w.w.; Kunito *et al.*, 2004). The only two studies published in the north and northeastern regions of Brazil found the lowest concentrations of mercury in Guiana dolphin, with values ranging between 0.10 and 29.5 $\mu g.g^{-1}$ w.w. in the liver of individuals from Ceará (Monteiro-Neto *et al.*, 2003) and between 0.07 and 0.79 $\mu g.g^{-1}$ w.w. in the muscle of individuals from Amapá (Moura *et al.*, 2012a). In a preliminary study in the south of Maracaibo Lake (Venezuela), it was found a mean mercury concentration of 2.96 ± 0.16$\mu g.g^{-1}$ w.w. in the liver (n=2) and 0.69 ± 0.01$\mu g.g^{-1}$ w.w. in the muscle (n=6; Yurasi Briceño, pers. comm.).

Investigations on the bioaccumulation of other trace elements, such as cadmium (Cd) and lead (Pb), are even scarcer in Guiana dolphin and the tissues analysed vary between them (see Table 4). In northeastern Brazil, two studies reported cadmium values ranging from <0.002$\mu g.g^{-1}$ w.w. in liver to 4.1$\mu g.g^{-1}$ w.w. in kidney (Korn *et al.*, 2010; Monteiro-Neto *et al.*, 2003). Most studies have been carried out along the coast of Rio de Janeiro state, with cadmium concentrations ranging from <0.047$\mu g.g^{-1}$ w.w. in the liver of Guiana dolphins from northern region to 3.29$\mu g.g^{-1}$ w.w. in the kidney of individuals from the central-southern region of the state (Dorneles *et al.*, 2007; Lemos *et al.*, 2013). Between the south coast of São Paulo and the north of Paraná state, it has been reported cadmium concentrations ranging from 0.19 to 2.9$\mu g.g^{-1}$ d.w. in liver (Kunito *et al.*, 2004). Regarding lead, only four published articles were found, with the highest mean concentration reported in the liver of Guiana dolphins from Cananéia, São Paulo state (3.2$\mu g.g^{-1}$ w.w.; Salgado *et al.*, 2018).

Persistent Organic Pollutants

Most published studies about persistent organic pollutants (e.g. organochlorine compounds and organobromine compounds) in Guiana dolphins are from the southeastern and southern of Brazil (Dorneles *et al.*, 2010; Kajiwara *et al.*,

Table 3

Summary of the current knowledge on fisheries interactions and Guiana dolphin bycatch.
Information were collected from stranding events and interviews with fishermen.

Location	Years	Fishing gear	% of carcasses or bycatch rates*	Seasonal capture	Information from
Venezuela					
Maracaibo Lake, (west-central coast) – (VEML)	2018-20	Gillnet	21 individuals/year	No seasonal difference detected	Yurasi Briceño, pers. comm.
Maracaibo Lake (west-central coast) – (VEML)	2011-12	Artisanal longline	5 individuals/year	No seasonal difference detected	Delgado-Ortega (2012)
Maracaibo Lake, Zulia state (southern portion) – (VEML)	2016-20	Gillnet	144 individuals 36 individuals/year	No seasonal difference detected	Yurasi Briceño, pers. comm. Sánchez and Briceño (2017)
Maracaibo Lake, Zulia state (northern portion) – (VEML)	2007-13 2017-20* 2005*	Gillnet	91 individuals registered 15 individuals per year (only one artisanel port) *52 individuals 17 per year *-30 individuals that year	Wet season (Aug.-Nov.) *not seasonal difference	H. Barrios-Garrido, pers.comm. Yurasi Briceño* Sánchez and Briceño (2017) Ramírez (2005)
Brazil - North					
Pará – (BRNO)	2006-07	Gillnet	166 individuals 5.35 individuals/sets	No seasonal difference	Emin-Lima *et al.* (2008)
Northeastern Brazil					
Ceará (BRNE1)	1992-98		4-11 individuals/year (30#)	Spring	Monteiro-Neto *et al.* (2000)
Ceará (BRNE1)	1992-2005	Gillnet and trawling	30.6% of stranded individuals	Winter and spring	Meirelles *et al.* (2010)
Southeastern Brazil					
North of Rio de Janeiro (BRSE1)	1987-88	Gillnet	33 individuals$	-	Lodi and Capistrano (1990)
North of Rio de Janeiro (BRSE1)	2001-02	Gillnet	0.031 (km of net.day)$^{-1}$	No seasonal difference	Di Beneditto (2003)
North of Rio de Janeiro (BRSE1)	2001-07	Gillnet	~33% of stranded individuals	Winter and spring	Moura *et al.* (2009)
Sepetiba Bay, Rio de Janeira (BRSE2)	2005-16	Gillnet	75% of stranded individuals	-	Flach (2015)
Central São Paulo State (BRS/SE)	1999-19	Gillnet	19 individuals	Not evaluated	Bertozzi, pers. comm.
South of São Paulo State (BRS/SE)	2004-07	Gillnet	18 individuals	Not evaluated	Sidou (2008)
Southern Brazil					
Paraná (BRS/SE)	1997-99	Gillnet	45 individuals	-	Rosas (2000)
Paraná (BRS/SE)	2007-12	Gillnet	~61% of stranded individuals	-	Domiciano *et al.* (2016)
Babitonga Bay, Santa Catarina (BRS/SE)		Gillnet		Spring and summer	Pinheiro and Cremer (2003)
Baía Norte, Ilha de Santa Catarina - Santa Catarina (BRS/SE)	1983-2014	-	-	Winter	Vianna *et al.* (2016)
North and Central Santa Catarina (BRS/SE)	1983-2014	-	-	Autumn	Vianna *et al.* (2016)

*Percentage of carcasses found with evidence of bycatch; # number of dolphins bycaught in 1996; $between 1987 and 1988, blank=not available.

2004; Lailson-Brito *et al.*, 2010; Lavandier *et al.*, 2015; Yogui *et al.*, 2003; 2011), except a study carried out in the northeast of Brazil (Santos-Neto *et al.*, 2014). See Table 5 for details. Regarding organochlorine compounds, the highest concentrations of PCBs were reported for Guiana dolphins from Guanabara Bay (RJ; 6.7-99.0µg.g^{-1} lipid weight; lw), an area with a high degree of industrialisation. The highest concentrations of DDT and its metabolites were recorded in specimens collected in areas with greater agricultural influence, in the south coast of São Paulo and in the coast of Paraná state (0.54-150µg.g^{-1} lw; Alonso *et al.*, 2010; Kajiwara *et al.*, 2004; Lailson-Brito *et al.*, 2010; Yogui *et al.*, 2003). The lowest concentrations, both for PCBs and DDTs, were reported in Guiana dolphins collected along the coast of Ceará, with mean values of 1.1µg.g^{-1} lw and 0.3µg.g^{-1} lw, respectively (Santos-Neto *et al.*, 2014). The other chlorinated pesticides (HCH and its isomers, HCB and Mirex) bioaccumulated in lower concentrations in Guiana dolphins from all studies (see Table 5).

Studies on the bioaccumulation of organobrominated compounds (polybrominated diphenyl ethers - PBDEs) in Guiana dolphins are quite scarce and without standardisation regarding the tissue analysed (subcutaneous adipose tissue, liver and muscle; Dorneles *et al.*, 2010; Lavandier *et al.*, 2015; Yogui *et al.*, 2003; see Table 6). Thus, it is difficult to compare the results and limits the understanding of the bioaccumulation potential of these compounds in Guiana dolphin along its distribution.

Table 4

Mean±SD, minimum and maximum concentrations of total mercury (HgT), cadmium (Cd) and lead (Pb) in Guiana dolphin (*Sotalia guianensis*) from the Brazilian coast. The concentrations were expressed as μg.g^{-1} wet weight.

		THg			Cd			Pb			
Regions	N	Liver	Muscle	Kidney	Liver	Muscle	Kidney	Liver	Muscle	Kidney	References
Brazil											
Northern											
Amapá (BRNO)	27	-	0.4 ± 0.16 0.07-0.79	-	-	-	-	-	-	-	Moura *et al.* (2012a)
Northeastern											
Ceará (BRNE1)	11	4.62 0.10-29.51	-	1,24 0,06-5,63	0,22 0,01-1,32		0,78 0,01-4,09	0,11 0,10-0.12	-	0.11 0.11-1.28	Monteiro-Neto *et al.* (2003)
Bahia (BRNE4)	3	-	-	-	<0.002-1.2	4.9°	2.10-3.31	0.04-0.36	0.02°	<0.001-0.32	Korn *et al.* (2010)
Southeastern											
North coast of Rio de Janeiro (BRSE1)	29	8.67ª# 0.84-87.92	-	-	-	-	-	-	-	-	Kehrig *et al.* (2008)
North coast of Rio de Janeiro (BRSE1)	6	9.98 1.10-21.7	0.73 0.34-1.42	-	0.34 0.18-0.56	0.10 0.07-0.18	-	-	-	-	Carvalho *et al.* (2008)
North coast of Rio de Janeiro (BRSE1)	19	27.8 ± 24.7ª 3.60-72.98	-	-	0.41ª 0.01-1.48	-	-	-	-	-	Seixas *et al.* (2009)
North coast of Rio de Janeiro (BRSE1)	20	1.07 ± 0.35 (0.2-1.66)	-	-	-	-	-	-	-	-	Moura *et al.* (2012b)
North coast of Rio de Janeiro (BRSE1)	11	15.4 ± 20.1 0.17-58.77	-	-	<0.047 <0.047-0.97	-	-	-	-	-	Lemos *et al.* (2013)
North coast of Rio de Janeiro (BRSE1)	21	-	3.28±1.69ª	-	-	-	-	-	-	-	Kehrig *et al.* (2013)
North coast of Rio de Janeiro (BRSE1)	14	4.1 ± 2.8 (Imaturos) 12.7 ± 7.1 (Maduros)	0.6 ± 0.1 (Imaturos) 1.3 ± 0.3 (Maduros)	-	-	-	-	-	-	-	Kehrig *et al.* (2016)
North coast of Rio de Janeiro (BRSE1)	28	-	3.91±2.16ª	-	-	-	-	-	-	-	Baptista *et al.* (2016)
Guanabara Bay, RJ (BRSE2)	NI	17.44	-	-	-	-	-	-	-	-	Lailson-Brito *et al.* (2002)
Guanabara Bay, RJ (BRSE2)	19	19.9 ± 32.3 (0.35-132)	-	-	-	-	-	-	-	-	Lailson-Brito *et al.* (2012)
Guanabara Bay, RJ (BRSE2)	12	-	0.92±0.65	-	-	-	-	-	-	-	Bisi *et al.* (2012)
Sepetiba Bay, RJ (BRSE2)	42	-	0.26±0.33	-	-	-	-	-	-	-	Bisi *et al.* (2012)
Ilha Grande bay, RJ (BRSE2)	6	8.8 ± 2.1ª	1.9 ± 0.8ª	-	-	-	-	-	-	-	Seixas *et al.* (2014)
Ilha Grande bay, RJ (BRSE2)	9	-	0.68±0.22	-	-	-	-	-	-	-	Bisi *et al.* (2012)
Central-south area of Rio de Janeiro (BRSE2)	5	-	-	-	-	-	1.18±1.10 0.04-3.29	-	-	-	Dorneles *et al.* (2007)
São Paulo State and Paraná State* (BRS/SE)	20	77 ± 107ª (1.4-380)	-	-	0.65±0.75ª (0.19-2.9)	-	-	0.07±0.053ª 0.028-0.19	-	-	Kunito *et al.* (2004)
Cananéia, SP (BRS/SE)	21	-	-	-	-	-	-	3.17 ± 2.84 <DL-9.62	-	-	Salgado *et al.* (2018)

NI: data not informed; *authors did not differentiate individuals from the two states; ªvalues expressed on dry weight; #median values; °n=1; DL=detection limit; dash=not analysed.

Noise Pollution and Collisions

Only four studies have been published regarding the impact of noise pollution on the acoustic behaviour of the Guiana dolphin in Brazil: (i) one in Guanabara Bay, Rio de Janeiro state BRSE2 (Bittencourt *et al.*, 2017); (ii) one in Cananéia, São Paulo state - BRS/SE (Resende, 2008); (iii) one in Caravelas estuary, Bahia state - BRNE4 (Pais *et al.*, 2018); and (iv) one in the district of Pipa, Rio Grande do Norte state – BRNE2 (Martins *et al.*, 2018). Changes in the whistles acoustic parameters were recorded for some studies and suggested as a response to the high underwater noise. However, Bittencourt *et al.* (2017) found that the Guiana dolphins produced whistles of shorter duration; conversely, (Martins *et al.*, 2018) reported a reduction in the number of clicks in noisy conditions. Stutz Reis (2013) observed different responses in Bevenuete bay, in Espirito Santo's state (BRS1), where Guiana dolphins produced longer whistles in a noisy habitat.

Table 5

Mean±SD, minimum and maximum concentrations of the organochlorine compounds (ΣPCB, ΣDDT, ΣHCH, HCB e Mirex) in blubber of Guiana dolphins (*Sotalia guianensis*) from the Brazilian coast. The concentrations were expressed as μg.g^{-1} lipid weight.

Regions	N	ΣPCB	ΣDDT	ΣHCH	HCB	Mirex	References
Brazil							
Northeastern							
North region of Ceará (BRNE1)	4	2.23±1.17 0.02-3.85	0.33±0.26 0.006-0.63	NA	0.02±0.02 0.003-0.04	0.08±0.04 0.02-0.12	Santos-Neto *et al.* (2014)
Metropolitan region of Ceará (BRNE1)	8	7.35±6.27 0.04-17.3	1.11±0.66 0.06-1.91	0.04±0.01 0.04-0.05	0.007±0.004 0.002-0.01	0.09±0.03 0.04-0.15	Santos-Neto *et al.* (2014)
South region of Ceará (BRNE1)	13	1.12±1.32 0.03-0.82	0.30±0.28 0.003-0.82	0.03±0.03 0.005-0.08	0.07±0.05 0.02-0.16	0.07±0.05 0.02-0.16	Santos-Neto *et al.* (2014)
Southeastern							
Guanabara Bay, RJ (BRSE2)	12	34.8±26.3 6.7-99.2	7.9±6.9 2.1-21.5	NA	0.046±0.04 <0.004-0.11	NA	Lailson-Brito *et al.* (2010)
Sepetiba Bay, RJ (BRSE2)	5	12.3±11.7 1.7-25.5	3.9±3.9 0.65-9.99	NA	0.029±0.028 0.013-0.08	NA	Lailson-Brito *et al.* (2010)
Ubatuba, SP (BRS/SE)	3	47.78 (25.87-66.03)	34.03 16.91-48.08	0.07 0.06-0.07	0.11 (0.08-0.14)	1.26 0.57-1.87	Alonso *et al.* (2010)
Baixada Santista, SP (BRS/SE)	3	39.69 27.86-61.34	36.98 24.57-55.91	0.09 0.03-0.21	0.12 0.07-0.17	0.76 0.24-1.04	Alonso *et al.* (2010)
Cananéia, SP (BRS/SE)	9	4.61±3.31 0.2-9.22	35.9±46.8 0.54-125	0.016± 0.02 <0.003-0.04	0.015±0.009	0.15±0.08 0.01-0.32	Yogui *et al.* (2003)
São Paulo state (BRS/SE)	1	1.97	5.87	0.011	0.067	0.046	Yogui *et al.* (2010)
São Paulo and Paraná states* (BRS/SE)	26	1.3-79	1-150	<0.001-0.061 NA	0.0016-0.40	NA NA	Kajiwara *et al.* (2004)
Southern							
Paranaguá Estuarine Complex, PR (BRS/SE)	15	4.6±4 0.76-14.3	5.7±5.8 0.98-23.5	NA	0.041±0.040 <0.004-0.16	NA	Lailson-Brito *et al.* (2010)

*Authors did not differentiate individuals from the two states; NA=not analysed.

Table 6

Mean±SD, minimum and maximum concentrations of the organobrominated compounds (ΣPBDE) in Guiana dolphins (*Sotalia guianensis*) from the Brazilian coast. The concentrations were expressed as μg.g^{-1} lipid weight.

			ΣPBDE			
Local	N	Sex	Blubber	Liver	Muscle	Reference
BRSE1						
North-central region, RJ	10	M/F	NA	53*	NA	Quinete *et al.* (2011)
North-central region, RJ	3	F	NA	0.20 ± 0.12 (0.07-0.29)	0.10 ± 0.06 (0.03-0.14)	Lavandier *et al.* (2015)
North-central region, RJ	5	M	NA	0.12 ± 0.045 (0.07 -0.17)	0.06 ± 0.02 (0.04-0.08)	Lavandier *et al.* (2015)
Metropolitan region and 'Região dos Lagos', RJ	6	F	NA	0.16 ±0.15 (0.01–0.45)	NA	Dorneles *et al.* (2010)
Metropolitan region and 'Região dos Lagos', RJ	13	M	NA	0.67 ±0.43 (0.26–1.62)	NA	Dorneles *et al.* (2010)
BR S/SE						
São Paulo state	4	F	73.2 ± 79.1	NA	NA	Yogui *et al.* (2011)
São Paulo state	5	M	59.5 ± 47.1	NA	NA	Yogui *et al.* (2011)

M: male; F: female; *values expressed wet weight; NA= not analysed.

In general, published and unpublished data (grey literature) from different areas along the Brazilian coast highlighted potential communication masking of Guiana dolphin acoustic signals when they are using noise areas (Alburquerque and Souto, 2013; Domit *et al.*, 2018; Martins *et al.*, 2018; Pais *et al.*, 2018; Resende, 2008; Rossi-Santos, pers. comm.). In a recent study, 20 years of acoustic data were analysed for Guiana dolphin population from Sepetiba Bay, Rio de Janeiro state (BRSE2). Changes in the spatial and temporal structure of Guiana dolphin repertoire potentially have been induced for noise pollution. In general, whistle diversity, duration and rate decreased significantly thought the years, whereas maximum and minimum frequencies increased. Spatially, Guiana dolphins emitted longer and more complex whistles in less noisy habitats (Maciel, 2020).

In the case of Venezuela, Barrios-Garrido *et al.* (2016) found that the significant amount of ambient noise produced by boats, ships, and tankers for the transportation of tourists, goods, and oil products may be affecting the whistle structure of Guiana Dolphin in the southern portion of the Gulf of Venezuela, specifically between Zapara Island and San Bernardo Bay. In Colombia, distribution of Guiana dolphins overlaps with ports, so the potential for negative interaction exists but has not been measured up to date (Trujillo, pers. comm.).

There is no specific study being conducted evaluating rates of vessels collisions in Guiana dolphins. Nevertheless, the systematic beach monitoring program (PMP-BS[1]) conducted along the beaches in southern and southeastern Brazil (BRS/SE and BRSE2 and BRSE1) recorded 832 Guiana dolphins stranded which eleven carcasses were reported with suggestive marks of vessel collisions. Moreover, alive and dead stranded individuals were recorded with marks suggesting traumatic injuries probably caused by boat propeller (Domiciano *et al.*, 2016; Paulo André Flores, pers. comm.).

Dolphin Watching and Recreational Nautical Tourism Activities

Nautical tourism activities are an increasingly significant threat to marine mammals worldwide, resulting in a billionaire industry (O'Connor *et al.*, 2009). Nautical tourism is a significant economic activity along the South and Central America; however, few studies have investigated the potential impact on Guiana dolphins population.

'Commercial dolphin-watching programs are reported for Maracaibo Lake, Venezuela (VEML) and in Brazilian waters, such as Baía Norte in Santa Catarina state, Cananéia in São Paulo state (both under BRS/SE) and at Pipa beach in Rio Grande do Norte state (BRNE2). In Baía Norte, commercial dolphin-watching tourism resulted in behavioural changes and long and short-term habitat displacement by Guiana dolphins (Pereira *et al.*, 2007). Similar results were reported in Cananéia instantly after boat approximation (Filla and Monteiro-Filho, 2009). In Pipa beach, behavioural changes were reported in groups with calves, particularly during resting and socialising (Santos *et al.*, 2006).

In Maracaibo Lake (VELM), Venezuela, commercial dolphin-watching tourism is reported to occur sporadically; however, no study investigated the potential impacts on Guiana dolphin ecology and behaviour (Hoyt and Iñíguez, 2008). In Colombia, small dolphin watching ventures exist in Morosquillo Gulf, but there is no information about the level of interaction and the number of boats pursuing this activity in the area (Trujillo, pers. comm.).

Recreational nautical tourism exists along the entire Guiana dolphin distribution. Behaviour categorised as negative reactions were reported in some areas in Sergipe state (BRNE 3; Marega-Imamura *et al.*, 2018; Nunes *et al.*, 2014), in Ilhéus, Bahia state (BRNE4; Marega-Imamura *et al.*, 2018; Santos *et al.*, 2013), Cananéia, São Paulo state (Filla and Monteiro-Filho, 2009), Paranaguá Estuarine Complex, Paraná state (Gaudard, 2011) and in Baía Norte, Santa Catarina State (Pereira *et al.*, 2007).

Diseases

Cetaceans are considered environmental sentinels and their health often reflects either anthropogenic or natural spatio-temporal disturbances. Over the years, several pathogens have been identified as the cause of stranding episodes and mortality and, in fact, represent a potential risk to the life and conservation of cetaceans and at least for Guiana dolphin (Groch *et al.*, 2018). Several diseases have been documented in Guiana dolphins such as herpesvirus in general (Sacristán *et al.*, 2019), generalised poxvirus infection (Crespo *et al.*, 2010; Sacristán *et al.*, 2018; Van Bressem *et al.*, 2009), morbillivirus (Domiciano *et al.*, 2016; Groch *et al.*, 2014; Groch *et al.*, 2018; Marutani, 2020), *Toxoplasma gondii* (Bandoli and De Oliviera, 1977), Brucella spp. (Sánchez-Sarmiento *et al.*, 2018), and also lobomycosis and lobomycosis-like disease in Guiana dolphins from several localities (Van Bressem *et al.*, 2009). Many bacterial pathogens from the family Aeromonadaceae and Vibrionaceae have been isolated from Guiana dolphins. In addition, systemic infections caused by fungi of the genus *Aspergillus* spp., considered rare, have been reported more frequently (Groch *et al.*, 2018). Cases of toxoplasmosis and systemic aspergillosis have been observed in Guiana dolphins in Paraná state (PMP-BS[1]).

Studies investigating pathological findings are increasing, particularly along the Brazilian coastal area, due to an intense beach monitoring program that has been underway (Projeto de Monitoramento de Praias) and all fresh and early decomposed carcasses have been submitted for necropsy. Although some of the results of this program are unpublished, other studies have disclosed important results in terms of Guiana dolphin health status. Hepatic degeneration, lung problems and severe vascular thrombosis in Guiana dolphins caught on the Caribbean coast of Colombia were mentioned by Bössenecker (1978). Ruoppolo (2003), Marigo *et al.* (2010) and Domiciano *et al.* (2016) revealed parasitic pneumonia caused by the presence of *Halocercus brasiliensis* as one of the main causes of mortality of Guiana dolphin from the coasts of São Paulo and Paraná States (southeast and southern Brazil, respectively).

A study investigated the pathological findings and mortality of 50 Guiana dolphins from Paraná state (BRSE/S) and suggested major cause of death were ascribed to anthropogenic activities, including fisheries bycatch and trauma. However, the natural mortality, irrespective of the cause, were related to bronchointerstitial pneumonia, associated with parasitism, lymphadenitis and membranous glomerulonephritis. These results suggest, that while anthropogenic activities are a leading cause of cetacean strandings in Paraná, and probably in other regions, underlying pre-existing diseases may contribute towards deaths (Domiciano *et al.*, 2016). In the last years (2015-19) the main histological findings observed in Guiana dolphins evaluated in PMP-BS[1] in a specific area (Paraná state) were pneumonia (56%) (interstitial, granulomatous, chronic bronchopneumonia), lymphadenopathy (44%) (lymphoid depletion and lymphadenitis), hepatitis (20%), nephritis (16%) and lymphocytic encephalitis (8%). Granulomatous dermatitis was also observed in association with fungal infection. Interstitial pneumonia and lymphoid depletion were associated with morbillivirus infection in 11 animals. Also, coinfection with *Toxoplasma gondii* or *Aspergillus* spp. was detected.

The data compiled by Rosas *et al.* (2010) present a case of osteomyelitis reported by Furtado and Simões-Lopes (1999) in Guiana dolphins from Santa Catarina coast, in southern Brazil, and a case related to periodontal disease seen in the mandible of one individual from Venezuela. They also cited lesions potentially caused by *Crassicauda* sp. seen in the pterygoids of Guiana dolphins from Rio de Janeiro coast (Van Bressem *et al.*, 2007), which are also recorded in skulls of individuals found stranded in the Paraná coast (Domit, pers. comm.). Chronic bone lesions, degenerative infections, traumatic bone lesions and developmental bone anomalies in specimens from Rio de Janeiro state were reported by Ramos *et al.* (2001).

These results suggest a vulnerability of this species to environmental disturbances. Threats, including chemical contamination, underwater noise and habitat degradation are potential impacts evoking the types of stress, immunosuppression and diseases observed in different Guiana dolphin population along the species entire distribution.

Marine Debris

There is no specific study being conducted focusing on interactions with Guiana dolphins and marine debris. Nevertheless, the systematic beach monitoring program (PMP-BS) recorded 832 individuals stranded on the beaches in southern and southeastern Brazil and debris were observed in four of 328 Guiana dolphins evaluated by necropsy. The interaction includes ingestion and entanglement. In several occasions, Guiana dolphins have been recorded entangled to discarded artisanal longlines in the Maracaibo Lake, specifically to fishing gear design to capture blue crabs (*Callinectes* spp.) (H. Barrios-Garrido, pers.comm.).

Reduction of Prey Availability Due to Overfishing

The overlap of fisheries target species/food resources is an indirect interaction between marine mammals and fisheries. This interaction could increase the vulnerability of this dolphin species by reducing food availability, while also increasing their exposure to direct fisheries interactions, such as bycatch. Few studies have been conducted to assess the potential effect of overfishing Guiana dolphin prey along the entire species distribution. The most frequent fish consumed by Guiana dolphins range 3.2cm to 16.2cm, suggesting that the species does not compete directly with the fisheries (Di Beneditto, 2000; Oliveira, 2003; Santos *et al.*, 2002). However, de Gurjao *et al.* (2003) suggested that the Guiana dolphin might compete with the artisanal fisheries on the Ceará coast (northern Brazil – BRNE1), based on the fish families consumed by species and those which are most commonly captured in this region.

Available information on the diet suggests that many important prey for Guiana dolphins are of commercial interest (e.g. *Harengula clupeola, Pomadasys corvinaeformes*, *Thichiurus lepturus, Sardinella brasiliensis*, *Pellona harroweri*, *Isopisthus parvipinnis*, *Centropomus* sp., *Cetengraulis edentulus*, *Mugil* sp., *Lycengraulis grossidens*, and *Micropogonias furnieri*; Madeira di Beneditto and Siciliano, 2007; Oliveira *et al.*, 2008; Rodrigues *et al.*, 2020). Additionally, some fishes preyed by Guiana dolphins are bycatch of artisanal trawls, suggesting that Guiana dolphins could be feeding following fishing boats and exposed for threats.

Coastal Development (e.g. Port Activities)

Along the entire distribution of Guiana dolphin, the presence of coastal and maritime infrastructure, including ports, windy farms and oil platforms, are generating an array of anthropogenic activities, such as vessel traffic, dredging, pile driving, underwater explosions, environmental accidents and others. These activities might generate a wide range of direct and indirect impacts on Guiana dolphin populations (Domit *et al.*, 2009; Van Belleghem and Domit, 2017). Port areas harbour high levels of noise and chemical pollution, for example, tin occurs in antifouling paints used in ship hulls and port structures and has been found in elevated concentrations in tissues of Guiana dolphin (Dorneles *et al.*, 2008). However, even the impacts of all those activities on Guiana dolphins remain underestimated, changes in behaviour and habitat use patterns were observed for the population in Babitonga Bay affected by a port development (Santa Catarina State) (Cremer, 2011; Cremer *et al.*, 2009). Moreover, ports and other coastal and maritime development infrastructure could be responsible for synergetic and additive impacts. The cumulative effects of stress can lead to immunodepression, leaving the Guiana dolphin populations susceptible to diseases and other threats (Domiciano *et al.*, 2016; Groch *et al.*, 2018; Van Bressem *et al.*, 2009).

In Colombia, an ongoing study on mapping the distribution of Guiana dolphins and port infrastructure shows an overlap for at least four of the five regions along the Colombian Caribbean where these dolphins appear to have resident populations. The overlap implies that there are probably negative interactions due to ship traffic and noise, affecting the dolphins in these areas, but no regular study is currently being conducted to determine the potential effects of this interaction on Guiana dolphins populations (Trujillo, pers. comm.).

In the Gulf of Venezuela (VEML), Espinoza-Rodríguez *et al.* (2019) found that the area where most of the sightings of Guiana dolphins occurred were overlapped with the navigation channel used to transport multiple products, including oil tankers and other boats. Observations carried out for years in this area shown that the presence and abundance of Guiana dolphins on this area are likely related to dredging frequency and intensity. Further research in needed to improve our understanding on this potential threat in that area (Barrios-Garrido *et al.*, 2015).

Climate Change

Empirical and modelled studies indicate climate change will likely result in abundance and distribution shifts for marine mammals (Becker *et al.*, 2019; Derville *et al.*, 2019; Hamilton *et al.*, 2019; MacLeod, 2009). However, even though modelled predictions for Guiana dolphins do not exist yet, a study is ongoing in Brazil (Rodrigo Tardin, pers. comm.).

Research priorities and recommendations

Bycatch is a critical conservation problem faced by the Guiana dolphin, however other potential threats are also important and reported. Limited studies on habitat degradation, fisheries interactions and exposure to threats have been carried out along the entire distribution area. Several knowledge gaps must still be filled to appraise better their potential for short- and long-term synergistic and cumulative effects to the Guiana dolphin. Fitness, health and population viability should be addressed for monitoring anthropogenic impacts on Guiana dolphin population. The literature review stresses out some critical gaps and priorities on threats assessment and mitigation.

- Develop spatial planning and threats exposure analysis, integrating layers of Guiana dolphins occurrence and anthropogenic activities, such as: (a) fisheries; (b) sources pf chemical and noise contamination; (c) coastal and maritime development activities associated with potential threats (e.g. ports; oil/gas; mining); and (d) tourism.
- Assess the effect of cumulative and synergistic impacts of anthropogenic activities on Guiana dolphins, especially in critical areas from south and southeast Brazil, but also in Maracaibo Lake and other areas exposed to high-level of contaminates.
- Improve stranding networks and sampling programs in order to collect samples of Guiana dolphins as well as biopsies for integrated broad ecological studies.
- Develop habitat preference modelling (HPM) to quantify and qualify the relationship between species presence or abundance and environmental processes (including natural and anthropogenic factors). This model enhances the ability to predict distributions and must facilitate dynamic management strategies.
- Investigate the potential effects of anthropogenic noise (including dredging, vessels traffic, seismic and other port activities) on behaviour, habitat use, acoustic parameters and health condition of Guiana dolphins.
- Increase the geographic extent of ecotoxicological investigations, increasing the effort on determination of highly toxic emerging compounds (e.g. persistent organic pollutants, POPs).
- Conduct studies on trophic transfer of pollutants in ecosystems used by Guiana dolphins, especially in critical areas from south and southeast Brazil, but also in Maracaibo Lake and other areas exposed to high-level of contaminates.
- Strength studies with contaminant-specific biomarker assays of exposure and effects.
- Perform pollutant level monitoring of most threatened populations a through remote biopsy sampling of skin and blubber.
- Implement protocols and initiatives of health assessment for Guiana dolphins, including: (1) metal, organic and emerging composts (nanoparticles, hormones, pharmaceuticals); (2) exposure biomarkers; and (3) the presence of diseases through extensive pathological assessments (histological, bacteriological, fungal and/or virologic).
- Implement government policies and regulation (e.g. through environmental licenses) to straight monitoring and mitigation actions, regarding noise and acoustic pollution effects.
- Strengthen recommendations for mitigating impacts related to the establishment of new port areas along the coast.
- Evaluate the effects of ports and other coastal development infrastructure in the health and habitat quality of entire Guiana dolphins distribution.
- Develop measures to improve tourism management, especially attention for dolphin watching activities and in engaging the stakeholders (public and private sector, academia, etc.).
- Define areas of great relevance for the conservation of the species aiming the definition of new protected areas or other measures to reduce the impacts on important habitats for Guiana dolphins.
- Develop management plans for protected areas of relevance to Guiana dolphins along with monitoring of potential benefits generated by economic and ecosystem services might be provided by the species.
- Enforce regulations where protected areas already exist.
- Strengthen international scientific and political cooperation among the countries that comprise Guiana dolphin occurrence, encouraging conservation strategies, edu-communication and outreach campaign.
- Further, despite the recognition of the unequivocal responsibility of local governments, coordinate international efforts and multiple governance strategies towards the reduction of threats/stressors sources, particularly fisheries interactions, pollution and emergent diseases.

In terms of assessing and mitigating Guiana dolphins bycatch the most import recommendations, include specific actions considered a priority by the IWC Bycatch Mitigation Initiative Workplan 2018-2020 (e.g. Objectives 2, 3 and 4 in the work plan).

- Conduct a bycatch assessment (e.g. rapid assessment as suggested by FAO; Lee *et al.*, 2020), particularly for small-scale fisheries, estimating fishing effort, existing bycatch data, and also the challenges and opportunities for co-management initiatives to mitigate fishing interaction.
- Identify specific fisheries where achievable bycatch mitigation strategies could be tested and introduced.
- Build capacity and methods to design alternative approaches to achieve effective bycatch mitigation and monitoring solutions, if possible, in partnership with fishing communities.
- Perform experiments to evaluate the effectiveness of methods already known for reducing bycatch, such as pingers.
- Engage communities participating in pilot and affiliated projects to mitigate fishing mortality.
- Develop a 'toolbox' of socio-economic incentive-based approaches for small-scale fisheries.
- Strengthen the maintenance of the beach monitoring project as a strategy to assess species mortality, including assessing the effectiveness of mitigation methods.

Management and conservation issues

To achieve the objectives of species conservation, monitoring populations is a central activity, which is generally expensive and depends on baseline knowledge of the species or species involved (Danielsen *et al.*, 2019; Marsh and Trenham, 2008). In general, management and conservation actions are a way to minimise, mitigate and regulate human activities that directly or indirectly affect valued sites and/or valued species, with the goal of sustaining existence of specific species or of biodiversity in general. Examples of these actions are the establishment of regulations on boat traffic and fisheries, elaboration of action plans, creation of protected areas, evaluation of species on the red lists, among others.

In the world, there are many effective example of management strategies and conservation actions to mitigate adverse effects on cetacean populations, but the initial planning, development and final effectiveness of these actions depends on how much is known about what is expected to protect (Heywood, 2006). In the case of Guiana dolphin the scarce of biological and ecological data limits the establishment of management and conservation actions throughout its distribution. Furthermore, the methods applied by different research groups are not standardised and, thus, the results are often incomparable.

Currently, Guiana dolphin is classified as Near Threatened by IUCN (Secchi *et al.*, 2018) and is listed in Appendix II of the Convention on the Conservation of Migratory Species and in the Convention on International Trade in Endangered Species (CITES). The few data available on population abundance and trends, the impact of threats, identification of the critical areas for the conservation of the species influences the creation and execution of conservation actions along its distribution.

Nicaragua

The species has been evaluated and classified as 'Data Deficient' according to the national red list, following IUCN criteria.

Honduras

No data available.

Costa Rica

No data available.

Panamá

No data available.

Colombia

There is 'The Action Plan for South American river dolphins 2010-2020'. In 2006, the Red Book of Threatened Mammals of Colombia was published, where Guiana dolphin was included as 'Vulnerable' (Vu) (Trujillo *et al.*, 2006). A diagnosis of aquatic mammals in Colombia was published presenting all the knowledge about the species in each region of the country (Trujillo *et al.*, 2013). In addition, a work on the ecology of Guiana dolphins resulted in the creation of area with special management for the species in the gulf of Morrosquillo (Dussán-Duque, 2013). In 2014, the Management Plan for aquatic mammals in Colombia was published (Trujillo *et al.*, 2014) and endorsed by the Ministry of Environment. In addition to the strategic lines of research, management, education and communications, specific recommendations were made for the *ex situ* management issue, given that Colombia is one of the countries in which specimens of Guiana dolphin i have been held in aquariums for long periods. Likewise, in 2017 the Plan for the Conservation and Management of Aquatic Mammals (cetaceans, manatees and otters) of the department of Magdalena (Trujillo *et al.*, 2017) was published, where one of the species of greatest interest is Guiana dolphin.

Venezuela

In 2017, the Guiana dolphin was considered in the action plan elaborated with the purpose of systematising and orienting the management and conservation actions of aquatic mammals (Plan de acción para la conservación de los mamíferos acuáticos de Venezuela: delfines de agua dulce, nutrias y manatíes 2017-27). It is important to highlight that in 1992 the

'Cienagas de Juan Manuel, Aguas Blancas y Aguas Negras' National Park was created, which covers 150km^2 of water in the south of Lake Maracaibo. Although it was not created for the specific protection of this species, it is an important area of resting and feeding for Guiana dolphins. Currently, some progress has been made in Lake Maracaibo, in the southern region, population estimates, and threat identification were made, but it deserves more effort to meet the proposed goals. In addition, the species has been evaluated in the national red list of endangered species following IUCN criteria.

Guyana
The species has been classified as 'Endangered' according to the National Red List, following IUCN criteria.

Suriname
No data available.

French Guiana
The species has been evaluated and classified as 'Endangered' according to the National Red List following IUCN criteria.

Brazil
Accounting for the Conservation Units with a considerable marine portion, there are 92 protected areas along the Guiana dolphin distribution in the country. These Conservation Units are divided into eight different protection categories considering the Brazilian System of National Conservation Units. Also, there are areas within the categories Ia, II, III, IV and V established by the IUCN Protected Areas Categories System, however none of the category IV (Habitat/Species Management Area) have been decreed considering the species. Of those 92 areas throughout the distribution of the species in Brazil, 32 correspond to federal areas, while 50 and 11 correspond to state and municipal areas, respectively. Although it has many protected areas, only a total of 40 areas have management plans, and less than a quarter of them, mentioned the species in its plans.

The species is listed as Near Threatened in the IUCN Red List (Secchi *et al.*, 2018) and as Vulnerable in the Brazilian National Biodiversity Red list of Threatened Species, which also used the IUCN criterion (Directive MMA 444/2014). The species has, also, been considered in different federal government conservation tools such as: National Conservation Plan for Marine Cetaceans, National Action Plan for the Conservation of Threatened Species and of Socioeconomic Importance of the Mangrove Ecosystem (Directive ICMBio 500/2019), Impact Reduction Plan of oil and gas exploration, Impact Reduction Plan of mining and also the species has been taken into account in the ordinance which aims to establish the Marine Priority Areas for Brazilian Coast (Decree MMA 5092-2004, Directive MMA 9/2007).

In some Brazilian states, there has been created specific tools for the conservation of the species. In Santa Catarina State the species has been classified in the 'endangered - EN' category in the Official List of Endangered Species of Fauna (Resolution CONSEMA 02/2011). The Conservation Plan for Marine Tetrapods in Paraná was elaborated to ensure the maintenance of Guiana dolphin populations in the state and preserve their natural habitat. Also in Paraná state, the species has been cited in the Paraná Book of Fauna in Extinction. In São Paulo State, the species has been classified as 'Near Threatened' under the Endangered and Probably Endangered Species of Wild Fauna list of the state (Decree 63.8532/2018). In Rio de Janeiro state the species is not listed into the Threatened Fauna Species list (Decree 15.793/1997), however more recently the species has been mentioned as one of the top 10 priorities species for conservation in this state and a public awareness campaign has begun (Defending Endangered Species Embrace These Ten). In Sepetiba Bay, municipality of Mangaratiba, also in Rio de Janeiro state, the Law 940/2014 established the creation of the Área de Proteção Ambiental Marinha Boto cinza (APA Marinha Boto Cinza), however, this area is not part of the National System of Conservation Units mentioned above. The species is list as 'Vulnerable' in the Bahia State threatened species list.

Regulations, legislations, a list of conservation units and other important information are presented in Annexes F, G and H.

RECOMMENDATIONS

Recently, the IUCN category for the species changed to Near Threatened, which implies that the existing data are not sufficient to qualify to one of the threat categories (Secchi *et al.*, 2018). Despite of the few known of population parameters (i.e. abundance estimates, trends and mortality levels) in most of its distribution, this coastal species faces numerous threats along its habitat. The Guiana dolphin inhabits a diverse number of habitats, however, the knowledge about the species is not homogeneous throughout its distribution. Therefore, one of the research priorities should identify areas of higher concentrations in places where there is no information and use standardised methodologies to estimate population parameters and mortality rates in the main areas. Notwithstanding and although the species is globally considered as Neat Threatened, there are some countries along its distribution that considered it in another category (e.g. Brazil, Colombia, Venezuela=Vulnerable, Guyana=Endangered), bear out the importance of regional as well as globally assessments.

Although the existence of a large system of Marine Protected Areas along the species distribution (e.g. Brazil), it has been shown that these areas design are not necessarily protecting the most vulnerable populations (e.g. ESEC Tamoios in Brazil; Tardin, 2020). Thus, new studies should focus in the understanding of human activities and its interaction with the species, to allocate better Conservation Units along the range of the species. Moreover, and to support the previous, it should be highlight that although some regions show many conservation units (e.g. Rio de Janeiro state *n*=19), there are a lack of Conservation Units as well as management actions in areas with a high human pressure (Guanabara Bay) which certainly could take the population to extinction in a short time (Azevedo *et al.*, 2017).

5. EXPERT ELICITATION: PERCEPTIONS ON CURRENT KNOWLEDGE AND RESEARCH PRIORITIES TO ASSESS AND IMPROVE THE CONSERVATION STATUS OF GUIANA DOLPHINS

To assess the current knowledge and perceived research priorities to assess and improve the conservation status of the Guiana dolphins, an expert elicitation was conducted in 2019, through an online questionnaire (Google Forms; see Annex I). Experts were identified through a web-based survey of the literature (including grey literature) and consisted of both senior and early-career scientists with knowledge on Guiana dolphins and its habitat conservation. These experts were contacted by email and were provided with information on the aims and objectives of the assessment. The survey was conducted online using the Google Form platform, in Portuguese and Spanish. The survey was available for five weeks, and the selected experts received up to two reminders by e-mail. A correspondence e-mail address was provided to be used to solve any doubts.

Experts filled an online survey of 19 questions (open and multiple-choice questions), consisting of five parts: (1) characterising the experts in terms of the study area, institution, experience time and themes; (2) perceived conservation status of Guiana dolphins and their habitat; and research priorities to improve the conservation status assessment; (3) perceived threats to the Guiana dolphin populations and research priorities to reduce these threats; (4) the current knowledge gaps on Guiana dolphin populations; (5) priorities for management actions to address the conservation of the species.

The 35 experts that contributed to the survey have been working with Guiana dolphins in seven different countries which included Nicaragua (3%), Panama (3%), Costa Rica (5%), Venezuela (10%), Colombia (8%), French Guinea (3%), and Brazil [southern (28%), south-eastern (33%) and north-eastern (10%) Brazil]; the respondents could choose more than one location. Most respondents represent Universities (73%), some of them are working for NGOs (15%) or in Scientific institutions (6%), and a few work as independent consultants. About 47% have more than 12 years' experience studying dolphin ecology and conservation issues (21% of them >20 years), and only 6% are early-career scientists (≤3yrs). Concerning scientific topics, a total of 39% of the respondents have experience with population parameters (e.g. demography), 29% with impact assessment, 14% with biological parameters, 11% with conservation policies, and only 7% with population structure analysis. The respondents have a wide background experience with impact assessment on Guiana dolphins, highlighted by the similar percentage of experience in assessing impacts from bycatch (19%), noise pollution (18%), coastal infrastructure development (16%), chemical pollution (14%), marine/vessel traffic (14%), and also 'multiple-impacts' (19%); the respondents could indicate more than one impact.

Based on the experience and perception of the respondents, the most threatened Guiana dolphins populations are the ones from Guanabara Bay (*n*=13) and Sepetiba Bay (*n*=7), both in the state of Rio de Janeiro in Brazil, followed by the population in the Paranaguá Estuarine Complex (*n*=5) in the state of Paraná in Brazil and in the Maracaibo Lake in Venezuela (*n*=4). However, another 18 areas were cited, covering almost the entire Guiana dolphin distribution. In general, the respondents suggest that all populations occurring in areas with ports and industrial activities are the most impacted ones, thus being conservation priorities areas due to the risk for the populations.

To obtain insights on which research lines and topics should be prioritised now, and during the next five years, the respondents were asked open-ended questions on current knowledge gaps, the conservation status of the species and how status assessment can be improved, current threats and how the risks for the species can be mitigated. Word clouds of the responses of each open-ended question (see Fig.7) reveal the most common topics that emerged within the answers of the respondents.

Considering the question 'What are research priorities to evaluate the conservation status of the species?' the majority of the respondents (88%, see Fig.8) indicated that research on population dynamics should be prioritised both now and during the coming 5 years. These studies include: (i) abundance and population size estimates; (ii) population structure over time with long term monitoring and estimates of both population and biological parameters, such as reproduction, growth and mortality rates (e.g. supporting Population Viability Analysis); (iii) genetic flow and connectivity among the populations; and (iv) population ecology and demographic analyses, considering intrapopulation variations such as residence patterns, behaviour, habitat use, social structure and organisation.

More than half of the respondents pointed out that both now and during the coming five years, the assessment of anthropogenic impacts to Guiana dolphins is crucial to evaluate its' conservation status (see Fig.8). The anthropogenic activities that raised most concerns in the light of the conservation status are fisheries, port activities and tourism, which generate bycatch, pollution, vessel traffic, acoustic pollution and habitat degradation. The cumulative and synergic impacts, including climate change, should be spatially evaluated along the entire distribution of Guiana dolphin.

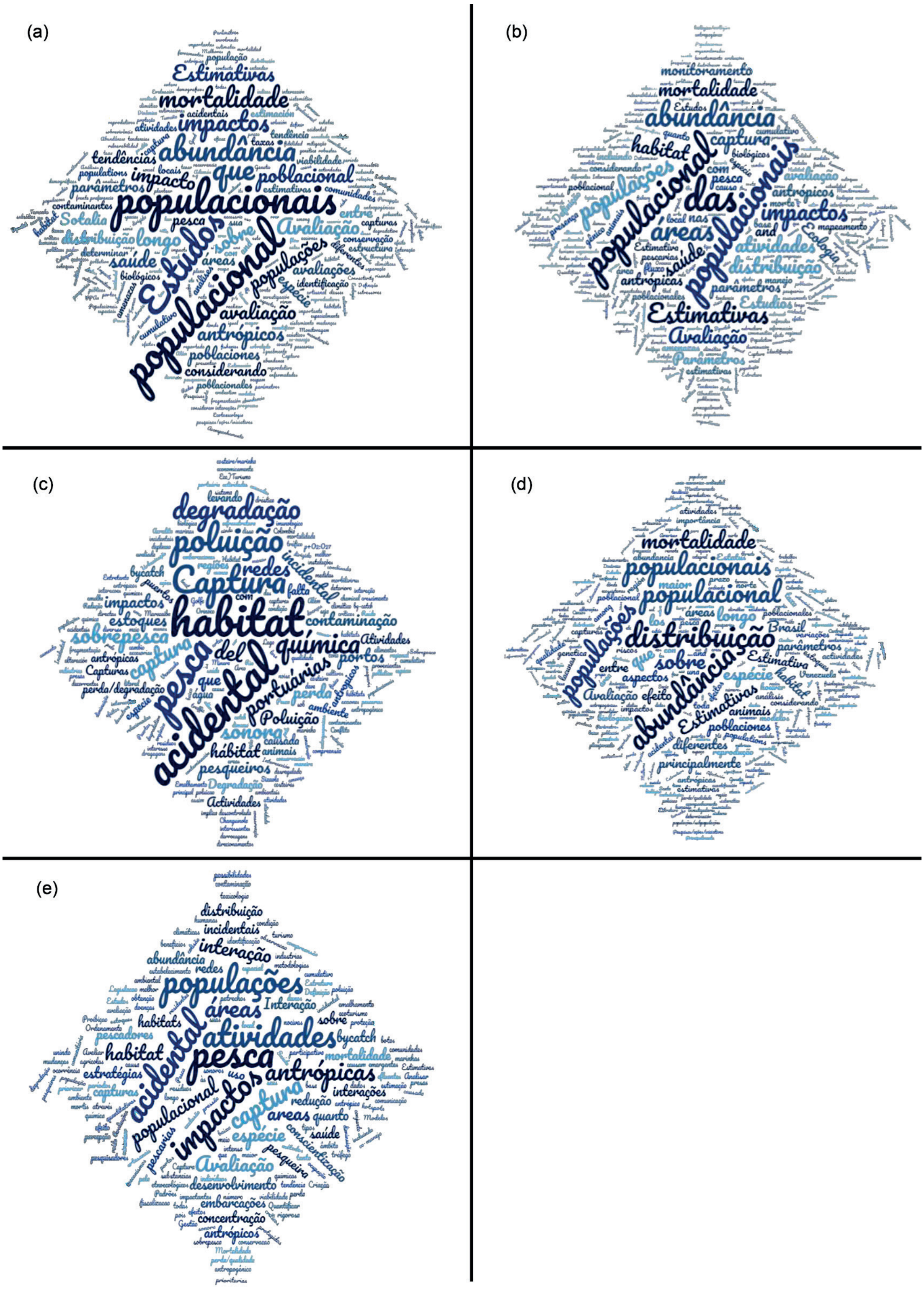

Fig. 7. Word clouds of the answers of the open questions:
(a) What are research priorities to evaluate the conservation status of the species?
(b) Which research lines should be prioritised over the next 5 years, to evaluate the conservation status of the species?
(c) What are the main threats to the conservation of *S. guianensis*?
(d) What are the main knowledge gaps about this species, considering the priorities to evaluate extinction risk?
(e) Which research lines should be prioritised over the next 5 years, to reduce the threats to this species?]

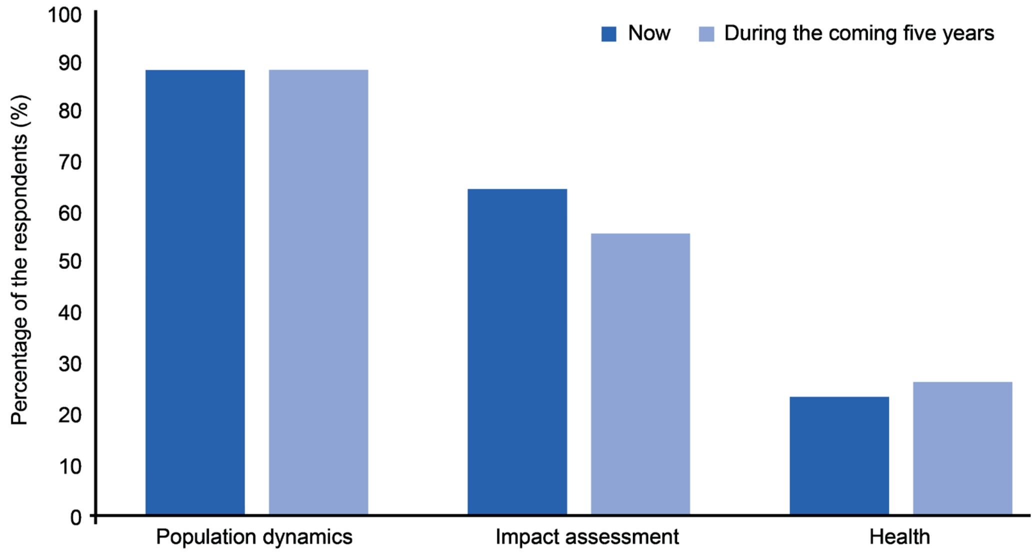

Fig. 8. The respondents were asked the open-ended question 'What are research priorities to evaluate the conservation status of the *S. guianensis*?' twice, once investigating research priorities right now, and once investigating research priorities to evaluate the conservation status during the next five years. The answers were categorised in three categories: those which mentioned research on: (i) population dynamics; (ii) impact assessment; and (iii) health.

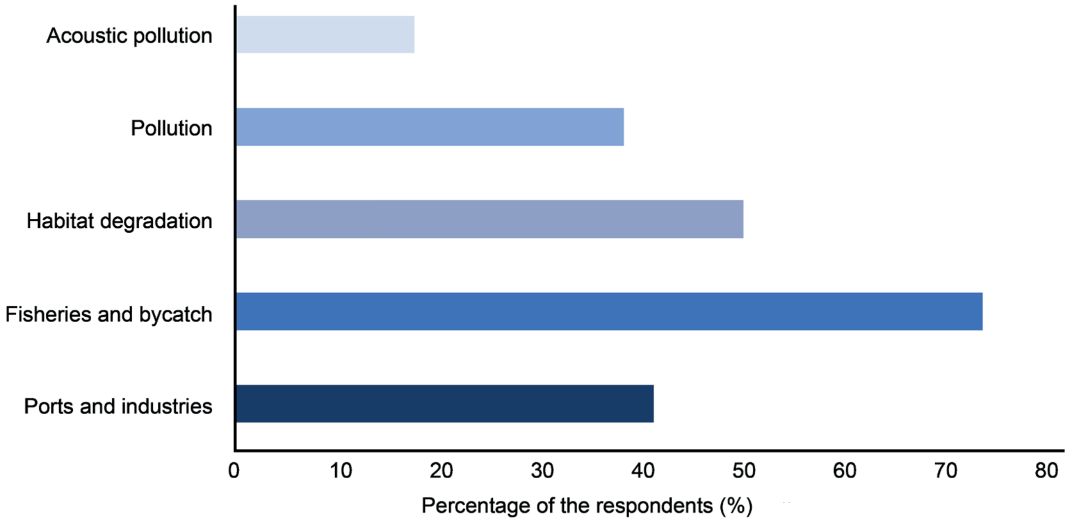

Fig. 9. The respondents were asked the open-ended question 'What are the current main threats to the conservation of *S. guianensis*?' The answers were categorised in five not mutually exclusive categories: 'ports and industries', 'fisheries and bycatch', 'habitat degradation', 'pollution and contamination' and 'acoustic pollution'.

A quarter of the respondents mentioned the importance of health assessment of population and individuals, as a priority to evaluate the conservation status of the species (for now and the next 5 years) (see Fig.8). This includes ecotoxicology and contaminants (such as trace elements and organic persistence) analysis, but also the evaluation of causes of mortalities, particularly considering the significant mortality event in Rio de Janeiro in 2018, caused by morbillivirus (Groch *et al.*, 2018). Other research priorities that were mentioned to improve the evaluation of the conservation status of the species are outreach and stakeholder involvement (with the fisheries, port and tourism sector) and initiatives related to public policies and co-management.

When asked 'What are the current main threats to the conservation of *S. guianensis*?', most of the respondents (73.5%; see Fig.9) indicate fisheries interactions and consequently bycatch as the main threat to Guiana dolphins. Secondly, habitat degradation and loss are mentioned by half of the respondents, which might be caused by pollution/contamination (mentioned by 38% of the respondents in Fig.9). Pollution (chemical and acoustic) might be caused by the presence of ports, industries or other coastal infrastructure, which was mentioned by 41% of the respondents as important threats (Fig.9).

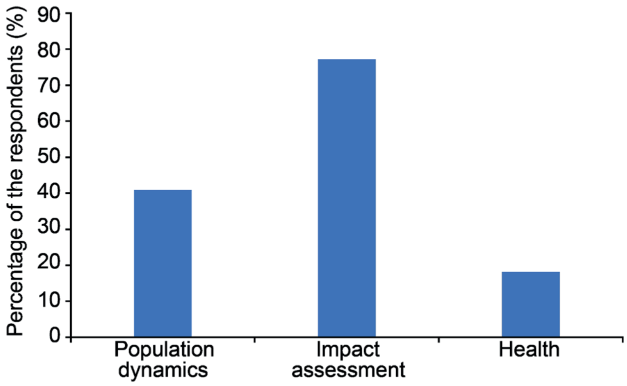

Fig. 10. The respondents were asked the open-ended question 'Which research lines should be prioritised over the next 5 years, to reduce the threats to this species?' The answers were categorised in nine not mutually exclusive categories: 'stakeholder involvement and management', 'health', 'impact assessment, 'population dynamics', 'ports and industries', 'fisheries and bycatch', 'habitat degradation', 'pollution and contamination' and 'acoustic pollution'.

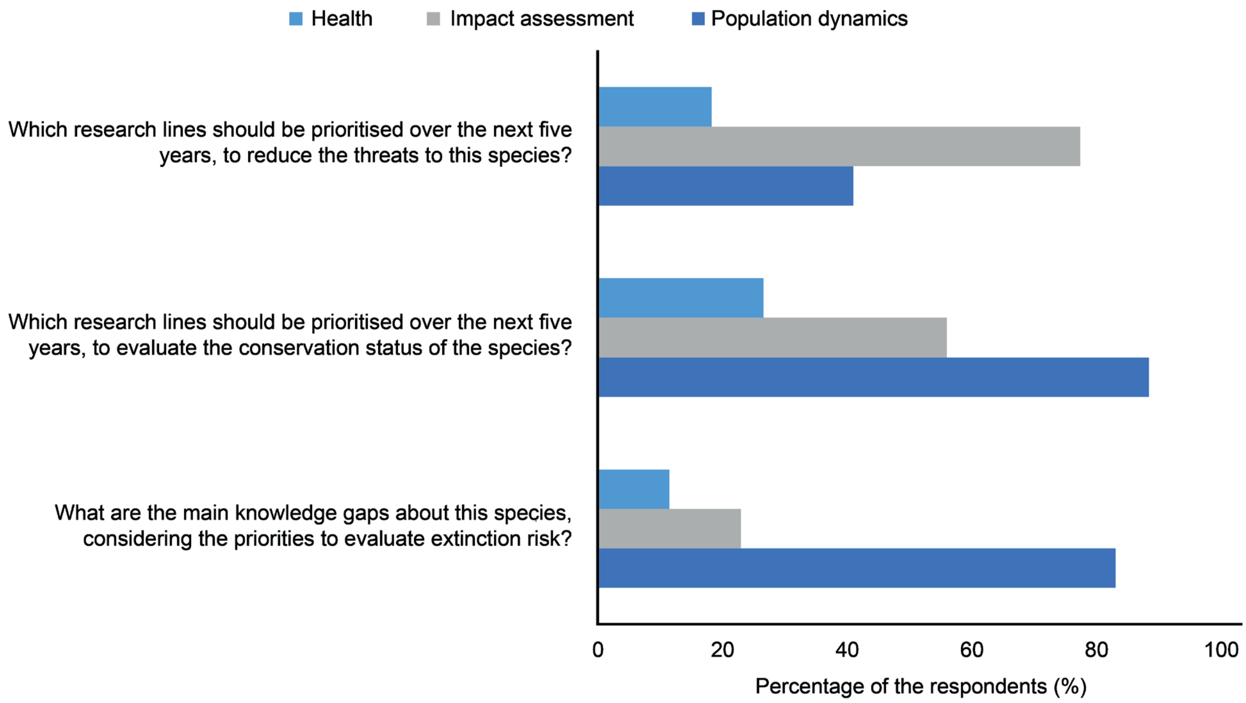

Fig. 11. The responses to the following three open-ended questions 'What are the main knowledge gaps about this species, considering the priorities to evaluate extinction risk?', 'Which research lines should be prioritised over the next 5 years, to reduce the threats to this species?', 'Which research lines should be prioritised over the next 5 years, to evaluate the conservation status of the species?' were categorised in 9 not mutually exclusive categories: 'stakeholder involvement and management', 'health', 'impact assessment', 'population dynamics', 'ports and industries', 'fisheries and bycatch', 'habitat degradation', 'pollution and contamination' and 'acoustic pollution'.

The respondents were also queried about 'Which research lines should be prioritised over the next 5 years, to reduce the threats to this species?'. Most of the respondents (77%; see Fig.10) mentioned impact assessment as a priority, especially considering fisheries and bycatch (63.6%), for example, mortality rate estimates and research on strategies to reduce bycatch considering different types of fishing gear. A significant part (40.9%) of the respondents pointed out that accurate population dynamic studies are crucial to reduce the threats to Guiana dolphins along the species distribution. Over a quarter (31.8%) of the respondents highlighted the importance to work on stakeholder involvement in research and management, especially co-management with artisanal fisheries communities and ports and industries. Lastly, the development of management and mitigation actions and policies, such as protection of critical habitats, also emerged as a priority to reduce the threats to Guiana dolphins during the coming 5 years.

The respondents were also asked 'What are the main knowledge gaps about this species, considering the priorities to evaluate extinction risk?'. There was a very high level of consensus among the respondents (82.9%; Fig.11) that there exists a significant lack of knowledge on population dynamics, especially population parameters such as growth, mortality and reproductive rates, but also distribution, abundance and connectivity. Moreover, other knowledge gaps that were pointed out are the cumulative and synergistic impacts caused by fisheries, ports, industries and tourism; and in what different ways degraded habitats might affect the populations of Guiana dolphins. The knowledge gap on the population in Maracaibo lake in Venezuela, and the connectivity among populations of Venezuela, Colombia and Central American countries were also mentioned as important topics to be addressed during the next years.

Throughout all five of the open-questions, respondents reinforced the importance of outreach and stakeholder involvement, and initiatives related to public policies and co-management. The results highlight that the experts consider management actions and conservation policies as a crucial part of the efforts to support species conservation. A total of 47% of the respondents have been involved in some level (regional, national, international) in action plans for Guiana dolphin conservation; however, is important to highlight that another 47% of the respondents have never been involved in conservation policies or in developing tools or plans focusing on the conservation of Guiana dolphins.

The integrated analysis of this online questionnaire provided insights in the conservation status of Guiana dolphins, stressing that future research on both short and long term should be focused on population dynamics and impact assessment. These efforts will not only improve the accuracy of the conservation status, but they will also provide crucial baseline information to reduce the impacts caused by anthropogenic activities, particularly in fisheries, ports and industries. It is also essential to reach out and involve stakeholders, such as artisanal fishermen and port management, in research, management and public policies, in order to improve the conservation context of Guiana dolphins.

6. CONCLUSION

Almost all marine mammal species have been reported to face at least one threat and many populations have experienced significant declines due to cumulative impacts of anthropogenic activities. Bycatch in artisanal gillnets is one of the most important concerns for the conservation of most Guiana dolphins populations (Di Beneditto, 2003; Monteiro-Neto *et al.*, 2000; Cremer *et al.*, 2018). However, there is critical information on the harmful effects of noise pollution, high levels of contaminant loads and emerging diseases (MeCV, herpesvirus, skin diseases of unknown aetiology) affecting diverse populations throughout its range (Barrios-Garrido *et al.*, 2016; Bittencourt *et al.*, 2014; 2017; Cremer *et al.*, 2009; Dorneles *et al.*, 2010; Espinoza-Rodríguez *et al.*, 2019; Filla and Monteiro-Filho, 2009; Groch *et al.*, 2018; Kunito *et al.*, 2004; Lailson-Brito *et al.*, 2010; 2012). Conversely, there is a striking lack of data on population and biological parameters for most areas of the species' distribution range.

Combined effects of the dense human-population on coastal areas, fisheries, ports, agriculture and industrial activities, and emergent diseases are rapidly driving Guiana dolphins to many uncertainties regarding its future (Azevedo *et al.*, 2017; Cremer *et al.*, 2018). Also, some of the new threats for this species are of great concern, particularly disease by exposure to viruses and other etiological pathogens, and the uses of their meat for human consumption in Maracaibo Lake or also used as fish bait in northern Brazil (Cunha *et al.*, In prep; Flores and Da Silva, 2009; Briceño, pers. comm.).

Guiana dolphins are considered 'Vulnerable' in Brazil, Colombia and Venezuela, and there is an urgent need for conservation action for this species. Management units (MU) of *Guiana* dolphins that occur in areas with high human population densities are exposed to multiple and cumulative impacts that affect their conservation and resilience. In this context, the management units BRSE1, BRSE2, BRS/SE in Brazil, and the ones placed on Maracaibo lake MU (Venezuela), and stand out, in particular the resident populations of Guanabara and Sepetiba Bays (both in Rio de Janeiro State), Paranaguá and Babitonga (Paraná and Santa Catarina State). Guanabara Bay (RJ) is a region with a high degree of environmental degradation, where Guiana dolphin population has shown a continuous decline over the years (Azevedo *et al.*, 2017).

7. GENERAL INFORMATION

The Workshop steering group was composed by Camila Domit (CEM/UFPR, Brazil), Fábia Luna (ICMBIO/CMA, Brazil), Adriana Miranda (ICMBIO/CMA, Brazil) , Juan Pablo Torres-Flores (ICMBIO/CMA, Brazil), Susana Caballero (Universidad de los Andes, Colombia), and also Alexandre Zerbini (NOAA, USA) and Lindsay Porter (IWC, small cetacean sub-committee).

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Threats
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Annex A

List of Participants

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Annex B

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Annex C

Agenda

Day 1 (25 November 2019)
Afternoon (14:00-18:30)
Welcome and participants presentation (14:00)
Proposed agenda (14:30)
IWC and Scientific Committee Guiana dolphin pre-assessment – Workshop objectives and future steps (15:00)

Coffee break (15:30)
Management and Conservation – Main results, data gaps and topic discussion (16:30)

Day 2 (26 November 2019)
Morning (08:30-12:30)
Population structure - Main results, data gaps and topic discussion (08:30)

Coffee break (10:30)
Proposal of population units (11:00)

Afternoon (14:00-18:30)
Abundance and trends - Main results, data gaps and topic discussion (14:00)

Coffee break (16:00)
Biological parameters - Main results, data gaps and topic discussion (16:30)

Day 3 (27 November 2019)
Morning (08:30-12:30)
Threats - Main results, data gaps and topic discussion (08:30)

Coffee break (10:30)
Threats - Main results, data gaps and topic discussion (11:00)

Afternoon (14:00-17:00)
Discussion about further issues (14:00)
Google forms: the researchers' perspectives (16:00)

Coffee break and meeting closing (16:30)

Day 4 (28 November 2019)
Morning and afternoon
Report compilation (08:30-12:00; 14:00-16:00)

Annex D

Scientific Paper Submitted to the IWC Scientific Committee (SC68B), Concerning the Review of Genetic Analysis and the Population Structure Proposal for Guiana Dolphin

SC/68B/SDDNA/06rev1. Cunha, H.A., Farro, A.P.C. and Caballero, S. Review of population structure studies for *Sotalia guianensis* and a proposal for Management Units. 9pp.
Document can be found at: *https://archive.iwc.int/?r=17367&k=3f8a29cf34.*

Annex E

Table Presenting the Anthropogenic Activities Potentially Impacting Guiana Dolphins Identified for Each Management Unit During the Workshop

Threat	BRS/SE	BRSE2	BRSE1	BRNE4	BRNE3	BRNE2	BRNE1	BRNO	FRGU	VEOR	VEML	CCOL
Port activities	1	1	1	1	1	1	0	1	1	1	1	1
Industrial activities	1	1	1	1	1	0	0	0	NA	1	1	0
Oil and gas exploration/ exploitation	1	1	1	0	1	1	1	1	NA	1	1	1
Mining	1 (Dragagem de areia para exploração)	0	0	0	NA	0	0	1	NA	1	1	1
Agriculture	1	1	1	0	0	0	0	0	NA	0	1	1
Aquaculture	1	0	0	0	0	1	1	NA	NA	0	1	0
Trawling	1	1	1	1	1	1	1	NA	NA	0	0	1
Gillnets	1	1	1	1	1	1	1	1	NA	1	1	1
Longlines	0	0	0	0	0	0	0	0	NA	0	0	0
Direct captures	0	0	0	1	0	1	0	1 (fish bait)	NA	1	1	0
Tourism	1	0	0	0	0	1	0	0	NA	0	1	0
Water sports	1	1	1	1	NA	1	1	NA	NA	0	0	0
Purse seines	1	1	NA	0	0	0	0	0	NA	0	0	0
Oil spills	1	1	1	1	1	1	1	1	NA	1	1	NA
Multi-activities	10	8	7	6	5	8	5	4	1	6	7	5
Recognised habitat loss	1	1	1	1	1	1	1	NA	NA	1	1	1

Annex F

Management and Conservation Actions by Country

Country	Specific management or conservation action (protected area, action plan, status evaluation, among others)	Law	Regional status (Red List)
Nicaragua	1	Yes	Deficient data
Honduras	0	Yes	Not evaluated
Costa Rica	0	Yes	Not evaluated
Panama	0	Yes	Not evaluated
Colombia	5	Yes	Vulnerable
Venezuela	3	Yes	Vulnerable
Guyana	1	Yes	Endangered
Suriname	1	Yes	Not evaluated
French Guiana	1	Yes	Endangered
Brazil	27	Yes	Vulnerable

Annex G

Existing Laws by Country Granting Some Protection to Guiana Dolphin Populations

Honduras
Gazzette No. 34,000 Decree No 115-2015. 2016. Animal Protection and Welfare Law.

Nicaragua
Presidential Decree (1991) - Create Cayos Miskito Reserve.

Costa Rica
Regulamento para la Operación de Actividades Relacionadas con Cetáceos en Costa Rica Nº 32495 its breach is punishable by Ley Orgánica del Ambiente Nº 7554, la Ley de Conservación de Vida Silvestre Nº 7317 y La Ley de Pesca y Acuacultura Nº 8436.

Panama
Gazette No. 28389-B Resolution 0530-2017. Whale watching in the jurisdictional waters of the Republic of Panama.

Colombia
Law (2005) from the Ministry of Environment and Territorial Development of Colombia.

Venezuela
Presidential Decree No. 1485 (1996). Species protected from hunting.

Presidential Decree No. 1486 (1996). On endangered species.

Ley de Protección de la Fauna Silvestre y su Reglamento No. 29.289/No. 4.925.

Guyana
Environmental Protection Agency (EPA) Act, 1996 [general protection of wildlife].

Suriname
Nature Protection Act 1954 and the Game Act 1954.

French Guiana
Law Arrêté du 1er juillet 2011 fixant la liste des mammifères marins protégés sur le territoire national et les modalités de leur protection.

Brazil
Nº 5197 (03 Jan. 1967). Protection of Fauna. Modifications: Nº 7653 (17 Feb. 1988) and Nº 9111 (10 Oct. 1995).

Nº 6938 (31 Aug. 1981). National Environmental Policy, its objectives and implementation mechanisms.

Nº 7643 (18 Dec. 1987). Prohibition of hunting or any form of intentional harassment of cetaceans in national jurisdiction waters.

Nº 9605 (12 Feb. 1998). Penal and administrative sanctions from detrimental behavior and activities to the environment (a.k.a. Environmental Crimes Law).

Nº 9985 (18 Jul. 2000) – National System of Protected Areas Federal Decrees.

Nº 88218 (06 Apr. 1983). Create the Abrolhos National Marine Park.

Nº 528 (20 May 1992). Create and define the limits of the Anhatomirim Environmental Protection Area, specially created to protect the local population of Sotalia fluviatilis.

Nº 3179 (21 Oct. 1999). Regulations pertaining to the Environmental Crimes Law. Regulations.

IBAMA (Instituto Brasileiro de Meio Ambiente e Recursos Naturais Renováveis). Nº 117 (26 Dec. 1996). Regulations to prevent harassment in national jurisdictional waters.

IBAMA Nº 05-N (20 Jan. 1998. Establish regulations to safeguard the reproduction, resting, and calving of *Sotalia fluviatilis* in the Anhatomirim Environmental Protection Area, Santa Catarina.

IBAMA Nº 98 (14 Apr. 2000). Regulations for the maintenance and management of aquatic mammals in captivity with the objectives of rehabilitation, research, education and public display.

Licenciamento Ambiental de atividades potencialmente poluidoras.

Lei de molestamento de cetáceos de 1987.

Annex H

Table Compiling Information on Management and Conservation Actions for Guiana Dolphins by Country

Protected area (national park, reserve, refuge)	Action Plan	National Red List*	Other
Brazil			
Área de Protección Ambiental de Anhatomirim (APAA), Baia Norte de la Isla de Santa Catarina	Action Plan for Aquatic Mammals of Brazil (IBAMA 1997, 2001, 2011, 2019)	Yes	Lista Oficial de Espécies da Fauna Ameaçada de Extinção do Estado de Santa Catarina, 2011
Plano de manejo da UC e seu zoneamento incluindo zona de proteção do golfinho *Sotalia guianensis*, Florianopolis on the coast of Santa Catarina	Plano de Conservação para Tetrápodes Marinhos no Paraná		Livro da Fauna do Paraná em Extinção, 2007
Decree nº 6698 17, December de 2008. Sanctuary	Plano de manejo da UC e seu zoneamento incluindo zona de proteção do golfinho Sotalia guianensis, Florianopolis on the coast of Santa Catarina		
Zoning with regulation of use in the Cananéia estuarine-lagoon complex			
Santuário as águas jurisdicionais marinhas brasileiras de baleias e golfinhos, Decreto nº 6698 17 de Dezembro de 2008			
APA Baía de Todos os Santos, 1999, Bahia State/Northeast Brazil			
Parque Nacional Marinho de Abrolhos, Abrolhos Bank. 1986			
APA Ponta da Baleia, Bahia State. 1993			
Reserva Faunística Costeira de Tibau do Sul, Rio Grande do Norte State/ Northeast Brazil. 2006			
Área de Proteção Ambiental (APA) Dunas do Rosado, Rio Grande do Norte State/Northeast Brazil. 2018			
Apa Marinha Boto-Cinza, Baia de Sepetiba/Mangaratiba (RJ).2015			
ESEC Tamoios, Baía de Ilha Grande/Paraty e Angra dos Reis (RJ). 1990			
Parque Estadual da Ilha Grande, Insular Baía de Ilha Grande (RJ). 1971			
APA Cairuçu, Baía de Ilha Grande e Paraty (RJ).			
APA de Setiba, Guarapari, Vila Velha (ES). 1994			
Parque Estadual Ilha do Cardoso, Cananéia (SP). 1962			
Parque Estadual Xixová-Japuí, São Vicente, Praia Grande/Litoral Central (SP). 1993			
Parque Estadual Marinho da Laje de Santos, Santos (SP). 1993			
Apa Marinha do Litoral Centro, Bertioga, Guarujá, Santos, São Vicente, Praia Grande, Mongaguá, Itanhaém, Peruíbe (SP). 2008			
Apa Marinha Litoral Norte. 2008			
APA Marinha Litoral Sul, Cananéia (SP). 2008			
Nicaragua			
No	No	Yes	-
Honduras			
No	No	No	-
Costa Rica			
No	No	No	-
Panama			
No	No	No	-

Protected area (national park, reserve, refuge)	Action Plan	National Red List*	Other
Colombia			
Protected area: Gulf of Morrosquillo	The action plan for South American river dolphins 2010-20; Management Plan for aquatic mammals in Colombia; Plan for the conservation and management of aquatic mammals (cetaceans, manatees and otters) of the department of Magdalena	Yes	-
Venezuela			
National Park: Ciénagas de Juan Manuel, Aguas Blancas y Aguas Negras, south of Lake Maracaibo	Plan de acción para la conservación de los mamíferos acuáticos de Venezuela: delfines de agua dulce, nutrias y manatíes 2017-27	Yes	-
Guyana			
No	No	Yes	-
Suriname			
No	No	No	Previously the Marine Mammals Conservation Corridor for Northern South America proposal; since 2015 no more activities undertaken
French Guiana			
No	No	Yes	

*following the IUCN criteria.

Annex I

Google Forms Questionnaire

Guiana dolphin pre-assessment - IWC.SC

Levantamento de trabalhos, dados e demais informações sobre o status de conhecimento sobre_Sotalia guianensis_

*Obrigatório

Endereço de e-mail *

Seu e-mail

Qual é a sua área de atuação? *

Report of the Workshop on Advancing Efforts to Address Underwater Noise from Shipping

Virtual Meeting, 11 May 2020

Report of the Workshop on Advancing Efforts to Address Underwater Noise From Shipping[1]

This workshop was held as a pre-meeting to SC68B on Monday 11 May 2020, 14:00-17:00 by remote video link. The list of participants is given in Annex A.

1. CONVENOR'S OPENING REMARKS AND TERMS OF REFERENCE

Cholewiak and Leaper convened the meeting. Cholewiak opened the remote meeting noting that it was only three hours because of the need to accommodate different times zones. This meant that the original agenda and scope for the planned full day face-to-face meeting had been considerably reduced. The Workshop therefore focussed on low-frequency noise from large ships, assessment frameworks for ambient sound, and collaboration with other organisations to address shipping noise.

2. APPOINTMENT OF RAPPORTEURS

Calderan and Genov volunteered to act as rapporteurs.

3. ADOPTION OF AGENDA

The adopted agenda is Annex B.

4. AVAILABLE DOCUMENTS

The documents available to the Workshop were Merchant *et al.* (2018); Erbe *et al.* (2019); IMO (2014); IWC (2016a; 2016b); IWC (2018a; 2018b); TGNoise (2019); van Oostveen *et al.* (In prep., published 2020); and Weilgart (2018).

5. BACKGROUND INFORMATION

5.1 IWC work on underwater noise

The IWC Scientific Committee has been discussing the impacts of noise on cetaceans since at least 2004, including seismic surveys in 2005, noise from shipping in 2008, measurements of ambient noise and sound mapping in 2014 and a workshop on masking in 2016 (IWC, 2016b). Following the workshop in 2016, the Committee consolidated a number of its recommendations related to underwater noise and these were listed in the contribution of the IWC to the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea in 2018. The Commission also passed a Resolution, 2018-4 (IWC, 2018b) on anthropogenic underwater noise in 2018 which gave a number of instructions to the Scientific and Conservation Committees.

Many of the concerns about noise from shipping arose because of the impacts on baleen whales which are low-frequency specialists. More recently there have been a number of studies showing impacts of higher frequency noise from small vessels such as recreational craft (Erbe *et al.*, 2019). The IWC interest is on direct impacts on cetaceans but also on other ecosystem effects, particularly those that affect prey species (Weilgart, 2018) and by extension, cetaceans. The IWC Resolution 2018-4 noted that cetacean research and conservation management efforts should include the protection of the acoustic habitat and the impacts of anthropogenic underwater noise on lower trophic levels, including fish and invertebrates.

The IWC has observer status at the IMO and members of the Secretariat and Scientific Committee usually attend meetings of the Marine Environment Protection Committee. The IWC participated in the IMO correspondence group developing the 2014 guidelines (IMO, 2014) and provided a short summary update paper to the MEPC in 2018 (IWC, 2018a).

In 2008, the Committee endorsed a noise reduction target arising from the Okeanos Foundation workshop representing a broad set of interests that established a goal for 'initial global action that will reduce the contributions of shipping to ambient noise energy in the 10-300Hz band by 3dB in 10 years and by 10dB in 30 years relative to current levels' (Wright, 2008). The 2008 workshop had also noted that this goal would be accomplished by reducing noise contributions from individual ships. There has been considerable work done on the issue since 2008, including the setting of objectives for underwater noise for all EU member states under the Marine Strategy Framework Directive. One objective of the current workshop is to evaluate and review this target in the context of the considerable body of more recent work.

[1]Presented to the Scientific Committee as SC/68B/REP/06.

5.2 Work of the IWC Conservation Committee on underwater noise

Iñíguez summarised the work of the Conservation Committee on anthropogenic noise. This is one of the primary threats considered in the Conservation Committee Strategic Plan for 2016-26 (Chair of the Conservation Committee, 2016a) with actions identified in the work plan (Chair of the Conservation Committee, 2016b). The aims include: (i) to consider and act upon, as appropriate, the advice and recommendations from the Scientific Committee on the impacts of anthropogenic noise on cetaceans; and (ii) establish linkages between the IWC and other relevant bodies to ensure the dissemination of the IWC advice on anthropogenic noise. Actions include to further identify and engage with appropriate regional and international bodies addressing anthropogenic noise and progress any opportunities for capacity building, in particular with regards to the IMO.

Iñíguez noted that a workshop to develop the Conservation Committee costed programme to address underwater noise, which had been planned for early 2020, was postponed due to the Covid-19 pandemic.

5. AMBIENT SOUND, NOISE BUDGETS AND INDICATORS

Širović described recent studies on deep-water ocean ambient sound across the northern hemisphere. Based on the recordings of ocean ambient sound collected during the mid-2010s across the North Pacific, the western Atlantic, and the Gulf of Mexico, it is clear that there is a substantial level of variation in deep ocean ambient sound. The Gulf of Mexico generally had the highest levels of ambient sound at frequencies below 100Hz, resulting from heavy industrialization of this ocean basin. In other regions, the levels were related to the exposure of monitoring locations to shipping lanes, resulting in a variation of up to 15dB at 40Hz. Sound levels at low frequencies were also locally and seasonally affected by baleen whale songs. While sound levels were generally lower in the 2010s than during the late 2000s in the North Pacific, there is no readily available explanation for these observed lower sound levels.

Discussion following Širović's presentation examined why ambient sound levels had continued to decrease even as economic activity and trade recovered post-2008. This was considered likely to be a combination of slower speeds and improvements in vessel design. Investigating historical AIS data for both vessel speeds and routes in relation to the acoustic moorings was recommended as a means of looking into this further. It was suggested that for long term changes in ambient sound, it might be helpful to examine different frequency bands beyond the 50Hz band plotted by Širović, as ship engine noise characteristics have changed since the 1960s. Looking at a greater bandwidth would also take account of the effects of changes in ambient noise on a wider range of cetacean species. However, Širović noted that there was limited scope for looking at different frequency bands in historical data sets. It was also noted that noise measurements in the Bering Strait Region of the Arctic showed similar trends over time to those in the North Pacific even though the levels of anthropogenic noise were relatively low (Southall *et al.*, 2020).

Merchant described the OSPAR (Convention for the Protection of the Marine Environment of the North-East Atlantic) indicator framework for the exposure of marine fauna to impulsive and continuous noise. The impulsive noise indicator is further advanced than that for continuous noise and is based on a noise registry that has been developed with a consistent specification for the OSPAR, HELCOM and Mediterranean regions (TGNoise, 2019). Noise monitoring in the OSPAR region is being conducted through two joint monitoring programmes, JOMOPANS in the North Sea and JONAS in the large scale, open ocean habitat of the North Atlantic. The generic framework includes a spatial analysis of the noise pressure coupled with data on sensitive species or habitats to generate an exposure assessment. For a particular population, the Exposure Index (EI) expresses the overall exposure of the population based on integrating the area under the exposure curve. The exposure curve represents the percentage of the population exposed for a percentage of the time. Results were presented for impulsive noise and harbour porpoise in the North Sea. The OSPAR Intersessional Correspondence Group on Underwater Noise intends to adapt the impulsive noise risk indicator for continuous noise pollution (largely generated by shipping). An example was given for the modelled proportion of time that broadband ship noise excess level exceeded 20dB during July 2017 for an area around the British Isles.

It was discussed whether variation in sound speed profiles both temporally and spatially was significant enough over the large scales of the project area to warrant further investigation and inclusion in the modelling. Using more than one indicator species was also discussed, to enable investigation of ambient sound effects on different hearing groups, and this was compared to work being carried out by Transport Canada and others on the west coast of Canada. The difference between the impacts of static and moving sound sources was discussed with reference to noise modelling and management measures.

Kinneging noted that the Proposal assessment framework for the OSPAR candidate indicator ambient underwater sound (see van Oostveen *et al.*, 2020) was still in draft form and comments were welcomed. It is expected to be finalised during the next few months for potential approval by OSPAR in late 2020.

Folegot presented a study quantifying the potential for masking of mating calls of harbour seals in Kattegat, the Baltic Sea, by acoustic modelling. The aim was to evaluate and quantify masking from shipping. In this case, the study species was the harbour seal, but the methodology can be applied to other species and also uses a framework derived from the OSPAR approach for impulsive noise which had been described by Merchant. Although shipping traffic follows predictable routes, the noise propagation varied in space and time due to the effects of the local environmental conditions on propagation loss. The study modelled the excess level induced by ship noise and assessed the masking effect on communication range associated with reduced signal-to-noise ratio. This allowed an estimate of the proportion of time for which there was a certain percentage reduction in communication range. The study provided a framework for quantification of masking potential, giving an objective method to compare habitats that could provide an index for assessing whether Good Environmental Status with respect to noise, as defined in the European Union Marine Strategy Framework Directive, had been achieved.

6. DISCUSSION OF THE IWC ENDORSED TARGETS IN THE CONTEXT OF MORE RECENT WORK

It was noted that there had been a considerable amount of work on underwater noise since noise reduction targets had been endorsed by the Scientific Committee in 2008. This included a better understanding of the impacts on many species as well as hearing thresholds, considerable development of sound propagation models, and improved understanding of the radiated noise from ships. In addition, the presentations had outlined some of the work to develop pressure indicators to quantify the extent to which anthropogenic sound was contributing to ambient sound levels. The IWC endorsed targets were expressed in terms of a pressure indicator, i.e. a reduction in the input of sound energy at source rather than an impact indicator. This is in line with the proposals that will be considered by OSPAR for ambient noise (van Oostveen *et al.*, 2020). The proposed OSPAR assessment framework involves modelling of both anthropogenic and natural sounds in order to create a sound map of the 'excess' level resulting from shipping. The approach underlying the IWC endorsed targets is consistent with the concept of an excess level in that in areas where shipping consistently contributes to elevated sound levels, a reduction in shipping noise at source will result in a reduction in the excess level.

There was broad agreement that there is a need for a clear target on lowering ship noise to facilitate regulation, and that the target should not be too complex. It was also recognised that there is a need to make progress on developing practical indicators and targets. It was also noted that targets based on pressure indicators are more achievable than biological-based targets based on impacts given that a reduction of source levels is the main variable that can be controlled and measured. There were concerns that the 3dB and 10dB targets endorsed by the IWC were rather too simplistic, partly because the 10-300Hz bandwidth might not be sufficient to cover impacts on many cetacean taxa, and partly because they may not be ambitious enough to avoid harmful effects. However, it was noted this bandwidth includes the primary frequencies used in communication by most baleen whales, and therefore is relevant to addressing the impact reduction on communication space. However, it is also acknowledged that this bandwidth does not encompass the full hearing range of baleen whales and therefore the full range over which signal detection may be important.

The approaches used within the OSPAR area under the JOMOPANS and JONAS projects could help to better understand the implications of simple targets. For example, the models could include simulating different ship quieting scenarios across the fleet and evaluate the resulting changes to the assessment indicators. Although this detailed work would be done at a regional scale it could be informative for targets set for global shipping. It was recognised that there is a need for global standards and targets, even though these would not be perfect for all regions. Standards for measurements and assessment should also be global in order to ensure comparability. The focus of the workshop was on low-frequency noise propagating over large distances from large ships. In many areas, higher frequency noise from vessel traffic is also a problem for many species. Areas where higher frequency bands are dominated by vessel noise are often coastal, and management measures may be implemented through domestic legislation. By contrast management of environmental impacts of shipping needs to be coordinated at a global level and this is done through the IMO.

7. FUTURE COLLABORATION

7.1 Collaboration with the IMO Marine Environmental Protection Committee (MEPC)

The IWC has been contributing to work on underwater noise at IMO MEPC since the item was put on their agenda in 2009 and during the development of the guidelines, which were finalised in 2014.

Sanders presented information on Canadian efforts to address underwater vessel noise, through both domestic policies and interaction with the IMO. She described two domestic policy tools that are in development, including Underwater Vessel Noise Management Plans (UVNMPs), and the establishment of a new Underwater Vessel Noise Reduction Target Working Group. Transport Canada is in the process of developing a framework for the UVNMPs, which are intended to be customized plans that are developed by fleet owners and operators, to reduce fleets' underwater noise using both operational and technological measures. The objective of the Working Group is to develop recommendations on noise reduction targets for Canadian vessels, and is anticipated to begin working in summer 2020. At the same time, Canada is continuing to engage in international collaboration and with the IMO. A technical workshop held at the IMO Headquarters in January 2019 acknowledged that quieting ships is necessary to protect the marine environment and developed a number of recommendations. Canada also organised a follow up policy workshop in November 2019 on 'Quieting Ships to Protect the Marine Environment'. That workshop was intended to assist in the development of a proposal to the IMO Marine Environment Protection Committee (MEPC 75) to include underwater noise as a new work item. Members of the IWC Secretariat and Scientific Committee attended these workshops.

Several papers on underwater noise were tabled for MEPC 75. Australia, Canada and the US submitted a proposal for a new output concerning a review of the 2014 Guidelines for the reduction of underwater noise from commercial shipping to address adverse impacts on marine life (MEPC.1/Circ.833) and identification of next steps (MEPC/75/14), with comment papers from European Union countries (MEPC/75/14/1) and other organisations (MEPC/75/14/2 and MEPC/75/14/3). MEPC 75 was postponed due to the Covid-19 pandemic so it is not clear when these issues will be discussed.

Sanders noted that the IWC's work has been well-received at IMO as it offers a scientific perspective independent of any specific member state. It was noted that since 2008, there has been considerable progress in knowledge and awareness of underwater noise from shipping, including both its impacts on marine species and the marine environment, as well as technological and operational solutions to reduce noise from vessels. This also includes increased data collection and in-water testing to support action. A Transport Canada initiative which funds an underwater listening station in the shipping lanes en route to the Port of Vancouver shipping lane was discussed. The listening station measures sound levels in real time to assess source levels based on ISO standards. Ships can be measured entering and leaving port with different draughts. The data from the listening station will provide a database of ship source levels, which has been identified as a need by both modellers and shipping companies.

7.2 The IWC Conservation Committee

The Arctic was highlighted as an area where the IWC has a close interest, including a workshop in 2014 on Impacts of Increased Marine Activities on Cetaceans in the Arctic (Reeves *et al.*, 2016), and also the IMO has specific regulations within the Polar Code. The potential for large changes in shipping associated with receding ice cover requires special attention. Merchant noted that OSPAR does not have a current monitoring programme in the Arctic but the OSPAR Secretariat is in joint initiative with Canada under the Arctic Council to assess ocean noise.

It was noted that the Conservation Committee and Scientific Committee need to work intersessionally in order to make progress, and that Convenors should attend the Conservation Committee, with efforts made to optimise liaising and communications between the committees. It was also noted that underwater noise from shipping and ship strikes should be considered together where appropriate as many issues are common to both threats and some of the same mitigation actions such as reduced speed and routeing measures can be effective.

This meeting had been planned to follow on from a planning workshop on noise by the Conservation Committee and the IMO MEPC 75. Given that both these meetings have been postponed and the very limited time available at the meeting, it was not possible to identify specific recommendations for how the Scientific Committee could best contribute. There will be a need for further discussions once these other bodies have agreed on their work programmes.

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Annex A

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Annex B

Agenda

1. Welcome and aims of the meeting
   - Meeting goals for discussion and documented outputs
   - Communication paper on IWC endorsed targets aimed at shipping industry
   - Input regarding IWC-IMO potential collaboration
   - Input into IWC Conservation Committee work plan
2. Appointment of rapporteurs
3. Adoption of Agenda
4. Available documents and Sharepoint folder
5. Background information and presentations
   - 5.1 Brief introduction from Russell Leaper on IWC work on underwater noise
   - 5.2. Brief introduction from Miguel Iñíguez on the work of the IWC Conservation Committee
   - 5.3 Presentations
     - 5.3.1 Ana Širović: Deep-water ocean ambient sound across the Northern Hemisphere
     - 5.3.2 Nathan Merchant: Marine noise budgets and OSPAR
     - 5.3.3 Thomas Folegot: JONAS project
     - 5.3.4 Michelle Sanders: Canadian proposal to IMO and Underwater Vessel Noise Reduction Target Working Group
6. Discussion of IWC endorsed targets in the context of more recent work
   - 6.1 Questions for group discussion
   - 6.2. Plan for intended communication paper to IMO
7. Future collaboration
   - 7.1 IWC Scientific and Conservation Committees and the IMO Marine Environmental Protection Committee (MEPC)
     - Discussion of what the IWC can most usefully do to collaborate with the IMO on reducing shipping noise
   - 7.2 IWC Conservation Committee – Work item on noise
     - Discussion of high priority items that the Conservation Committee may take up under their work plan, and how these may link to the IMO process
8. Other business

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