INTERNATIONAL WHALING COMMISSION

Journal of Cetacean Research and Management

Volume 24 Supplement April 2023

INTERNATIONAL WHALING COMMISSION

The Journal of Cetacean Research and Management

ISSN 1561-0713

The Journal is published by the International Whaling Commission (IWC), with at least one Supplement that will contain the full Report of the Scientific Committee of the IWC

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:

- population assessment and trends
- population dynamics
- population biology
- taxonomy
- risk averse management strategies
- direct and indirect exploitation
- environmental changes and threats in the context of cetaceans
- scientific aspects of whale watching and sanctuaries

Editorial Staff:
Scientific Programme Coordinator: Jemma Jones
Assistant Editor: Patrick Naylor
Editorial Assistants:
Stella Duff and Andrea Davies

EDITORIAL BOARD

Editor: Iain Staniland
International Whaling Commission, Cambridge, UK
E-mail: *iain.staniland@iwc.int*

Associate Editors:
Alex Zerbini
Alaska Fisheries Science Centre, Seattle, WA, USA
E-mail: *alex.zerbini@noaa.gov*

Greg Donovan
Former Scientist Emeritus
E-mail: *corkblue1o@gmail.com*

Russell Leaper
University of Aberdeen, Fort William, UK
E-mail: *russell@rcleaper.com*

Karen Stockin
Massey University, Auckland, New Zealand
E-mail: *k.a.stockin@massey.ac.nz*

André Punt
University of Washington, School of Aquatic and Fishery Sciences, Seattle, WA, USA
E-mail: *aepunt@uw.edu*

Leslie New
14204 Salmon Creek Aveue, Vancouver, WA
E-mail: *leslie.new@wsu.edu*

Ralph Tiedemann
University of Potsdam, Germany
E-mail: *tiedeman@uni-potsdam.de*

Debra Palka
Northeast Fisheries Science Center, Woods Hole, MA, USA
E-mail: *debra.palka@noaa.gov*

AVAILABILITY DETAILS

For availability, see *www.iwc.int* or contact: *IWCJournal@iwc.int*

GUIDE FOR AUTHORS

A Guide for Authors is available at: *www.iwc.int/publications/authorsguide.htm*. This must be consulted prior to submission of manuscripts to the Journal.

Journal articles should be submitted via the OJS system:
https://journal.iwc.int/index.php/jcrm/about/submissions

Editorial correspondence should be sent to:
The Editor, Journal of Cetacean Research and Management
The International Whaling Commission
The Red House, 135 Station Road
Impington, Cambridge CB24 9NP, UK
Tel: +44 (0)1223 233971
E-mail: IWCJournal@iwc.int

Please note that publication of a paper in this journal does not necessarily mean endorsement of the contents by the International Whaling Commission.

©International Whaling Commission, 2023

Editorial

For a third year running the IWC Scientific Committee meeting was forced to be held online (25 April to 13 May 2022) because of the continued difficulties associated with the COVID-19 pandemic. The IWC was only able to hold a Commission virtual special meeting (9-10 September 2021) so this Scientific Committee meeting adopted the nomenclature of SC68D. During the intersessional period, having served his term, Robert Suydam stepped down as Chair to be replaced by Alex Zerbini with Lyndsay Porter taking on the role of Vice-Chair.

Again the wide range of time zones occupied by committee members, allowed for just two 1.5 hour sessions daily and the meeting was spread over three working weeks with no weekend sessions. Plenary items were dealt with through a combination of dedicated online sessions and written reports.

As with the previous two virtual meetings the decreased time for discussion was reflected in a much reduced agenda. Given the need to progress important technical work the sub-committee on Implementation Reviews and Simulation Trials (IST) met in-person in Copenhagen Denmark, shortly after the main Committee meeting, 25-27 May 2022. The sub-committee's work was summarised and included in the main report. The full Committee was provided with the opportunity to comment on all sections of the draft report and the final text was agreed by the Heads of Delegation. The report from the SC68D meeting kept the revised layout used for the previous two years with summaries of the sub-group discussions and their recommendations combined into the main report text rather than the usual annexes.

Iain Staniland
Editor
Cambridge, March 2023

Cover image
The cover image shows a vaquita. With thanks to Paula Olson of NOAA.

Contents

1 Scientific Committee Report*

191 Annex A: List of Participants

195 Annex B: Agenda

201 Annex C: List of Documents

207 Annex D: An Update on the 2023/2024 IWC Budget and Implications for the Scientific Committee

221 Annex E: Report of the Abundance Steering Group

245 Annex F: Catches Reported for the 2021 Season

246 Annex G: Extinction Initiative - Next Steps

250 Annex H: Bycatch and Ship Strikes of Large Cetaceans Reported in the National Progress Report Database

271 Annex I: Bycatch of Small Cetceans Recorded in the Progress Reports Database

282 Annex J: Written Statement from the UK Government Condeming Russia

283 Annex K: Statements on the Agenda

284 Annex L: State of the Cetacean Environment Report (SOCER) 2022

306 Annex M: Intersessional E-mail Groups

315 Annex N: Database Request Proforma

317 Annex O: Status of DNA Registers

320 Annex P: List of Recommendations Relating to Hector's and Māui Dolphins

323 Annex Q: Recommendations for Vaquitas

331 Reports of Intersessional Meetings

331 Report of the IWC Climate Change Workshop (SC/68D/REP/01)

365 Report of the Pollution 2025 IWC Intersessional Workshop (SC/68D/REP/02)

389 Report of the IWC-POWER Planning Meeting 2021 (SC/68D/REP/03)

*Detailed contents for the Scientific Committee Report section (pp.1-190) are given on the next pages.

Report of the Scientific Committee

Virtual Meeting, 25 April-13 May 2022

Scientific Committee Report Contents

Page	Item	
1.	**1-3.**	**Introductory Items**
4.	**4.**	**Cooperation with Other Organisations**
11.	**5.**	**General Assessment and Modelling Issues**
11.	5.1	Use of ISTs for consideration of species' and populations' status
11.	5.2	Progress on previous recommendations
11.	5.3	Biennial workplan
11.	**6.**	**AWMP and RMP *Implementation*-Related Matters**
12.	6.1	AWMP *Implementation Review* for the West Greenland bowhead whale hunt
14.	6.2	RMP *Implementation Review* for North Atlantic common minke whales
18.	6.3	Planning for the RMP *Implementation Review* for North Atlantic fin whales
18.	6.4	Biennial workplan
19.	6.5	Long-term workplan
20.	**7.**	**Stocks Subject to Aboriginal Subsistence Whaling (ASW)**
20.	7.1	New information and progress on recommendations
23.	7.2	Biennial workplan
23.	**8.**	**Whale Stocks Not Subject to Directed Takes by Contracting Governments**
23.	8.1	Comprehensive or In-Depth Assessments
32.	8.2	Potential new assessments: progress on previous recommendations and prioritised workplan (SH and NH)
47.	8.3	New information for other northern stocks
48.	8.4	New information (if provided) for other southern stocks
51.	**9.**	**Stocks that Are or Have Been Suggested to be the Subject of Conservation Management Plans (CMPs)**
51.	9.1	Stocks with existing CMPs: new information and progress with previous recommendations
57.	9.2	Progress with identified priorities
61.	9.3	Budget requests
61.	9.4	Biennial workplan
62.	**10.**	**Stock Definition and DNA Testing**
62.	10.1	DNA testing and advice on stock structure to other groups as required
66.	10.2	DNA data quality and genetic analysis guidelines
67.	10.3	Recommendations on the avoidance of sample depletion
67.	10.4	Review terminology used for stock structure related terms used within the IWC
68.	10.5	New genetic approaches of use to the Scientific Committee in addition to stock structure issues
68.	10.6	Annual workplan
68.	**11.**	**Cetacean Abundance Estimates and Stock Status**
69.	11.1	Review of abundance estimates
76.	11.2	Update and review abundance table maintained by the IWC
79.	11.3	Review and refine the abundance review process
81.	11.4	Methodological issues
82.	11.5	Provide advice to the Commission on the status of stocks
87.	11.6	Review and provide advice on surveys (past and future)
87.	11.7	Progress on previous recommendations
88.	11.8	Biennial workplan

88. **12. Bycatch and Entanglements**
88. 12.1 IWC's Bycatch Mitigation Initiative
89. 12.2 Collaboration on bycatch mitigation with IGOs
90. 12.3 Review new methods and estimates of bycatch and entanglement rates, risks and mortality
91. 12.4 Reporting of bycatch and entanglements (both large and small cetaceans) including National Progress Reports
91. 12.5 Review mitigation measures for preventing bycatch and entanglement
93. 12.6 Review studies examining the implications of effort reductions on cetacean bycatch, fisheries economics and yields
94. 12.7 Review of topics related to Hector's and Maui dolphins in New Zealand
94. 12.8 Consider definition of R_{max} for small cetceans for use by the Scientific Committee (joint session with IST)
95. 12.9 Progress on previous recommendations
98. 12.10 Biennial workplan

98. **13. Ship Strikes**
98. 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)
100. 13.2 Mitigation of ship strikes in high risk areas
101. 13.3 Cooperation with IMO Secretariat and relevent IMO committees
101. 13.4 Review progress for obtaining Automated Information Systems (AIS) data
101. 13.5 Progress on previous recommendations
101. 13.6 Biennial workplan

102. **14. Environmental Concerns**
102. 14.1 Chemical pollution
104. 14.2 Diseases of concern
108. 14.3 Strandings and mortality events
110. 14.4 Climate change
112. 14.5 Underwater noise
113. 14.6 Marine debris
114. 14.7 Habitat alteration as anthropogenic impact on cetaceans
114. 14.8 State of the Cetacean Environment Report (SOCER)
115. 14.9 One Health
116. 14.10 Biennial workplan

116. **15. Ecosystem Modelling**
116. 15.1 Workshop on the Role of Cetceans in Ecosystem Functioning: Gap Analysis
117. 15.2 Review results of ecosystem modelling in the Antarctic Ocean and northeast Atlantic Ocean
117. 15.3 Review progress on estimating pre-exploitation and current abundance of large whale populations
118. 15.4 Progress on multi-species distribution models (MSDMs)
120. 15.5 Progress with development of individual-based energetic models (IBEMs)
122. 15.6 Modelling of competition among whales and relationships between whales and prey
122. 15.7 Standing topics
122. 15.8 Progress on previous recommendations
122. 15.9 Biennial workplan

123. **16. Small Cetaceans**
123. 16.1 Small cetacean use as aquatic wildmeat
124. 16.2 Potential CMP small cetaceans
125. 16.3 Previous recommendations
138. 16.4 South Pacific island small cetaceans
143. 16.5 Review direct takes and live captures of small cetaceans
145. 16.6 Status of the Voluntary Fund for small cetacean conservation research
145. 16.7 Workplan

146. **17. Whale Watching**
146. 17.1 Assess the impacts of whale watching and swim-with-whale operations on cetaceans
146. 17.2 Update on IWC's General Principles for Whale Watching after intersessional discussion with the Conservation Committee and Secretariat

147. 17.3 Progress with regional reviews of whale watching
148. 17.4 Collaborative work within the IWC
149. 17.5 Progress on previous recommendations
149. 17.6 Biennial workplan

150. **18. Whale Sanctuaries**
150. 18.1 Updates from relevant sub-committees on new information relevent to the Southern Ocean Sanctuary management plan
152. 18.2 New information for other sanctuaries
153. 18.3 Progress on previous recommendations
153. 18.4 Biennial workplan
153. **19. Extinction Initiative**

154. **20. IWC List of Recognised Species**

154. **21. IWC Database and Catalogues**
154. 21.1 Guidelines for IWC catalogues and photo-ID databases
154. 21.2 Progress with existing or proposed new catalogues
155. 21.3 Progress with existing IWC databases
156. 21.4 Potential future IWC databases
157. 21.5 Biennial workplan

158. **22. IWC Multinational Research Programmes and National Research Cruises that Require IWC Endorsement**
158. 22.1 IWC-POWER and cooperation with Japan
159. 22.2 Southern Ocean Research Partnership (IWC-SORP)
160. 22.3 IWC-ATLAFCO collaboration for capacity building and cetacean surveys
161. 22.4 National cruises that require or request IWC oversight
161. 22.5 Review and provide advice on plans for future surveys
161. 22.6 Other cruise plans and reports
162. 22.7 Biennial workplan

163. **23. Scientific Committee Budget for the Current and Next Biennium**
163. 23.1 Status of funded research, workshop proposals, data processing and computing needs

171. **24. Committee Priorities for the Biennium 2023-24 and Initial Agenda for 2023**

171. **25. Working Methods of the Committee**
171. 25.1 Update on Rules of Procedure and Handbook of the Scientific Committee
171. 25.2 Reporting to the Commission and related matters
172. 25.3 Capacity building and succession plan for Scientific Committee
172. 25.4 Update on Date Availability requests and consideration of potential updates/clarifications
172. 25.5 Committee involvement in the IWC Database of Recommendations
172. 25.6 Governance Review
173. 25.7 Joint Conservation Committee-Scientific Committee Working Group

173. **26. Publications**

173. **27. Adoption of Report**

174. **References**

Report of the Scientific Committee (SC68D)

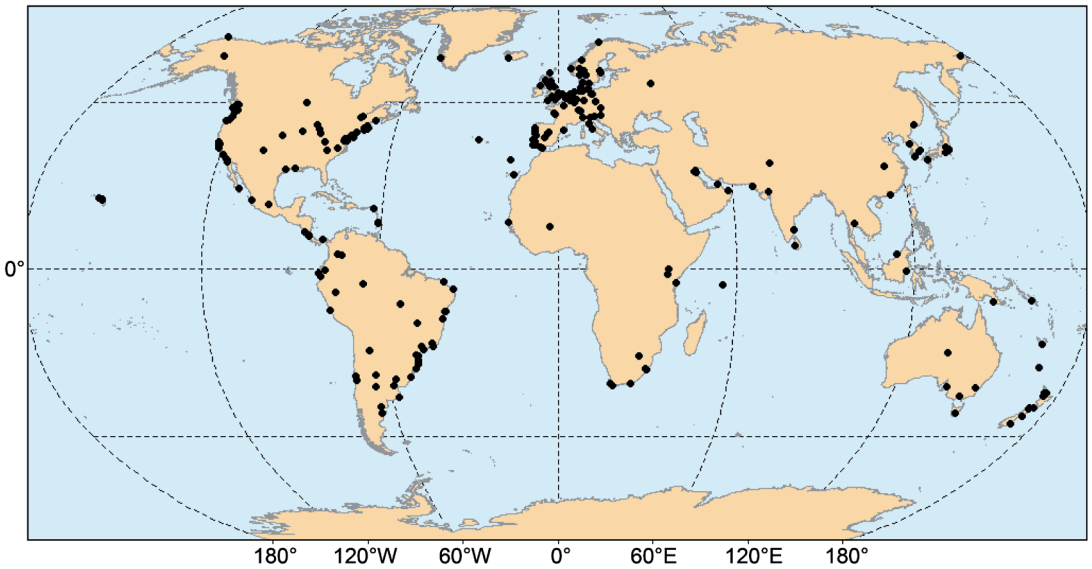
Virtual meeting, 25 April – 13 May 2022

1. INTRODUCTORY ITEMS

The 2022 meeting of the Scientific Committee (henceforth 'Committee' or 'SC') was held 25 April to 13 May 2022. As in 2020 and 2021, it was held virtually due to the global coronavirus pandemic (COVID-19). The Chair (Zerbini) and vice-Chair (Porter) of the Committee worked with the Convenors and the Secretariat to plan a series of pre-meetings and workshops prior to and after the main Committee meeting.

1.1 Chair's welcome and opening remarks

The incoming Chair, Zerbini, welcomed participants to the meeting and introduced the new vice-Chair, Porter. In welcoming participants, he noted that as in the two previous years, the meeting was being held virtually. He also stated that as was successfully implemented last year, the meeting would be held over a three-week period, rather than the usual two but the Committee would only meet Monday to Friday. He expressed his pleasure at the global distribution of participants (see map) and noted that over 500 people were participating in the meeting. Due to the broad range of time zones, some participants would need to be in Committee meetings late at night or early in the morning. He apologised that this was consistently the case for some members but greatly appreciated those who worked at atypical times of the day. Zerbini thanked the Secretariat for its hard work in the lead up to this virtual Scientific Committee meeting, in particular Creek, Duff, Lent, Staniland and Tandy.



Map: Global distribution of SC68D participants.

Zerbini noted that it may be difficult to discuss highly technical issues during virtual sessions. Some of those discussions may need to wait until the Committee meeting in 2023 or at intersessional in-person meetings. The number of sessions allocated was still less than half that of a typical in-person meeting.

The Committee's leadership established a plan for developing, reviewing and agreeing the Committee's 2022 report and the 2022/23 budget requests and workplans. The agreed report, budget request and workplan represent the Committee's decisions and recommendations.

The Committee reviewed and agreed the 2022 report in a manner similar to the process used for the two previous virtual meetings. Each sub-group summarised, reviewed and approved their discussions and recommendations and these were subsumed into the main Committee report. In contrast to typical in-person meetings there were no sub-group annexes, although more technical or complicated issues were appended as necessary. A technical meeting convened by the sub-committee on *Implementation Reviews* and Simulation Trials was held shortly after the main Committee meeting, 25-27 May, and its report was summarised and included in the Committee report. The full Committee was provided with the opportunity to comment on all sections of the draft report. Final review and approval of the 2022 Committee report was conducted by the Heads of Delegation. The 2022 recommendations herein will be presented to the Commission at its planned in-person meeting in October 2022.

Table 1

Committee sub-groups and Convenors/rapporteurs for the 2022 SC meeting.

Sub-committee/Working Group	Convenor	Co-Convenor	Rapporteur(s)
Scientific Committee Plenary	Alex Zerbini	Lindsay Porter	IWC Secretariat
Ad hoc Working group on Photo-ID, PH	Paula Olson	-	-
Standing Working Group on Abundance Estimates, Stock Status and International Cruises, ASI	Geof Givens	Leslie New	Thomas Doniol-Valcroze Nat Kelly
Ad hoc Working Group on Sanctuaries, SAN	Chris Parsons	-	Convenor
Ad Hoc Working Group on Databases and Related Issues, GDR	Mike Double	-	IWC Secretariat
Sub-committee on *Implementation Reviews* and Simulation Trials, IST	Greg Donovan	John Brandon	David Miller Mike Wilberg
Sub-committee on Aboriginal Subsistence Whaling, ASW	Lars Walløe	Thomas Nelson	Lars Walløe
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	Phil Clapham Kristin Privitera-Johnson André Punt
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 Danielle Buss Trevor Branch
Sub-Committee on Conservation Management Plans, CMP	Bob Brownell	Dave Weller	Sarah Mallette
Sub-Committee on Non-deliberate Human-Induced Mortality of Cetaceans, HIM	Russell Leaper	Gianna Minton	David Mattila
Sub-Committee on Environmental Concerns, E	Patricia Holm	Danielle Cholewiak	Tilen Genov Penny Clarke Gaby Hernandez Rocio Gonzalez Stephanie Plön
Standing Working Group on Ecosystem Modelling, EM	Toshihide Kitakado	Megan Ferguson	Convenors
Sub-Committee on Small Cetaceans, SM	Lindsay Porter	Fernando Trujillo	Frank Cipriano Maria Clara Jimenez Naomi Brannan Peter Thomas
Sub-Committee on Whale Watching, WW	Robert Suydam	Jorge Urbán-Ramirez	Naomi Rose

*Helena Herr, Els Vermeulen and Ana Širović chaired SH sessions during SC68D.

The Executive Secretary, Lent, thanked the Committee Chair and vice-Chair as well as the Convenors, rapporteurs, reviewers of funding requests and all participants for their efforts to advance the work of the Committee in these challenging circumstances. Lent took the opportunity to introduce four new members of staff who had joined the Secretariat since the last meeting. Details of the forthcoming in-person Commission meeting to be held 14-21 October 2022 in Portorož, Slovenia, were outlined. Lent noted that two major topics to be discussed at the Commission meeting are the governance review and the work of the Working Group on Operational Effectiveness.

The list of meeting participants is given as Annex A. This year 503 participants and 33 member countries were represented.

1.2 Remembrances

Zerbini provided a remembrance of Dr. Fabio Hazin from Brazil, who passed away in June 2021 due to COVID-19. He specialised in the study of sharks, rays and Atlantic tuna and chaired both the FAO Committee on Fisheries and the International Commission for the Conservation of the Atlantic Tunas. Even though he did not participate in SC discussions, he recently played a key role in reviewing the work of the Committee as one of the members of the governance review panel.

Seiji Ohsumi, an eminent whale scientist and key IWC member passed away in November 2019 (IWC, 2020b). A special volume of the journal *Cetacean Population Studies* (CPOPS), dedicated to his legacy, was recently published[1].

The Committee paused in silence and respect for these scientists.

1.3 Appointment of rapporteurs

Members of the Secretariat, led by Staniland, were appointed rapporteurs for Plenary Items 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 schedule

Participants were provided with a comprehensive set of documents, which outlined the organisation of the Committee and its meetings. The Chair provided information to Committee participants on the proposed process; three concurrent sessions

[1] *https://cpops.jp/archive/pdf/CPOPS003.pdf.*

were held within two fixed time slots each day. To accommodate region-specific items, additional sessions that were more conducive to the region/time zone of participants were scheduled. A timetable of virtual sessions was made available approximately a week in advance and regularly updated on the meeting's SharePoint. Zoom instructions were prepared for Committee participants and posted on the SharePoint in advance of the meeting and each session was recorded and made available throughout the meeting. The purpose of the recordings was to assist those participants whose first language is not English and those who could not attend a session due to challenges associated with time zones (i.e. meetings held late at night or early in the morning).

1.5 Establishment of sub-committees and Working Groups

Table 1 lists the sub-committees and Working Groups of the Committee that met in 2022, the relevant Convenor, co-Convenor and rapporteur(s). The Committee is grateful for the commitment of these individuals, without whom the Committee could not advance its work.

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 available electronically only. 113 primary papers and three intersessional meeting and workshop reports were available.

3.2 National Progress Reports on research

All member nations are urged by the Commission to provide Progress Reports to the 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 Progress Reports should be submitted electronically through the IWC Progress Reports data portal. The Secretariat noted that improvements have been made to the online process in order to facilitate the submission of data, including more detailed instructions. Countries were reminded on 28 February 2022 (IWC.ALL.413) of the critical importance of providing National Progress Reports as well as any data relevant to the work of the Commission. The Secretariat reported that it has received 13 National Progress Reports thus far this year (Argentina, Australia, Brazil, Croatia, Colombia Germany, Italy, Mauritania, Mexico, Netherlands, New Zealand, United Kingdom, USA), which is the same number as in 2021 and a decrease from the 17 received in 2020. The Secretariat is investigating ways of making the data entry easier and welcomes any suggestions or feedback from all countries.

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 2021 meeting. Details of large whale catches from the 2021 season are listed in SC/68D/O/06Rev1.

Table 2

Catch data from the 2021 season.

Date received	From	IWC ref.	Details
22/03/2022	Canada: R. Apro	E146 Cat2021	Details of the Canadian bowhead harvest for the 2021 season.
31/03/2022	Japan: T. Iida	E146 Cat2021	Individual data for commercial catches by Japan in the North Pacific in 2021.
12/04/2022	St Vincent and The Grenadines: J. Cruickshank-Howard	E146 Cat2021	Information on the St Vincent and The Grenadines aboriginal hunt 2021/22.
14/04/2022	Russia: D. Litovka	E146 Cat2021	Individual data from Russia aboriginal hunt 2021.
18/04/2022	USA: J.J. Citta	E146 Cat2021	Individual records from USA Alaska aboriginal bowhead hunt 2021.
21/04/2022	Iceland: G. Vikingsson	E146 Cat2021	Individual record of 1 common minke whale caught by Iceland 2021.
23/04/2022	Norway: N. Øien	E146 Cat2021	Individual minke records from the Norwegian 2021 commercial catch.
Catch and other data from earlier seasons			
18/10-2/11/2021	Japan: L. Pastene	E134	Updates to the table of North Pacific minke whale abundance estimates, including revised abundance estimates, area coverage and sizes.
Sightings data			
31/12/2021	Japan: K. Matsuoka	E148	2021 POWER sightings cruise data (including photographs and sightings data).
22/04/2022	Japan: K. Matsuoka	E147	Sighting data from the 2021 Japanese dedicated sighting survey in the North Pacific, and 2021/22 JASS-A survey (weather, effort, sighting, distance and angle experiment records). For access, apply through the Institute of Cetacean Research's data access protocol.

3.3.2 Progress of data coding projects and computing tasks

The catch database v7.1 was released in December 2020 and is available on request. Allison and Burkett are finalising a new version of the database.

The table of assessed abundance estimates has been updated from the 2021 Committee meeting and after Commission approval, the 2022 assessments will be added.

Programming work has concentrated on updating the control programme for the North Pacific common minke whale trials (see Item 8.1.3) and adjusting the mixing matrices to improve model fit.

3.4 Guidance for the format of the Database of Recommendations

Webster briefly explained the background to the Database of Recommendations (DoR). Its establishment was requested by the Commission in 2016 and after extensive work it is now available online. The DoR includes recommendations from the Scientific Committee, Conservation Committee (CC) and Commission from 2000 to 2021 (SC/68D/GDR/01). Regarding back-data entry, Commission resolutions and Committee workshop recommendations are currently prioritised. It is hoped that by reviewing previous recommendations, the Scientific and Conservation Committees can improve those made in the future. Recommendations for 2020 and 2021 were provided to each sub-committee at this meeting as well as guidance on their drafting. A well-constructed recommendation should: (1) be concise; (2) stand alone; (3) give specific instructions on who it is targeted at; (4) give details of others who should be aware of it; (5) have a single action; and (6) have a clear timeline.

A template is being developed to allow progress on recommendations to be easily displayed in reports and also to update the DoR.

4. COOPERATION WITH OTHER ORGANISATIONS

4.1 Summary of cooperation with other organisations

The reports of observers representing the Commission at the meetings of other international organisations are provided in paper SC/68D/O/05rev1. The report by members of the Secretariat on cooperation with other organisations is also presented in this paper (see Table 3).

The Commission and the Scientific and Conservation Committees have adopted numerous recommendations for strengthening engagement with other organisations. The IWC Secretariat, in collaboration with members of the SC, CC and Standing Working Groups (SWGs) have been working to fulfil these mandates, in addition to exploring emerging opportunities. The pandemic has altered the ability of the Secretariat, CC and SC to engage with other IGOs with participation possible at a greater number of virtual meetings but less opportunities for in-depth work. Whilst the number of meetings has proliferated in order to continue IGO work, staff time continues to be stretched given the usual constraints of FTEs and budget. This has underscored the need to establish priorities for engagement and representation by other means, such as through virtual participation in meetings as well as engaging members of the IWC community, particularly those who may already have delegations at these meetings of other international organisations. The Secretariat regularly updates Contracting Governments and observers on the relevant activities in other IGOs and these include requests for assistance in preparation for IWC engagement, whether by the Secretariat or member country representatives.

4.2 African States Bordering the Atlantic Ocean (ATLAFCO)

The Secretariat maintains regular communication with ATLAFCO as a means to ensure effective outreach and increased engagement with IWC member countries in Africa. ATLAFCO served as host for its members to join the Virtual Special Meeting of the Commission in September 2021. The Secretariat continues to collaborate with ATLAFCO to provide regular updates for the Commissioners in Africa on intersessional activities of the IWC, encourage engagement in the WG-OE process for the governance review, and join on-line meetings of the Scientific and Conservation Committees. ATLAFCO also hosted a call with the Secretariat to encourage and enhance engagement of African countries in the provision of National Progress Reports. During SC68C, the SC agreed to establish an intersessional Working Group to pursue the design and implementation of capacity building workshops in West Africa, focused on at-sea surveys and abundance estimation for cetaceans in the waters off West Africa (Diallo *et al.*, 2021). A steering Group was established and charged with follow-up work. A list of topics of interest to ATLAFCO where the IWC could offer expertise and training was agreed. The next steps are to identify suitable experts to address these topics, schedule workshops and seek funding to accomplish specific objectives. Finally, the IWC Secretariat and ATLAFCO have agreed to an internship programme that will allow scientists and other staff engaged in cetacean work from ATLAFCO member countries to participate in a short-term internship with the IWC Secretariat. At its meeting in April 2022, the IWC Bureau supported the use of Voluntary Assistance Funds to launch this programme.

4.3 Arctic Council

No report was received under this Item.

Table 3

International organisations collaborating with the IWC

Organisation	Observer
ACCOBAMS	Donovan (IWC-SC representative); Secretariat (Observer)
Arctic Council	Vacant
ASCOBANS	Simmonds (UK)
CBD	Vacant
CCAMLR	Kelly (Australia)
CITES	Secretariat
CMS	Lent (Secretariat)
COMHAFAT/ATLAFCO	Staniland (Secretariat)
FAO	Lent (Secretariat); Passadore (Secretariat); Bycatch coordinator
IATTC	Vacant
ICES	Haug (Norway)
IMO	Leaper (UK)
IOTC	Lent (Secretariat); Passadore (Secretariat)
IUCN	Reeves/Cooke (IWC-SC representatives)
Marine Mammal Protected Areas (ICMMPAS)	Rojas-Bracho (Mexico)
Marine Traffic	Vacant
NAMMCO Council Meeting	Lent (Secretariat) and Secretariat staff
NAMMCO Scientific Committee	Haug (Norway)
PICES	Tamura (Japan)
Protocol on Specially Protected Areas and Wildlife (SPAW)	Mattila (Secretariat)
SPREP	Mattila (Secretariat)

4.4 Convention on Biological Diversity (CBD)

As a member of the Liaison Group of Biodiversity-related Conventions (BLG), the IWC is participating in discussions on the development of the post 2020 framework for biodiversity and associated targets and indicators. The Secretariat has organised and hosted several BLG virtual meetings and has provided interventions on behalf of the BLG at a number of events, including the recent meeting of the Open-Ended Working Group of the CBD.

The Secretariat seeks to raise awareness within the CBD and other relevant organisations of the scientific and conservation programmes of IWC that are already underway in order to ensure that this work is made available for as broad a range of needs as possible. Given the significant investments made through the SC research budget and programmes supported by voluntary funds, ensuring the proper dissemination and use of this information is fundamental to ensuring healthy cetacean stocks, particularly for those threats whose mitigation is not under the purview of IWC. Sharing the IWC's outcomes also helps avoid duplication in an era of ever-shrinking budgets and ensures maximum impact of IWC's work. Along these lines, in November 2021 the Secretariat contributed comments and text to the CBD Technical Series on Anthropogenic Underwater Noise, and the Convenor of HIM participated in a webinar in May 2022 that launched this study.

The Secretariat has compiled the information on potential elements of the post-2020 CBD process in terms of indicators and programmes. These include the IWC compilation of population estimates and statuses as provided on the IWC website, the SC and CC work on *inter alia* the BMI, ship strikes, underwater noise, pollution. The IWC Secretariat also notes the key role of the IWC in working with ASW countries to establish whaling quotas.

The Chair of IWC and several members of the Secretariat have participated in various virtual meetings of the CBD, including its Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) and post-2020 preparatory meetings in the autumn of 2021. In May 2022, the Chair and the Executive Secretary of the IWC attended a series of in-person meetings in Geneva. Additional preparatory meetings are planned for the CBD CoP will likely be an in-person event in China in late 2022. Another round of CBD's Open-Ended Working Group (OEWG) discussions will be held in Nairobi in July 2022. Further information will be provided to IWC Contracting Governments when this timeline is clear. The latest Zero draft of the post-2020 framework is available online[2].

The IWC Secretariat is also exploring the possibility of working with the Biodiversity Indicators Partnership (BIP)[3] and the IUCN GSAP initiative to facilitate this coordination with the overall CBD process.

The Secretariat continues to highlight issues directly relevant to healthy cetacean populations and aims for them to be addressed or strengthened in the framework. It also promotes opportunities to address threats to cetaceans, including through increased cooperation, capacity building, engagement of key sectors (e.g. shipping and fisheries) and data management and reporting. IWC68 brings the opportunity for the Commission to welcome the Post 2020 Framework for

[2] *https://www.cbd.int/doc/c/abb5/591f/2e46096d3f0330b08ce87a45/wg2020-03-03-en.pdf.*

[3] *https://www.bipindicators.net/about/join-the-bip.*

Biodiversity and to make any observations on the role of the IWC in delivering relevant objectives in the framework. The Secretariat will draw this opportunity to the attention of the Contracting Governments nearer the time but proposes that the development of any proposals to the Commission should be led by Contracting Governments.

4.5 Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)

Scientists at the British Antarctic Survey (BAS) have been in contact with the IWC Secretariat regarding opportunities to enhance collaboration through the Scientific Committee of CCAMLR. A draft workplan has been developed, however, its implementation has been delayed due to COVID-19 and the requirement to meet virtually with focused agendas. This plan was discussed at the recent meeting of CCAMLR's Scientific Committee and plans are underway for the Executive Secretary to follow-up correspondence to encourage consideration at the respective Commission meetings. This may include the possible development of an MoU or other formal agreement. There have also been ongoing discussions between the science leads as well as the two Executive Secretaries in regard to practical ways to increase scientific collaboration.

The Chair of the CCAMLR Scientific Committee outlined areas of mutual interest with the IWC SC including bycatch, interactions between whales and krill, the role of cetaceans in the ecosystem, climate change and other threats. In particular, there was an interest in bringing relevant experts from the two committees into each other's work (see Item 12.2.2). In discussion, the Committee **welcomes** closer collaboration between the two Secretariats and Kelly was nominated as an observer for both Committees.

4.6 Convention on the Conservation of Migratory Species (CMS)

The Secretariat and representatives from the IWC SC have continued ongoing cooperation with the CMS on a wide range of common challenges including bycatch, strandings, CMPs, ship strikes, ecosystem functioning and whale watching. The IWC has an MoU with the CMS and also collaborates with the daughter agreements, ASOCBANS and ACCOBAMS. Joint work has continued on the IWC Whale Watching Handbook, particularly translations. In February 2022 both the CC and SC whale watching groups provided input to the CMS Guidelines for in-water interactions with wildlife and the revised CMS Guidelines will be published shortly.

4.6.1 Scientific Council

The Fifth Meeting of the Sessional Committee of the CMS Scientific Council (ScC-SC5) took place online from 28 June to 9 July 2021. The Scientific Council established a Working Group on Ecological Connectivity, with the aims of enhancing the scientific understanding of connectivity issues and providing advice on these in relation to migratory species. ScC-SC5 also reactivated the Working Group on Migratory Species and Health. The Group will provide a mechanism to increase attention to the issue, define a key role for CMS and advise Parties on the risk of zoonotic events, future disease outbreaks and pandemics, and responding to wildlife disease and diseases of zoonotic origin. An Intersessional Working Group on Linear Infrastructure and Migratory Species was also established. Though it is mainly focusing on terrestrial and avian species issues, it is also relevant to aquatic species. One of its tasks is to develop a workplan and identify priority tasks based on the existing information, such as standards, guidelines and best practices related to addressing the impact of linear infrastructure development.

ScC-SC5 established an intersessional working groups on the Definition of the Terms 'Range State' and 'Vagrant'; and on the Disaggregation of Higher Taxa listed on Appendix II. All Terms of Reference for the groups can be found on the ScC-SC5 webpage. If anyone is interested in participating in any of these working groups, kindly approach the CMS Secretariat.

4.6.2 Conference of Parties

The 14th Meeting of the Conference of the Parties (COP14) to CMS is expected, to take place in the 3rd or 4th quarter of 2023.

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

ASCOBANS held a virtual meeting on 23 September 2021 to discuss the potential for a global strandings database. In addition to IWC, ACCOBAMS and the Baltic Marine Environment Protection Commission – also known as the Helsinki Commission (HELCOM) - were in attendance. It was agreed that a platform should be developed that gathers data from multiple sources and visualises the data in one location for increased data access. The scale and size of this proposed platform will be discussed in a future workshop.

Numerous ASCOBANS meetings and activities have been ongoing, including workshops on the management of MPAs for small cetaceans, two Jastarnia Group workshops (harbour porpoise in the Baltic Sea), and the North Sea Group. The ASCOBANS Secretariat welcomes IWC participation in the following working groups: Data deficient taxa; *Lagenorhynchus* species; and Cetacean-friendly Marine Spatial Planning (MSP).

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

There is a strong, long-standing collaboration between IWC and ACCOBAMS on many issues including matters related to population assessment, ship strikes, bycatch, whale watching, noise, chemical pollution and CMPs. Opportunities for further collaboration were recently discussed in a virtual meeting between the IWC and ACCOBAMS Secretariats. Members

of the IWC Secretariat attended the 14th Meeting of the ACCOBAMS Scientific Committee 22-26 November, as observers. The former IWC Bycatch Coordinator was a member of the Joint ACCOBAMS/ASCOBANS working group on bycatch and it is hoped that the new Coordinator will be able to continue in this position.

ACCOBAMS requested that the IWC nominate an SC participant to serve on the ACCOBAMS Scientific Committee. The next Meeting of the Parties of ACCOBAMS will take place in November 2022, when membership of their SC will be formalised for the next triennium. The IWC SC nominated Donovan to continue representing the Committee on the ACCOBAMS SC.

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

No report was received under this Item.

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

The IWC Secretariat has continued to engage with the FAO Secretariat in relation to potential collaborations to promote the cetacean bycatch guidelines, including: through capacity building efforts; in pilot projects; review and updated technical information on mitigation measures; and in development of outreach material such as technical factsheets and audio visual materials explaining different mitigation measures in the guidelines.

The IWC Secretariat is also collaborating with the FAO, providing annual statistics on anthropogenic cetacean mortality, including direct takes, bycatch and ship strikes for its annual publication of fishery data, using information from the IWC Progress Reports or submitted directly to the IWC. The IWC Secretariat participates in several task groups under the Coordinating Working Party on Fishery Statistics, including the *ad hoc* task group on reference harmonisation standard, the *ad hoc task* group on fishing effort concepts and the *ad hoc* task group on catch concepts. In a process connected to the COFI meeting, the FAO hosts the Regional Secretariat's Network (RSN) which is an organisation of Executive Secretaries/ Directors of Regional Fishery Management Organisations and other Regional Bodies, including IWC. The RSN is an excellent opportunity for the IWC to exchange information on Secretariat-level administrative issues (such as the mechanics for virtual meetings) and is particularly important for collaboration on bycatch with RFMOs. It is through the RSN that the IWC has been invited to participate in a June 2022 FAO meeting that will convene representatives from several relevant regional organisations in the Indian Ocean, including the Indian Ocean Tuna Commission, the Southwest Indian Ocean Fisheries Agreement, the Southern Indian Ocean Fisheries Agreement and the Indian Ocean Rim Association. This will be an opportunity to review and discuss the policies and practices of these RFBs, with the overall objective of promoting and establishing effective regional and sub-regional cooperative frameworks among RFBs, with collaborative approaches on matters of common concern. The theme areas to be explored include addressing fisheries impacts on biodiversity, especially through bycatch.

The IWC Secretariat has been contracted by the FAO to prepare Fact Sheets that support the implementation of the marine mammal bycatch guidelines. These will be prepared in 2022 and reviewed by the Bycatch Expert Panel. The work will be carried out via a sub-contract with the former IWC Bycatch Coordinator (Tarzia).

The FAO Committee on Fisheries (COFI) plans to meet 5-9 September 2022. The Regional Fishery Body Secretariats' Network (RSN) will meet one day prior to and one day following the COFI meetings. The IWC Secretariat will attend these meetings as part of the mandate to address monitoring and mitigation of cetacean bycatch in active and ghost fishing gear, along with other biodiversity and ecosystem impacts of fishing.

4.9 Regional Fisheries Management Organisations (RFMOs)

Working in collaboration with RFMOs, SPREP and other partners, the IWC Secretariat was part of the development team that prepared the GEF/FAO Common Oceans ABNJ Tuna Phase 2 project. The IWC's role in this project is to advance efforts to assess and mitigate cetacean bycatch in tuna fisheries across two ocean basins - the Indian Ocean (with possible collaboration with IOTC and other partners) and the Pacific Ocean (with possible collaboration with SPREP, WCPFC, and other partners). The project will also lay the foundation to scale up to other regions and fisheries. At a regional level, the proposed activities fall across three themes: (1) assessing cetacean bycatch and data gaps across an ocean basin to inform RFMOs on the scale and scope of issues in relevant fisheries and provide a baseline; (2) building regional capacity and awareness on cetacean bycatch and available solutions; working with key countries to train fishers, fisheries managers and observers in cetacean bycatch mitigation, monitoring, safe handling and release and the review and dissemination of relevant information on best practices to address bycatch; and (3) collaboratively developing recommendations to address cetacean bycatch across multi-lateral environmental and fisheries agreements. The IWC will focus on developing recommendations for cetacean conservation through its own Committees and Commission processes and build a coordinated and collaborative approach with national governments participating in both IWC and the relevant RFMOs. The project is due to begin on 1 July 2022.

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

The ICES Working Group on Marine Mammal Ecology (WGMME) met online 1-4 February 2021. New and updated information on cetacean population abundance, population/stock structure, management frameworks as well as anthropogenic threats to individual health and population status were reviewed, along with findings on threats to marine mammals such as bycatch, pollution, marine debris and noise. Species-specific foraging distributions were reviewed and consumption by representative marine mammal species in case study areas was estimated.

Regulations for acoustic deterrent devices to mitigate marine mammal bycatch and legislation requirements for monitoring of bycatch were reviewed along with updated information on bycatch. A questionnaire survey of European stranding networks mapped information pertinent to bycatch assessments.

The ICES WorKshop on estimation of MOrtality of marine MAmmals due to bycatch (WKMOMA) met by correspondence during 13-15 and 20-21 September 2021. The WKMOMA addressed a special request from the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) regarding the bycatch mortality of harbour porpoise, common dolphin (and grey seal) within the OSPAR maritime area. The objective of the workshop was to generate bycatch rates and associated confidence intervals for static and towed gears for relevant species within the three species assessment areas defined by OSPAR. Subsequently, the species-specific bycatch mortality estimates in the defined assessment area were also requested. OSPAR provided thresholds for the relevant species/assessment units and ICES were tasked to compare the mortality estimates to the provided thresholds and identify any critical issues relevant for the comparison. As recommended by the ICES Working Group on Bycatch of Protected Species (WGBYC) 2020, a modelling procedure was carried out to generate bycatch rates.

Figures were generated for common dolphin and harbour porpoise, with comparisons across gear types, fishing area, and years of study. Estimated bycatch rates were extrapolated to fishing effort to give a total number of animals caught in a year e.g. 64,040 common dolphins in 2020.

The Working Group on Bycatch of Protected Species (WGBYC) met by correspondence 28 September - 1 October 2021. In 2021, WGYC addressed eight ToR, including a data scoping exercise as part of a special request on seabird bycatch from the North East Atlantic Fisheries Commission (NEAFC), which concluded that there was insufficient bycatch monitoring data from NEAFC waters to warrant further analyses at this time. The report also provides an overview of monitoring and fishing effort data contained in the WGBYC database for 2019 and 2020. This showed that during 2020, in most geographical areas of relevance, at-sea monitoring effort was significantly affected by the COVID-19 pandemic.

Data used by WGBYC on fishing effort, at-sea monitoring effort and bycatch records are primarily acquired through an ICES dedicated data call, which has been issued annually to all ICES member states since 2018 and all non-ICES EU coastal states from 2021. Although data quality and quantity are improving, WGBYC reiterated that significant gaps remain in data collection efforts and in data resolution and this limits the Working Group's ability to provide useful assessments of the likely impacts of fishing activity across a wide range of protected species and areas. WGBYC notes that broadscale low level monitoring programmes may be insufficient to highlight rare bycatch occurrences for populations at low abundance and/or low susceptibility to bycatch, but which could have significant population level impacts.

Due to the COVID-19 pandemic, the 2021 ICES Annual Science Conference (ASC) was virtually 6-10 September 2021. More information is available on the ICES website[4].

4.11 International Maritime Organisation (IMO)

The Secretariat and members of the Committee have continued to work with IMO particularly on underwater noise and ship strikes.

Underwater noise. The IMO adopted its Guidelines for the reduction of underwater noise from commercial shipping to address adverse impacts on marine life in 2014, however, there has been very little uptake and there is wide recognition that further work is needed at IMO to address the issue of underwater noise from shipping. Following the postponement of the IMO Marine Environment Protection Committee (MEPC 75) due to the COVID-19 pandemic, noise issues were not discussed until MEPC 76 in June 2021. IWC submitted a short paper (MEPC 76-12) in response to a proposal for further work on underwater noise, noting that the IWC would welcome the opportunity to contribute through the work of its Scientific and Conservation Committees. At MEPC 76, the IMO agreed to review the 2014 Guidelines and identify next steps. This was addressed in the Ship Design and Construction Sub-Committee (SDC 8) in January 2022, to which IWC contributed a paper to (SDC 8/14/5). An outcome from this meeting was the establishment of a correspondence group, coordinated by Canada, to work on updating the IMO noise guidelines and to identify next steps. IWC is a member of the correspondence group and will continue to provide input over the coming year.

Ship strikes. France, Monaco, Spain and Italy submitted an information paper to MEPC 77 in November 2021 on 'Identification of Western Mediterranean Sea as PSSA to minimise the risk of ship strikes with cetaceans' (MEPC77.inf27). This paper was intended to start the consultation process for designation of a Particularly Sensitive Sea Area (PSSA) with associated measures to reduce ship strike risks to fin and sperm whales. It is expected that the full proposal will be submitted in June 2022 for consideration at MEPC 79 in December 2022.

The IWC Secretariat and HIM Convenor met with the IMO secretariat in February 2022 to discuss ongoing requests from the shipping industry for a new Traffic Separation Scheme south of Sri Lanka which would improve maritime safety and reduce ship strike risks to blue whales.

[4] *https://www.ices.dk/events/asc/ASC2021/Pages/default.aspx.*

Table 4

Terms of Reference of the IUCN/IWC Coordination Group.

SC Agenda Item	Terms of Reference	Members
4.12	(1) Develop a process to enhance coordination among IUCN, the IWC SC, and other relevant parties involved in conservation actions for cetaceans. (2) Facilitate coordination between those responsible for managing IUCN Red List assessments for cetaceans and developers of the IWC Status of Stocks Initiative, including: (a) providing input to the Status of Stocks Steering Group regarding prioritisation of cases to consider; (b) assisting the Status of Stocks Group on Language, terminology, and content development in drafting website text for comparison of IUCN Red List and IWC Status of Stocks assessments; and (c) advising all groups working on this project, as necessary, to help avoid duplication of effort, the appearance of conflicting results, and public confusion about whale statuses.	Braulik, Porter (co-Convenors), Abel, Allison, Andriolo, Cipriano, Cooke, Donovan, Fortuna, Givens, Panigada, Punt, Reeves, Staniland, Taylor, Trujillo, Víkingsson, Zerbini.

4.12 International Union for the Conservation of Nature (IUCN)

IUCN has been directly involved in cetacean research and conservation in three main work streams: (a) for the past half-century, activities undertaken under the aegis of the Species Survival Commission's Cetacean Specialist Group, which notably includes overseeing Red List assessments; (b) since 2013, the Marine Mammal Protected Areas Task Force, a joint project of the International Committee on Marine Mammal Protected Areas, World Commission on Protected Areas and Species Survival Commission; and (c) since 2004 and through March 2022, independent review panels to advise on western gray whale conservation. Progress since SC68C is summarised briefly below. More information on the three work streams can be found on the Cetacean Specialist Group web site[5], the Important Marine Mammal Areas web site[6] and the Western Gray Whale Advisory Panel web site[7]. Of particular interest to many is the evidence regularly posted on the Cetacean Specialist Group web site (e.g. reports, videos, photographs) of continued illegal fishing in critical vaquita habitat[8].

The Committee noted that there are multiple areas of collaboration between IUCN and the IWC SC (e.g. cetacean Red List assessments, Integrated Cetacean Conservation Planning (ICPC), Marine Mammal Protected Areas Task Force, Status of Stocks Initiative). At last year's meeting, the Committee encouraged efforts to enhance coordination and communication between research programmes under the auspices of the Committee, IUCN/ICPC, NGOs such as WWF, and other fora (such as CMS) involved in cetacean conservation (IWC, 2022a). The Committee also agreed that a mechanism is needed to enhance communication among the different parties involved in conservation planning and actions for cetaceans, such as an annual meeting to provide updates on progress on the issues. The Committee established an intersessional email group to enhance coordination among the parties. The terms of reference of this group are provided in Table 4.

4.12.1. IUCN Red List status of cetaceans

Barbara Taylor serves as the Red List Authority Coordinator for cetaceans and she is regularly assisted in this work by Gill Braulik and Gianna Minton (Deputy Chairs of the Cetacean Specialist Group) and other members of the Cetacean Red List Authority. Progress on and plans for Red List work are summarised in SC/68D/O/01.

The next edition of the Red List (version 2022-1), scheduled for publication in July 2022, will include an assessment of Rice's whale, *Balaenoptera ricei*, as Critically Endangered and assessments of the Indus River and Ganges River dolphins, *Platanista minor* and *P. gangetica*, both as Endangered, as well as an updated assessment of the Critically Endangered vaquita, *Phocoena sinus*. Also included will be ten new or updated assessments of Mediterranean subpopulations of small and large cetaceans.

4.12.2. Integrated Conservation Planning for Cetaceans

Integrated Conservation planning was developed by the IUCN Species Survival Commission's (SCC) Conservation Planning Specialist Group. This approach uses multidisciplinary teams to devise and implement an integrated conservation plan, involving as many stakeholders as possible in the conservation planning process, including local community members. In 2020, the Integrated Conservation Planning for Cetaceans (ICPC)[9] was established as a sub-group within the IUCN SSC Cetacean Specialist Group in in response to concerns over the increasing number of endangered riverine and coastal dolphin and porpoise species and populations. The ICPC has six ongoing projects that aim to fill critical knowledge gaps for several species of small cetaceans. An update on these projects was presented to the Small Cetacean sub-committee (Item 16.8).

[5] *iucn-csg.org.*

[6] *https://www.marinemammalhabitat.org/immas/.*

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

[8] *https://iucn-csg.org/illegal-fishing-remains-the-sole-immediate-threat-to-vaquitas/.*

[9] *https://iucn-csg.org/integrated-conservation-planning-for-cetaceans-icpc/.*

4.12.3 IUCN Task Force on Marine Mammal Protected Areas (formerly ICMMPA)

Giuseppe Notarbartolo di Sciara (Deputy Chair of the Cetacean Specialist Group) and Erich Hoyt continue to lead ongoing efforts to identify, describe and formally list Important Marine Mammal Areas (IMMAs)[10]. A thorough summary of the IMMA programme and process was published in March 2022 (Tetley *et al.*, 2022).

As noted at SC68C, the most recent regional workshop, covering the Caspian and Black Seas and the Sea of Marmara and connecting straits, was held in February 2021. The next workshop will cover the South East Temperate and Tropical Pacific Ocean and is planned to take place in Costa Rica (dates not yet announced).

Western Gray Whale Panels: As noted at last year's SC meeting (Reeves *et al.*, 2021), the Western Gray Whale Advisory Panel's work was expected to be concluded by the end of 2021. The final meeting of the panel took place in Gland, Switzerland in November 2021. Although the report of that meeting was finalised in January 2022, it has yet to be released and posted on the IUCN web site. Some panel work continued through most of February 2022 and more work was planned through March 2022, however, due to the Russian invasion of Ukraine which began on 24 February 2022, all work stopped. A 'closing statement' by the panel is given in SC/68D/CMP/13.

4.13 North Atlantic Marine Mammal Commission (NAMMCO) - Tore Haug (Norway)

The 27th meeting (SC27) of the NAMMCO Scientific Committee (SC) was held online 25-29 January 2021.

The NAMMCO By-catch Working Group (BYCWG) met online 28 May 2020. Estimates for by-catch of marine mammals in Icelandic lumpsucker gillnets were reviewed, and the NAMMCO SC *endorsed* the stratified estimates and *recommended* the estimates with stratification by management area for use in assessments. The limitations and lack of reliability of self-reporting for estimating by-catch were again underlined and the NAMMCO SC *endorsed* the BYCWG recommendation that additional sources of information always be sought. The NAMMCO SC also *recommended* that the BYCWG provide to the next NAMMCO SC meeting an update on the effectiveness of video monitoring systems (being trialled in Norway and in use elsewhere), together with an update on the use of pingers as a by-catch mitigation measure. The NAMMCO SC *endorsed* all the recommendations for research from the BYCWG. The NAMMCO SC also agreed with the proposal of the WG to continue fulfilling its ToRs by reviewing the extent of all fisheries and associated by-catch risks.

Recording ecosystem issues, updates from recently published research on determining the weight of minke whales was presented, as well as ongoing work on a joint study estimating consumption done by marine mammals in the entire North Atlantic.

The NAMMCO SC received an update on the Mary River mine project, noting that Greenland and Denmark had brought issues related to transport and shipping. The NAMMCO SC recommended that a workshop be held to assess the impacts of disturbance from the Mary River mine on narwhals, belugas and walrus. Updated research on harp seals as monitors of change and ongoing research projects on human activities and stressors in the Barents Sea and along the Norwegian coast were also provided. The NAMMCO SC recommended that all NAMMCO member countries ensure that relevant information from seismic surveys be made available to enable proper sound estimation and impact assessment.

Updates were provided on the following species: narwhals, belugas, humpback whales, bottlenose dolphins, killer whales, pilot whales, dolphins, harbour porpoise, and bowhead whales. All the abundance estimates that could be generated for species covered by the previous NASS have now been completed and published, finalising data analysis from 30 years of survey effort. The NAMMCO SC agreed that based on the new information provided by member countries, 2024 was now the most appropriate year for the next coordinated survey.

In discussion it was noted that there was a need for greater coordination over estimates of abundance used by NAMMCO and the IWC. The Committee also noted that a mechanism could be developed to inform the respective Secretariats when estimates are revised.

4.14 North Pacific Marine Science Organisation (PICES) - Tsutomu Tamuta (Japan)

The North Pacific Marine Science Organisation (PICES) is an inter-governmental organisation in which Canada, China, Japan, Korea, Russia and the United States participate. PICES meets once a year for its regular meeting and its associated symposium with over 500 participants. Since 1997, PICES has addressed marine birds and marine mammals as relevant ecosystem components in the North Pacific, and has established a special working group to assess the impact of feeding by marine birds and marine mammals upon ecosystems (WG11). There was also a marine birds and marine mammals advisory panel (AP-MBM) under the BIO to examine the relationship between climate change and ecosystem fluctuation in the North Pacific Ocean, and compare the situation with those in other ocean basins. Since 2016, the AP-MBM is under Section-MBM (S-MBM) under the BIO. The PICES-2021 meeting was held online between 13 and 30 October 2021.

At the PICES business meeting held on 29 September, Tamura (Institute of Cetacean Research, Japan), as the representative of the IWC-SC, presented the observer report of the 2021 IWC/SC meeting on topics related to the North Pacific (e.g. the Research Plan for the IWC/POWER cruise). It was decided to extend the MBM project due to COVID-19. The revised future

[10] *marinemammalhabitat.org/imma-eatlas.*

five-year project (2022-26) focuses on the 'Interaction between MBMs and other ecosystem components and stressors'. This will include important sub-themes such as: forecasting changes in forage species and response of top predators and marine birds and marine mammals as ecological indicators and predictors of changing marine ecosystems. The 2022 annual meeting of the PICES will be held at Busan, Korea. The meeting will be held between 23 September and 2 October 2022.

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

The Secretariat has continued working with counterparts in SPAW on a draft MoU to facilitate collaboration in areas of common interest in cetacean science and stewardship, particularly in small scale coastal fisheries. A revised version of the draft MoU has just been received from the SPAW and this will be followed up with the development of a workplan for the next year or two. The Secretariat will present the draft MoU to the Bureau and then to the Commission at IWC68 if it is ready.

Areas of common interest and possible collaboration include small scale fishery bycatch, ship strikes, strandings response, entanglement response training, whale watching and swim-with programmes. In the spirit of this cooperation, the Secretariat has participated in several virtual meetings of various SPAW activities, including technical meetings of SPAW-STAC (Scientific and Technical Advisory Committee) and their COP. In addition, members of the Secretariat have continued to engage with stranding, entanglement and research initiatives in the Region. The CARI'MAM project hosted the Marine Mammal Stranding Workshop virtually on 17 November 2021. IWC Secretariat was invited to participate in the workshop and the Ship Strikes and Strandings Data Manager provided a brief overview on the scoping for a joint strandings database.

4.16 Secretariat of the Pacific Regional Environmental Programme (SPREP)

SPREP hosted the Chair's IWC Regional Meeting in the Pacific Islands in April 2021. As with COMHAFAT, this was an opportunity to update the Commissioners in the Pacific Islands region on intersessional activities of the IWC, encourage engagement in the WG-OE process for the governance review, and join on-line meetings of the Scientific and Conservation communities. At this Chair's Regional meeting it was noted that in August 2021 there will be a meeting of signatories to the CMS MoU on the Conservation of Pacific Islands Cetaceans and Their Habitats. As many SPREP members are also members of IWC, SPREP is exploring the opportunity for a member of the IWC Secretariat to join this meeting. The IWC Secretariat has held a number of meetings with the SPREP Secretariat in relation to work areas of common interest and overlap, including bycatch and whale watching. As noted in the FAO Section 4.8 above, the IWC is planning to collaborate with SPREP and other regional organisations on the GEF/FAO ABNJ Bycatch concept as part of the Common Oceans Programme. SPREP is currently involved in an EU-funded project through its Pacific-European Union Marine Partnership (PEUMP), which includes a multi-taxa bycatch component focused on coastal fisheries. The SPREP Secretariat is also actively engaged in raising awareness on cetacean bycatch in the Western Central Pacific Fisheries Commission (WCPFC).

4.17 Marine Traffic

The Secretariat continue to work with the SC HIM Convenor to request AIS data as needed for scientific research. The plan to develop an MoU between IWC and Marine Traffic has been set aside for now, however, the provision of data on shipping for scientific studies is still possible, for which the IWC is most grateful. An MoU would allow the IWC to serve as a single point for data requests in a standardised format, minimising work for the data provider. Should it eventually be possible to prepare a draft MoU, the IWC Secretariat will take it forward to the IWC.

5. GENERAL ASSESSMENT AND MODELLING ISSUES

5.1 Use of ISTs for consideration of species' and populations' status

This Item is dealt with under Item 11.5 (Provide advice to the Commission on the status of stocks).

5.2 Progress on previous recommendations

Progress under previous recommendations is dealt with under Item 11.5 (Provide advice to the Commission on the status of stocks) and Item 12.8 (Consider definition of r_{max} for small cetaceans for use by the Scientific Committee).

5.3 Biennial workplan

No specific work was identified under this Item although aspects are covered under Items 11.5 and 12.8.

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

The technical nature of the AWMP and RMP *Implementation* Related-Matters (IST) required an in-person meeting, which was kindly hosted at the Greenlandic Representation in Copenhagen, Denmark from 25-27 May 2022. The meeting was attended by 18 participants and was open for limited online attendance.

The primary objectives of both an AWMP and an RMP *Implementation Review* are to:

(1) review any new information (including data relevant to stock structure, biological data and abundance) to ascertain whether the present situation is as expected (i.e. within the space tested during the development of a *Strike Limit Algorithm* (*SLA*)) or the previous RMP *Implementation* or *Implementation Review*) and to determine whether new simulation trials are required to ensure that the Commission's conservation objectives are met; and

(2) review information required for the *SLA* or *Catch Limit Algorithm*, i.e. catch data and, when available at the time of the *Review*, new abundance estimates (note that receiving new abundance estimates can also occur outside an *Implementation Review* at an Annual Meeting).

More information on RMP *Implementations* and *Implementation Reviews* can be found in IWC (2012d) and for the AWMP in IWC (2019d).

6.1 AWMP *Implementation Review* for the West Greenland bowhead whale hunt

The *West Greenland Bowhead SLA* was agreed in 2015 and this, the first *Implementation Review* was initiated in 2021 (IWC, 2022a).

6.1.1 New information

6.1.1.1 Stock Structure

In 2015, although it was clear that the West Greenland aggregation was part of the much larger East Canada/West Greenland population, the conservative (and simpler to model) assumption used when the developing the *SLA* i.e. that the West Greenland aggregation be treated as a separate management unit, allows both the conservation and need objectives of the Commission and hunters to be met using the *West Greenland Bowhead SLA*, even assuming all Canadian catches were from the West Greenland aggregation (Canada is a non-member nation that sets its own catch limits).

Attention: SC, C

The Committee notes that knowledge of the stock structure of East Canada and West Greenland bowhead whale populations is based on both genetic and non-genetic (especially telemetric) information. It further notes that many bowhead whales have been genotyped for genetic mark-recapture studies. Given that the present conservative assumption, of treating the West Greenland aggregation as a separate management unit, did not lead to problems in either conservation or need satisfaction, the Committee:

(1) ***agrees*** *that the stock structure hypotheses shall remain unchanged for the current Implementation Review; and*
(2) ***encourages*** *genetic and other studies, prior to the next Implementation Review, that will provide new information on stock structure and movements of bowhead whales in Eastern Canada and Greenland.*

6.1.1.2 Abundance

The Committee reviewed the list of relevant abundance estimates for the West Greenland aggregation (Table 5). This table omits several estimates, archived by the Secretariat, that had been deemed unsuitable for use in conditioning or replaced by subsequent updated analyses. The most recent abundance estimate for the spring aggregation of bowhead whales in West Greenland is from 2012: an aerial survey estimate of 744 (CV=0.34) and a genetic mark-recapture estimate of 1,274 (CV=0.12; Rekdal *et al.*, 2015). An aerial survey for bowhead whales in West Greenland took place in spring 2022 and the results will be available prior to the 2024 annual meeting. It is also anticipated that an updated genetic mark-recapture estimate will also be available in 2023. These estimates will allow the *West Greenland Bowhead SLA* to be used to provide management advice to the Commission in 2024, in accordance with the Aboriginal Whaling Scheme (ASW, IWC, 2019h).

The most recent estimates for the entire population in East Canada/West Greenland are 6,446 (CV=0.26; Doniol-Valcroze *et al.*, 2015) from an aerial survey in 2013, and a genetic mark-recapture estimate of 13,899 in 2010 (95% CI: 7,782-30,602; Frasier *et al.*, 2020). The latter estimate has been endorsed by the ASI-WG as Category 3, indicating that it provides only a general indication of abundance and is not suitable for use in *SLA* calculations (although should it be necessary, may be used for conditioning). In discussion, it was noted that the magnitude of 2010 estimate highlights the degree of conservativism used when developing the *West Greenland Bowhead SLA*.

6.1.1.3 Removals

The Committee noted that all the necessary catch data, since 2015, has been provided to the Secretariat, including data kindly provided voluntarily by Canada (Table 6).

6.1.2 Consideration of need for new simulation trials

After reviewing the new information, the Committee agrees that there is no need to conduct additional simulation trials. Although it was clear that the West Greenland aggregation was part of the much larger East Canada/West Greenland population, the conservative (and simpler to model) assumption used when developing the *SLA*, i.e. that the West Greenland aggregation be treated as a separate management unit, allows the conservation and need objectives of both the Commission and the hunters to be met, even assuming all Canadian catches were from the West Greenland aggregation. Should the Greenland request for bowhead whales increase, and/or Canadian removals increase, above a total of 10 individuals (IWC, 2016b), then the option to model the full East Canada/West Greenland population may be required.

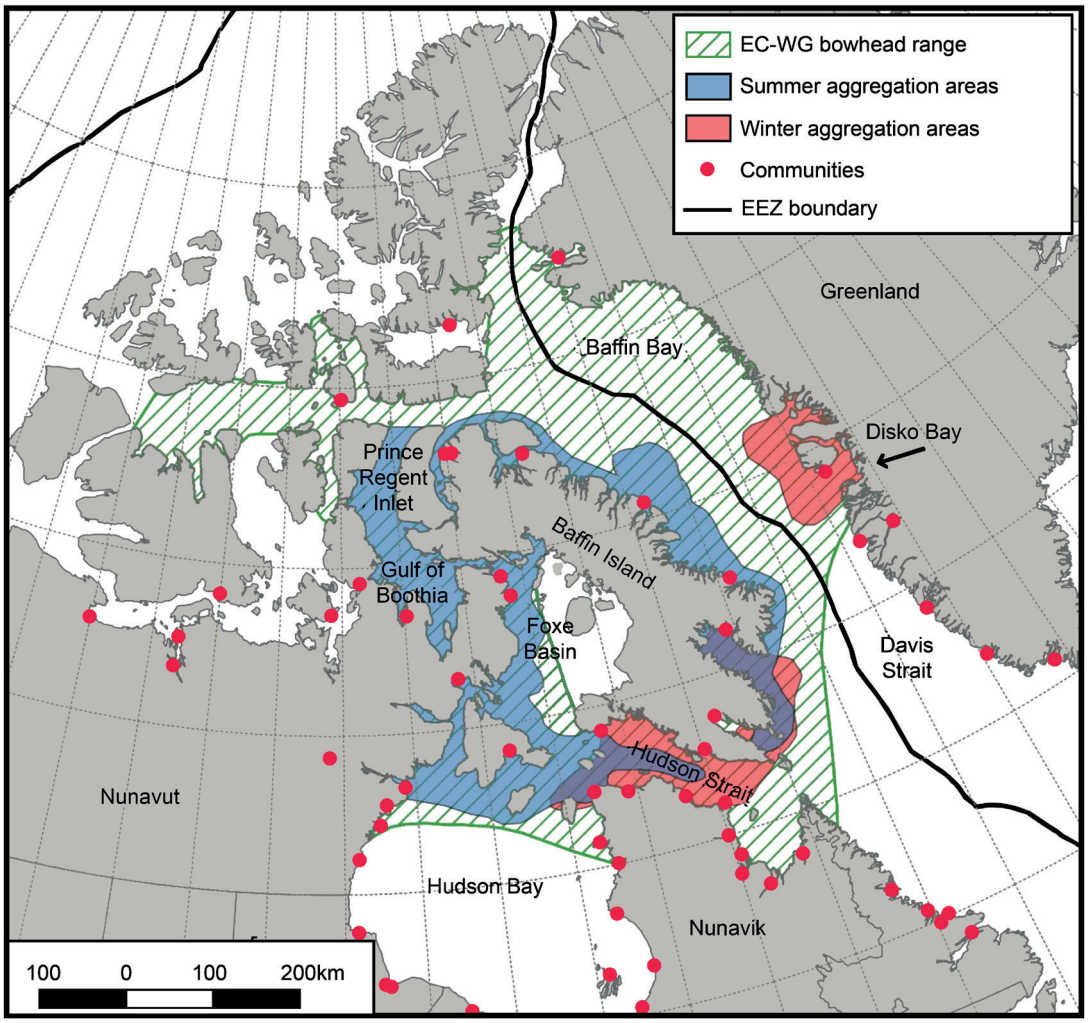


Fig. 1. Approximate geographic range of the Eastern Canada-West Greenland bowhead whale population, with important aggregation areas during the open-water ('summer') and ice-covered ('winter') seasons. Taken from Ferguson *et al.* (2021).

Table 5

Summary of estimates of abundance for the spring aggregation of bowhead whales in West Greenland endorsed by the Committee. Additional background and notes are provided in the full table available from the Secretariat. The mark-recapture (MR) estimate time-stamped 2012 is considered the best estimate of the number of animals visiting West Greenland. LT=Line Transect.

Area	Cat.	Date	Method	Estimate	CV	Approx. 95% CI	References
West Greenland	1A	2006	LT	1,229	0.47	495-2,939	Heide-Jørgensen *et al.* (2007); IWC (2008b, p.36)
West Greenland		2012	LT	744	0.34	357-1,461	IWC (2015a, p.436; 2015e, p.154); Rekdal *et al.* (2015)
West Greenland	1A	2012	MR	1,274	0.12	967-1,581	IWC (2015a, p.436; 2015e, p.154); Rekdal *et al.* (2015)

Table 6

Direct catches of bowhead whales (aboriginal-type whaling) in West Greenland and Canada. No reported bycatches off Canada were found.

	West Greenland Direct				West Greenland Bycatch				Canada Direct			
Year	Total	M	F	U	Total	M	F	U	Total	M	F	U
2015	1	-	1	0	-	-	-	-	2	0	1	1
2016	0	-	-	-	-	-	-	-	2	0	2	0
2017	0	-	-	-	1	-	1	-	1	0	1	0
2018	0	-	-	-	-	-	-	-	3	0	3	0
2019	0	-	-	-	-	-	-	-	4	0	3	1
2020	0	-	-	-	-	-	-	-	1	1	-	0
2021	0	-	-	-	-	-	-	-	2	1	1	0

6.1.3 Conclusion

Attention: SC, C, ASW, CG
*The Committee **concludes** that the Implementation Review for the West Greenland bowhead whale hunt is complete and **agrees** that the current West Greenland Bowhead SLA remains the appropriate tool to provide management advice to the Commission.*

6.2 RMP *Implementation Review* for North Atlantic common minke whales

The initial *Implementation* for North Atlantic common minke whale was conducted in 1993 and was reviewed in 2017. The 2017 *Implementation Review* incorporated a major review of stock structure that was initiated by a joint AWMP/RMP workshop in 2014 (IWC, 2015b).

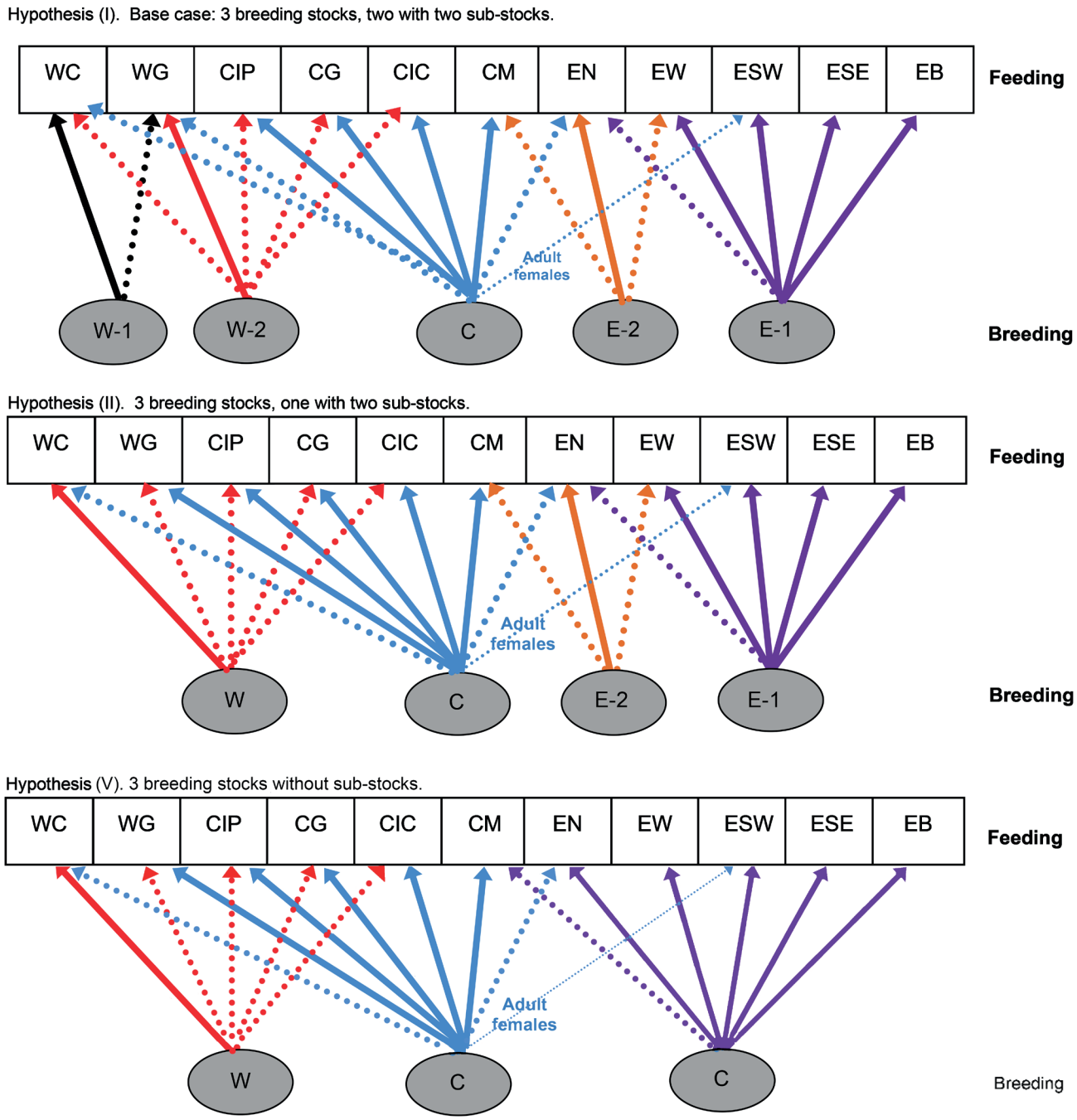


Fig. 2. Stock hypotheses considered high priority for the *Implementation Review* of North Atlantic common minke whales.

6.2.1 New information

6.2.1.1 Stock Structure

During the preparation for the 2017 RMP *Implementation Review*, the Committee undertook a major review of stock structure hypotheses for North Atlantic common minke whales, including the development of new analyses. At that time, it was concluded that two previous hypotheses III and IV could be dismissed and that there remained two plausible stock structure hypotheses (see Fig 2):

- Hypothesis (I): three breeding stocks (W, C, E), two with two sub-stocks (W1, W2; E1, E2).
- Hypothesis (II): three breeding stocks (W, C, E), one with two sub-stocks (E1, E2).

New information on stock structure, using microsatellite/mtDNA, was presented and discussed under Item 10.1.2.2 (SC/68D/SDDNA/04). In summary, the study, which was based on a data set of >4,000 samples and only 10 microsatellite loci, included the subareas used by E stock. The study found no indication of substructure within the E stock and, in light of this result, the Committee agrees that the hypothesis of a single E-stock was also plausible:

- Hypothesis (V): three breeding stocks (W, C, E) without sub-stocks.

The Committee noted that a genome-wide stock structure analysis on North Atlantic common minke whales is currently underway and includes Whole-Genome-Resequencing (WGS) on a representative subset of samples with the aim of developing a population/stock-informative Single Nucleotide Polymorphism (SNP)-panel to facilitate genetic stock assessment in a larger set of samples. This approach is expected to provide improved resolution for stock definition/assignment. The Committee welcomes information from the forthcoming genome-wide study and anticipates that the results will be available for the proposed 2026 AWMP *Implementation Review* for common minke whales off Greenland and for the next RMP *Implementation Review* for the entire North Atlantic in 2028 (see Item 6.6).

Attention: SC

*The Committee **draws attention** to the new information presented on stock structure for North Atlantic common minke whale (Item 10.1.2.2) as it supports a new hypothesis that no sub-stocks exist within breeding stocks W, C and E. The Committee notes that this new hypothesis has no negative conservation implications (i.e. is more conservative) and **agrees** that it does not warrant testing during the present Implementation Review;*

*The Committee further notes that a new study is underway that is expected to provide improved resolution of stock structure for North Atlantic common minke whales for the proposed 2029 RMP Implementation Review (see Item 6.6) and strongly **encourages** all the laboratories involved to consolidate a Single Nucleotide Polymorphism (SNP)-panel to facilitate genetic stock assessment.*

6.2.1.2 Abundance

The Committee reviewed the list of relevant abundance estimates used for conditioning and previous *Implementation Reviews* (Table 7). This table omits several estimates, archived by the Secretariat, that were deemed unsuitable for use in conditioning or replaced by subsequent, updated analyses.

Since the 2017 *Implementation Review*, the Committee has endorsed new estimates obtained from Norwegian surveys for several sub-areas (Solvang *et al.*, 2021; this report, Item 11.1.2). Several minor revisions and updates to previous estimates have also been agreed (Item 11.2.2) following revised stratification and inclusion of data missing from the FW block in the previous estimate. The 2015 estimate for the CIP sub-area is a sum of the estimates for blocks FW, IQ, IR + IW and differs from the estimate archived by NAMMCO as they use different area definitions. Furthermore, it was noted that the 2015 estimate for the CIP sub-area differs from the estimate archived by NAMMCO as it was updated using revised stratification and included new data from block FW. It was noted that new abundance estimates for common minke whales in the WC sub-area are available (Palka, 2020). Although these are not required for the current RMP *Implementation Review*, the information will be valuable for the next AWMP *Implementation Review* for common minke whales off West Greenland scheduled to begin in 2026 (Item 6.6).

The 2015 abundance estimate from an Icelandic survey for the CM sub-area covered only a portion of the CM sub-area and it was agreed that this estimate should be omitted from the trials and the 2016 estimate for CM (that covers the entire CM area) should be used.

The previous *Implementation Review* incorporated a *catch cascading* option within the E *Medium Area*. The *IST*s for the North Atlantic common minke whales include additional variance for the estimates of abundance for the E *Medium Area* based on a regression (through the origin) of survey CVs with additional variance on survey CVs ignoring additional variance (fig. 3 of IWC, 2017d). The estimate of the ratio of the survey CV for the 2014-19 period (Solvang *et al.*, 2021) including additional variance to that without additional variance is 1.67 (i.e. 0.172/0.103), which is within the range of data used to characterise additional variance in the current *IST*s. There is thus no reason to change the trials to update how additional variance is generated.

Table 7

Estimates of abundance for North Atlantic common minke whales endorsed by the Committee and deemed suitable at least for use in trial conditioning. Additional background and notes are provided in the full table available from the Secretariat.

Sub-area	Cat.	Year	Estimate	CV	References
EB	1A	1989	21,868	0.21	Bøthun and Øien (2011); IWC (2011b, p.95)
EB	1A	1995	29,712	0.18	Bøthun and Øien (2011); IWC (2011b, p.95)
EB	1A	2000	25,885	0.24	Bøthun and Øien (2011); IWC (2011b, p.95)
EB	1A	2007	28,625	0.23	Bøthun and Øien (2011); IWC (2011b, p.95)
EB	1A	2013	34,125	0.34	IWC (2016b, p.120-1); Solvang *et al.* (2015)
EB	1A	2017	55,165	0.153	Solvang *et al.* (2021); SC2022
EN	1A	1989	8,318	0.25	Bøthun and Øien (2011); IWC (2011b, p.95)
EN	1A	1995	22,536	0.23	Bøthun and Øien (2011); IWC (2011b, p.95)
EN	1A	1998	13,673	0.25	Bøthun and Øien (2011); IWC (2011b, p.95)
EN	1A	2004	6,246	0.47	Bøthun and Øien (2011); IWC (2011b, p.95)
EN	1A	2009	6,891	0.31	IWC (2016b, p.120-1); Solvang *et al.* (2015)
EN	1A	2018	17,792	0.242	Solvang *et al.* (2021); SC2022
ES	1A	1989	13,070	0.13	Bøthun and Øien (2011); IWC (2011b, p.95)
ES	1A	1995	24,891	0.10	Bøthun and Øien (2011); IWC (2011b, p.95)
ES	1A	1999	17,406	0.14	Bøthun and Øien (2011); IWC (2011b, p.95)
ES	1A	2003	19,377	0.28	Bøthun and Øien (2011); IWC (2011b, p.95)
ES	1A	2008	27,390	0.29	IWC (2016b, p.120-1); Solvang *et al.* (2015)
ES	1A	2014	23,059	0.156	Solvang *et al.* (2021); SC2022
ES	1A	2019	15,693	0.190	Solvang *et al.* (2021); SC2022
EW	1A	1989	20,991	0.17	Bøthun and Øien (2011); IWC (2011b, p.95)
EW	1A	1995	34,986	0.12	Bøthun and Øien (2011); IWC (2011b, p.95)
EW	1A	1996	23,522	0.13	Bøthun and Øien (2011); IWC (2011b, p.95)
EW	1A	2006	27,152	0.22	Bøthun and Øien (2011); Bøthun *et al.* (2009); IWC (2011b, p.95)
EW	1A	2011	21,218	0.32	IWC (2016b, p.120-1); Solvang *et al.* (2015)
EW	1A	2015	12,595	0.252	Solvang *et al.* (2021); SC2022
CM	1A	1988	4,732	0.229	IWC (2016b, p.120-1); Solvang *et al.* (2015)
CM	1A	1995	12,043	0.277	Borchers *et al.* (1998); IWC (2009a, p.135)
CM	1A	1997	26,718	0.140	Bøthun and Øien (2011); IWC (2009a, p.135; 2011b, p.95); Skaug *et al.* (2004)
CM	1A	2005	26,739	0.390	Bøthun and Øien (2011); Bøthun *et al.* (2009); IWC (2011b, p.95; 2013c, p.115)
CM	1A	2010	10,991	0.360	IWC (2016b, p.120-1); Solvang *et al.* (2015)
CM	1A	2016	37,020	0.261	Solvang *et al.* (2021); SC2022
CIC	1A	1987	24,532	0.32	Borchers *et al.* (2009); IWC (2009a, p.135)
CIC	1A	2001	43,633	0.19	Borchers *et al.* (2009); IWC (2009a, p.135)
CIC	1A	2007	20,834	0.35	IWC (2015d, p.117-9); Pike *et al.* (2011)
CIC	1A	2009	9,588	0.24	IWC (2015d, p.117-9); Pike *et al.* (2011)
CIC	1A	2015	12,710	0.53	IWC (2017d, p.132); Pike *et al.* (2016; 2019)
CIP	1A	1988	8,431	0.245	IWC (1993, p.66; pp.128-9)
CIP		2001	4,705	?	Pike *et al.* (2009)
CIP	1A	2007	1,350	0.38	IWC (2011b, p.95); Pike *et al.* (2010)
CIP	1A	2015	8,497	0.326	SC2022; Pike *et al.* (2019)
CG	1A	1987	1,555	0.26	IWC (1993, p.66, p.128-9)
CG+CIP	1A	1995	4,854	0.268	IWC (2009a, p.134-4); Pike *et al.* (2002)
CG		2001	7,990	0.29	Pike *et al.* (2009)
CG	1A	2007	1,048	0.60	IWC (2011b, p.95); Pike *et al.* (2010)
CG	1A	2015	5,368	0.350	Hansen *et al.* (2018); IWC (2018e, Item 4.2); Pike *et al.* (2016; 2019) Combined estimate (2,606 cv 0.52 + 2,762 cv 0.47)
WG	2	1988	3,266	0.31	IWC (1990, p.43; 2009a, p.135)
WG	2	1993	8,371	0.43	IWC (2009a, p.135); Larsen (1995)
WG	2	2005	10,792	0.59	Heide-Jørgensen *et al.* (2008); IWC (2008c, p.126)
WG	1A	2007	9,066	0.39	Hansen *et al.* (2018); IWC (2019g, p.400-1)
WG	1A	2015	5,095	0.46	Hansen *et al.* (2018); IWC (2019g, p.400-1)
WC	?	2007	20,741	0.30	Lawson and Gosselin (2009)

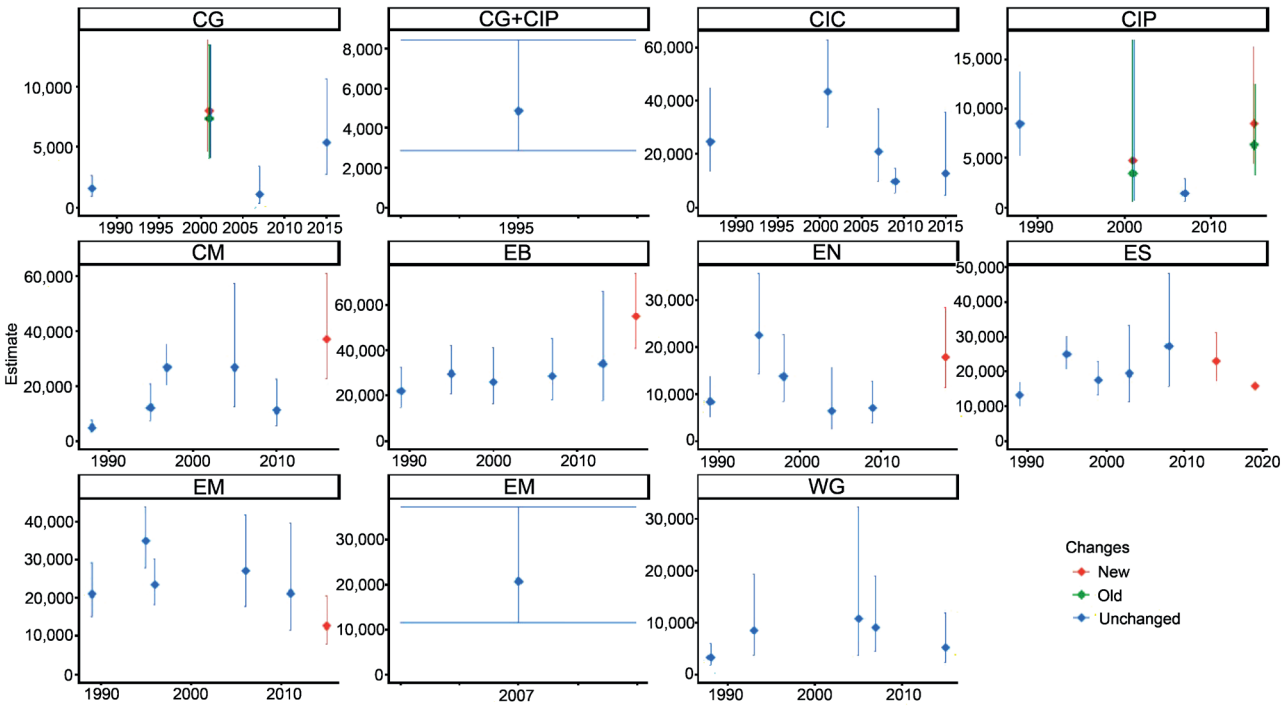


Fig. 3. Plots of the available abundance estimates, by sub-area and year, including an indication of which estimates are new for this *Implementation Review*. The new abundance estimates are consistent with previous data and thus provide no reason to pursue new simulation testing. Furthermore, the most recent estimate for the CIP sub-area (8,497 in 2015) was notably higher than the previous one (1,350 in 2007), alleviating any concern about the apparently anomalous low estimate.]

Table 8

Summary of catch information on North Atlantic common minke whales by sub-area since the last RMP *Implementation Review*.

	M	F	U	M	F	U	M	F	U	M	F	U
Year	WG	WG	WG	CG	CG	CG	CIC	CIC	CIC			
2017	33	95	5	3	6	1	12	5	0			
2018	21	91	4	1	1	0	3	3	0			
2019	36	116	8	1	8	2	0	0	0			
2020	26	129	7	5	15	0	0	0	0			
2021	30	137	10	8	12	1	0	1	0			
	EN	EN	EN	EW	EW	EW	ESE	ESE	ESE	EB	EB	EB
2017	5	2	0	9	24	1	43	332	0	2	14	0
2018	0	0	0	28	86	2	29	184	1	45	79	0
2019	1	2	0	19	56	0	59	180	2	42	68	0
2020	10	24	0	22	38	1	33	197	0	76	101	1
2021	17	22	2	16	57	1	23	80	0	75	278	6

Attention: SC

The Committee noted the available information on abundance estimates and the additional variance and ***agrees*** *that the new abundance estimates are consistent with previous data and thus provide no reason to pursue new simulation testing.*

The Committee ***further requests*** *that new estimates for the WC sub-area (Palka, 2020) are reviewed by ASI by the 2024 Annual Meeting to facilitate the 2026 AWMP Implementation Review.*

6.2.1.3 Removals

The Committee noted that all the necessary catch data since 2017 has been provided to the Secretariat (Table 8).

6.2.2 Consideration of need for new simulation trials and conclusion

Attention: SC, C, CG
After review of the new information, the Committee ***concludes*** *that the RMP Implementation Review for common minke whales is completed and that no new simulation trials are required. It was noted that consideration of the scenario with no sub-stocks within the E stock will occur in the context of the 'Status of Stocks' project (see Item 11.5). The Committee further notes that considerable new information on stock structure will be available prior to the AWMP Implementation Review for common minke whales off West Greenland scheduled for 2026 (see Item 6.6)*

6.3 Planning for the RMP *Implementation Review* for North Atlantic fin whales

The next RMP *Implementation Review* for North Atlantic fin whales is scheduled to start in 2023.

6.3.1 Stock structure

At the last *Implementation Review* eight stock structure hypotheses were considered (IWC, 2016b, p.138). At that time, there were relatively few genetic data available and each hypothesis was evaluated using other types of information including ageing data and Discovery mark tagging data. Three hypotheses (IV, VII, and VIII) were ranked 'low plausibility' and were omitted as they were considered incompatible with tagging data.

Víkingsson reported that considerable new genetic data from Iceland and Greenland are now available (samples from areas outside those covered by Iceland/Greenland may be scarce but efforts are underway to track any down) and will be analysed in time for the 2023 Annual Meeting, along with proposed kinship analyses, this will facilitate a comprehensive review of the present hypotheses.

Attention: SC
The Committee ***welcomes*** *the information on new genetic analyses on North Atlantic fin whales and* ***agrees*** *to establish an intersessional correspondence group (Tiedemann [Convenor], Øien, Pampoulie and Witting) to coordinate the compilation of a stock-structure-informative genetic data set and analyses for North Atlantic fin whales to be discussed by the SDDNA working group prior to the* Implementation Review *proposed for 2023 (see Item 6.6).*

6.3.2 Abundance

The Committee noted that the most recent abundance estimates for the EG, EI/F, WG and WI sub-areas were from 2015 and that new estimates from Iceland were expected to be available by 2024-25.

Leonard and Øien (2020a; 2020b) presented estimates of fin whale abundance in the eastern North Atlantic based on data collected during sighting surveys between 2002-18. The surveys were designed with common minke whales as target species so some recalculations will be necessary to allocate estimates to the agreed fin whale RMP areas as part of the *Implementation Review*.

The Committee noted that new fin whale abundance estimates from surveys in US and Canadian waters may be available. In discussion it was further noted that some of these estimates, in particular for the Gulf of Maine, may cover only a portion of the sub-area WC and although may not provide useful information on absolute abundance, but may provide an index of relative abundance that could be used for conditioning models. It was agreed that Donovan will enquire about the availability of such estimates for the Committee to consider further and to investigate whether there may be new estimates for other sub-areas as well.

The Committee also noted that new estimates were available from the other surveys (e.g. SCANS and CODA) and that Donovan will also enquire if these data might be available for the planned *Implementation Review*.

6.3.3 Removals

The Secretariat summarised the available data (direct catches and bycatches) available since the last *Implementation Review* (Table 9).

6.3.4 Future work

The Committee agrees that the intersessional steering group under Donovan continue and a new SharePoint site was established[11] to store relevant publications and primary papers written for the purpose of the forthcoming review.

6.4 Biennial workplan

The workplan aims to complete the RMP and AWMP *Implementation Reviews* for North Atlantic fin whales and, in addition to the work on stock structure outlined above, additional component will include integrating the operating models/control programme. Specifically the tasks are to:

[11] *https://iwcoffice.sharepoint.com/teams/rmpnafin.*

Table 9

Summary of catch and reported bycatch information on North Atlantic fin whales since the last RMP *Implementation Review.*

	West Greenland									Iceland				
		Landed			Lost	Bycatch					Landed		Lost	
Year	Total	M	F	U	U	Total	M	F	U	Total	M	F	U	Notes
2015	12	2	8	0	2	0	-	-	-	155	87	67	1	
2016	9	4	4	0	1	1	1	-	-	-	-	-	-	
2017	8	2	5	9	1	0	-	-	-	-	-	-	-	
2018	7	3	3	0	1	0	-	-	-	146	67	79	-	Incl. 2 hybrid blue/fin
2019	8	2	3	2	1	0	-	-	-	-	-	-	-	
2020	3	2	1	0	3	-	-	-	-	-	-	-	-	
2021	2	1	1	0	0	-	-	-	-	-	-	-	-	

Table 10

Schedule for future *Implementation Reviews* assuming adequate resources are available for an annual in-person meeting and intersessional workshops.

Species/area in order	Year *Implementation* (*IR*s) completed	Next *Implementation Review* assuming resources provided
North Atlantic fin whales (RMP)	2009 (2016)	Estimated start 2023/24
West Greenland fin whales (AWMP)	2018	Estimated start 2023/24
Alaskan and Chukotka bowhead whale hunts (AWMP)	2000 (2007, 2012, 2018)	Estimated start 2025
West Greenland humpback whales (AWMP)	2014	After completion of North Atlantic humpback whale In-depth assessment – estimated start 2025
Common minke whales off Greenland (AWMP)	2019	Estimated start 2026
Chukotka and Makah gray whales hunt (AWMP)	2004 (2010, 2020)	Estimated start 2027
West Greenland bowhead whales (AWMP)	2015 (2022)	Estimated start 2028
North Atlantic common minke whales (RMP)	1993 (2003, 2008, 2017, 2022)	Estimated start 2029

(1) incorporate the *SLA* into the control program to set the aboriginal catch in West Greenland (Katara, Secretariat);
(2) revise the control program to be able to run using different compilers (Katara, Secretariat);
(3) consider how stochastic mixing can be incorporated to mimic fluctuations in abundance in the West Greenland sub-area (Punt);
(4) replicate the most recent methods to run the trials (Katara, Secretariat); and
(5) investigate the availability of additional fin whale abundance estimates from Canada/USA and the SCANS and CODA surveys (Donovan) and their use as either absolute estimates or indices of abundance (Steering Group, ASI).

6.5 Long-term workplan

6.5.1 Provision of advice to the Commission on ASW hunts in 2024

The Committee noted that the Schedule currently states that AWMP strike limits shall be renewed by the Commission in 2024 under certain conditions, provided that 'the Scientific Committee advises in 2024, and every six years thereafter, that such limits will not harm that stock.' If the Commission cannot support a Committee meeting in 2024 (and potentially schedules biennial Committee meetings in odd years thereafter), the Commission and the Committee will need to determine how this Schedule requirement will be met.

Attention: C, ASW
The Committee ***recommends*** *that the Commission evaluate how Schedule requirements for the management of aboriginal subsistence whaling and the provision of scientific advice in 2024 and beyond can be achieved before making a budget decision that impacts the timing and/or frequency of Committee meetings. This is elaborated further under Item 6.6.2.*

6.5.2 Update of the long-term workplan in the light of potential changes to the Committee methods of working.

There is considerable uncertainty about the timing/frequency of Committee meetings and workshops. In updating its long-term workplan, Table 10 assumes no changes – any other scenarios will involve significant delays as explained below.

Attention: C, ASW
*The Committee **stresses** that its ability to provide timely management advice will be severely impaired by changes to the Committee meeting structure considered in the Commission's budget planning. In particular, Implementation Reviews are not only required under the Commission's agreed RMP and AWMP processes but provide continued scientific and international confidence in IWC management.*

Currently, with annual Committee meetings and intersessional workshops (usually one in-person intersessional IST workshop per year), the Committee has successfully achieved the Commission's requirement of completing individual IRs normally every 6 years, on a rolling schedule such that only one Implementation Review is undertaken per year (for human resource reasons). Clearly with half the meetings, the Committee will only be able to complete IRs for each case every 12 years.

*The Committee **highlights** that most Implementation Review work has been (and can only be) accomplished at in-person intersessional workshops (the technical work cannot be efficiently completed virtually). If the Commission decides to reduce Committee meetings to biennial and eliminate in-person intersessional workshops, this will lead to an Implementation Review completion cycle of at least 18 years such that the next West Greenland bowhead whale Implementation Review would occur in 2041. Such a proportionally long review cycle is not ideal to provide robust management advice.*

In addition, the RMP and the Aboriginal Whaling Scheme include a provision for Unscheduled Implementation Reviews in unanticipated situations where new data indicate that there is a significant conservation concern that had not been accounted for in previous work (e.g. a new, exceptionally low abundance estimate, or evidence of an unexplained large-scale mortality event). This will exacerbate the delays in Implementation Reviews.

*Considering these scenarios and the importance of providing robust management advice, whilst recognising the economic situation and the potential for virtual meetings in some circumstances, the Committee **strongly recommends** that the Commission retain sufficient funding for annual in-person meetings and intersessional workshops for complex matters such as those related to Implementation Reviews (including abundance estimation and stock structure). The Committee **cannot** provide timely conservation and management advice as currently required by the Commission without the time and budget to develop that advice. The alternative is that Commission, in the knowledge that this will severely impact the ability to provide robust and timely advice, instructs the Committee to increase greatly the required time span between IRs.*

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

SC/68D/O/06Rev1 reported on the Canadian subsistence hunt of Eastern Canada-West Greenland (EC-WG) bowhead whales for the year 2021 within the Nunavut Settlement Area (NSA) and the Nunavik Marine Region (NMR).

Department of Fisheries and Oceans Canada licenses bowhead whale hunts upon written confirmation that the appropriate Regional Wildlife Organization has approved the hunt plan. The combined maximum allowed take is seven EC-WG bowhead whales per year.

For the 2021 season, a total of two bowhead whales were reported taken for EC-WG, both of which were reported for the NSA. Of the two whales reported, one was a male and one a female. DNA samples were taken through the community harvest in Baker Lake, Nunavut, and provided to the Department of Fisheries and Oceans Canada for analysis; these were used to investigate stable isotopes, genetics, age, and physiological factors.

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 2021 (SC/68D/O/06Rev1).

The Committee noted that an annual review of management advice was not required and agreed that the new information provided did not require calling for an early Implementation Review (IWC, 2019f). The Canadian Scientific Committee report on the hunt of bowhead whales is taken into account within the West Greenland (WG) Bowhead Strike Limit Algorithm (SLA).

7.1.2 Bering-Chukchi-Beaufort Seas bowhead whales

The bowhead harvest report SC/68C/ASW/01 provides an annual summary of the Alaskan Native subsistence harvest of bowhead whales (*Balaena mysticetus*). In 2021, 70 bowhead whales were struck, of which 57 were landed. The total number of whales struck and the number landed in 2021 was higher than the averages for the previous 10 years (2011-20: mean struck=56.7, *SD*=10.5 and mean landed=44.3, *SD*=8; respectively). The harvest efficiency (no. landed/no. struck) in 2021 (81%) was slightly higher than over the past 10 years (2011-20: mean of efficiency=78%; *SD*=5.4). Spring hunts are logistically more difficult than autumn hunts because of the difficulty in accessing open water and changing sea ice

thickness and dynamics. The hunting efficiency during spring is usually lower than in autumn, which was the case in 2021. The efficiency of the 2021 spring hunt (77%) was higher than the previous 10-yr average (2011-20; mean spring efficiency=70%; *SD*=10) but lower than the 2021 autumn hunt (87%). The efficiency of the 2021 autumn hunt (87%) was lower than the average autumn hunting efficiency over the past ten years (2011-2020; mean autumn efficiency=92%; *SD*=9). Thirteen whales were struck and lost in 2021. Of those 13 whales, four were lost due to equipment malfunction (i.e. harpoon failure), six whales were lost when they swam under the ice, four whales sank, and three whales were lost for other or unknown reasons. Some whales had more than one reason attributed to their loss. Of the harvested whales, 27 were females and 30 were males. Based on total length (≥13.7m in length), seven of the females were presumed mature. One whale was pregnant with a midterm male foetus, which was 1.7m long.

During the discussion, it was asked whether the scientists advising the hunters considered if the number of struck and lost could be reduced. The response was that this number had considerably reduced from twenty years ago, and that further reduction was difficult given the equipment and weapons used by the hunters. The lack of information about genetic samples in the report was raised. It was noted that samples had been collected and this information would be presented next year together with similar information about samples from the 2023 catch.

Clarke *et al.* (2022) presented a summary of Bering-Chukchi-Beaufort (BCB) bowhead whale (*Balaena mysticetus*) calf distribution, ratio of calf to adult sightings, and encounter rate from data collected during line–transect aerial surveys conducted from July to October 2012-19 in the western Beaufort Sea (140°W-157°W). During 223,000km of survey effort, a total of 274 calves were seen: 100 in summer (July-August) and 174 in autumn (September-October), compared with nearly 3,200 non-calves. Calves were widely distributed in the study area in August and September, with a distribution in July largely east of 150°W and a distribution in October west of 143°W. Based on visual examination of a histogram summarising the data, the authors believed that calf ratios and encounter rates appear to follow a 3-4 year cycle. Most calves (240/274; 88%) were seen near an adult assumed to be the maternal female, but 9% (26/274) of all calves were observed unaccompanied at the surface and 3% (8/274) were observed with large whales at the surface but not close by. Of the total calves detected, 60% (165/274) were observed after circling was initiated, highlighting the importance of closely investigating all bowhead whale sightings if identification of calves is critical to project goals. Bowhead whale calf data from the eastern Beaufort Sea and Amundsen Gulf in August 2019 were also summarised.

During the discussion, it was pointed out that the data on calves were very valuable and that the committee hoped that similar data would be collected also in the future.

The fourth BCB bowhead health report (SC/68D/ASW/03) summarises general information on population indices, whale health and hunter observations of bowhead whales for 2020 and 2021. Briefly, two recent surveys (ice-based; aerial) provide new abundance estimates for the BCB stock. Both estimates are thought to be biased low (Givens *et al.*, 2021; SC/68D/ASI/01) but nevertheless provide confidence intervals for abundance that wholly encompass the 2011 interval (Givens *et al.*, 2016; Givens *et al.*, 2021). Furthermore, the 2019 abundance estimates do not substantially reduce estimated population growth. Plans for both a future ice-based visual/acoustic survey and a new aerial survey are at early stages, with a first attempt at the ice-based survey tentatively planned for spring 2024 or 2025. Other bowhead whale productivity indices, including calf production and body condition trends in sub-adults, remain within previous ranges and no large deviations are evident (Clarke *et al.*, 2022; George *et al.*, 2015; George *et al.*, 2018). An updated pregnancy rate estimate using data from 1973-2021 will be available next year (George *et al.*, pers. comm.). Preliminary results using pregnancy data for all whales (spring; autumn) and only autumn-harvested whales show that both estimates are consistent with the 1976-2016 estimate of 0.317, 95% CI [0.25, 0.39] with a minimum 3-year calving interval (Stimmelmayr *et al.*, 2020). General findings from post-mortem examination of whales suggest that the overall health of the population and individual bowhead whales remains good. Metrics of body condition are currently within the long-term range of variation. Assessment of evidence for fishing-gear entanglement, injuries from killer whales and ship strikes during 2020 - 2021, suggests that both line entanglement (3-13%) and killer whale predation attempts (~ 9%) are chronic, but low-level concerns for BCB bowhead whales. Although long-term data suggests vessel strikes are exceedingly rare (~2%) among BCB bowhead whales, during 2021 the vessel strike incidence (~6%) exceeded previous baseline data (George *et al.*, 2017). An analysis of a long time-series of floating and beach-cast bowhead whale carcasses detected during standardised line-transect, and 2021 beach, surveys confirm that killer whale predation of immature bowhead whales continues to occur (Willoughby *et al.*, 2020). Population indices and general health assessment findings reiterate that the general health of whales remains good and that the harvest is sustainable. Given the ongoing transformation of the Pacific Arctic ecosystem and the increasing complexity of environmental, ecological and anthropogenic stressors being present within the bowhead whale core habitat, continued monitoring of health and population indices will remain important to aid in our general understanding of how the BCB bowhead whale will continue to respond to these ongoing changes.

The Committee welcomes the new information and encourages further work on calf productivity, density, mortality, seasonality and other health issues in the future. The Committee noted that an annual review of management advice was not required and agreed that the new information provided did not require an early *Implementation Review* (IWC, 2020b).

The next AWMP *Implementation Review* of the Alaskan and Chukotka bowhead whale hunt is scheduled to start in 2025.

No bowhead whales were harvested by the Indigenous people of Chukotka, Russia, in 2021, and no bowhead whales were struck and lost (SC/68D/ASW/02).

7.1.3 North Pacific gray whales

Information on the 2021 subsistence hunt of gray whales in Russia was presented in SC/68D/ASW/02. In 2021, the Association of Indigenous Peoples of Chukotka distributed the Russian part of the block quota among the communities and 17 local whaling communities were involved in whaling.

During the 2021 season, 127 gray whales were struck and 126 whales were landed. Of all the gray whales landed, there were 66 males and 60 females – four of these 127 were 'stinky' whales [i.e. whales with a strong medicinal smell that are inedible]. Only one gray whale was struck and lost with harpoons due to the sudden outbreak of a storm.

The mean body length of gray whales taken was 10.4m, mean blubber thickness of 109mm and mean body weight was 13.4 tons. In 2020, the mean length and weight were 10.4m and 13.1 tons, respectively. The largest whale taken was a 14.9 m female weighing 35.3 tons and the smallest was a 7.96m female weighing 5.9 tons. The smallest whale was not accompanied by large whales and there were no signs of milk in its stomach. No females were lactating and three had a foetus. Thirteen of the whales landed had various injuries/traumas mainly attributed to interactions with killer whales.

The Committee welcomed the information on gray whales and noted that an annual review of management advice was not required and agreed that the *Gray Whale SLA* and the Makah Management Plan remain the best way to provide management advice, while noting that 'stinky whales' are accounted for in the *Gray Whale SLA* that calculates the aboriginal subsistence hunting strike limit.

Attention: SC, CG, ASW

With respect to matters related to hunts of North Pacific gray whales, the Committee:

(1) ***reiterates*** *previous advice that biological data, genetic samples and photographic data from Russia continue to be collected from live and harvested whales and analysed to provide information on stock structure and biology; and*

(2) ***recommends*** *collaborative sharing and integration of data from all ASW countries (e.g. photo-id catalogues, genetic samples) to inform conservation and management actions.*

7.1.4 Common minke whale stocks off East Greenland

Twenty-one minke whales (8 males, 12 females, 1 unknown sex) were landed in 2021 (SC/68D/O/06Rev1). None were struck and lost. These numbers include carry-over from 2019 to 2020 of two minke whales.

7.1.5 Common minke whale stocks off West Greenland

One hundred sixty-seven minke whales (30 males and 137 females) were landed in 2021 (SC/68D/O/06Rev1). Ten were struck and lost with 177 strikes. These numbers include carry-over from 2019 to 2020 of 52 minke whales in West Greenland.

The Committee agrees that an annual review of management advice is not required and noted that the review of the performance of the common minke SLA indicated that it is appropriate to provide management advice to the Commission on both the West and East Greenland common minke whale hunts.

7.1.6 Fin whales off West Greenland

Two fin whales (1 male and 1 female) were landed in 2021 (SC/68D/O/06Rev1). None were struck and lost. The Committee noted that an annual review of management advice was not required and agreed that the new information provided did not require calling for an early *Implementation Review* (IWC, 2020c).

7.1.7 Humpback whales off West Greenland (see Item 8.2.7)

Five humpback whales (2 males and 3 females) were landed in 2021 (SC/68D/O/06Rev1). None were struck and lost. Two whales were also bycaught in snow crab fishing gear. The Committee noted that an annual review of management advice was not required and agreed that the new information provided did not require calling for an early *Implementation Review* (IWC, 2020c).

7.1.8 Humpback whales off St. Vincent and The Grenadines (see Item 8.2.7)

Information on the subsistence hunt of humpback whales off St. Vincent and The Grenadines for 2021 and the first quarter of 2022 was presented in SC/68D/O/06Rev1.

One humpback whale was taken in 2021. The whale was a male with a length from mouth to tail 28ft, mouth to blowhole 6ft, width/girth 18ft, tail span 10ft and tail to hump 12ft. A sample of the muscle and blubber was collected.

For the first quarter of 2022, no humpback whale was taken. One humpback was struck and lost in the waters surrounding Bequia.

The Committee noted that an annual review of management advice is not required and agreed that the new information provided did not require any change to its existing management advice (IWC, 2020c).

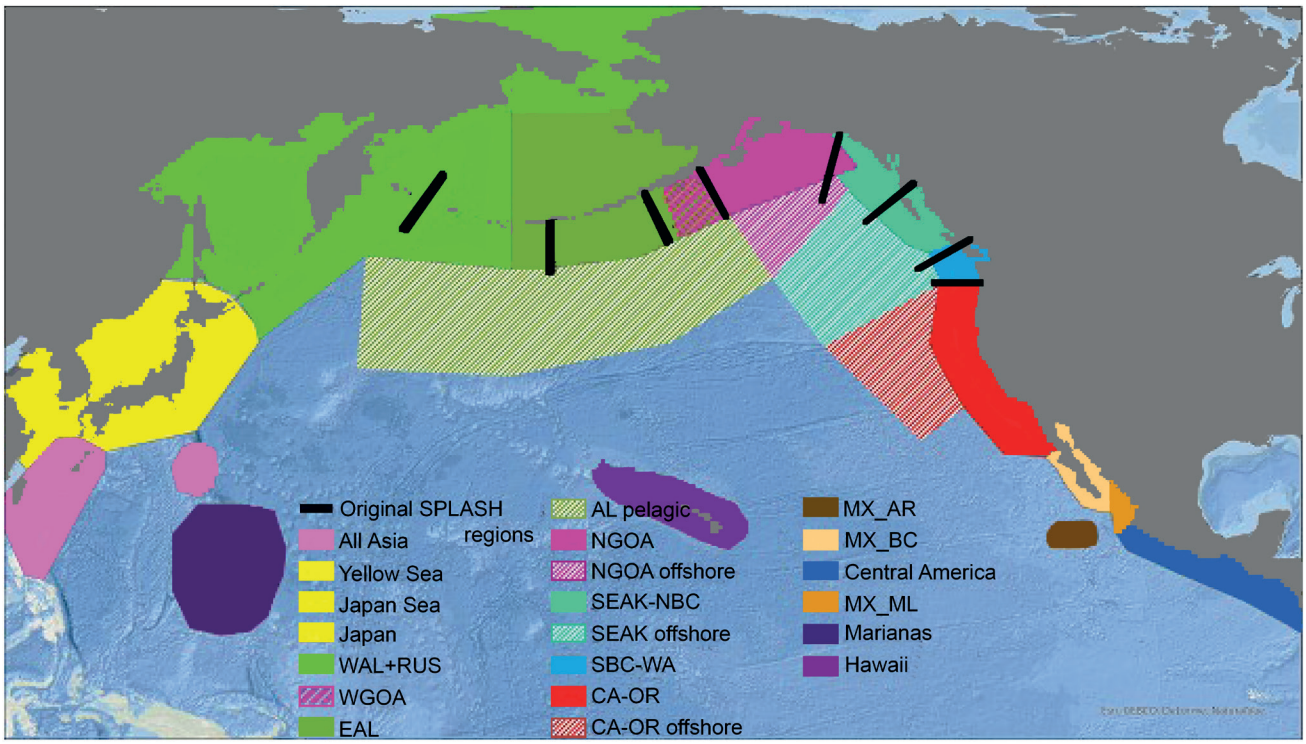


Fig. 4. Regions and region boundaries agreed by the Working Group on 20 April 2021; dark lines represent the boundaries from the original SPLASH project (as shown in Calambokidis *et al.*, 2008).

7.2 Biennial workplan

In 2023, the Committee will review new biological information and catch information on species and stocks subject to aboriginal subsistence whaling.

8. WHALE STOCKS NOT SUBJECT TO DIRECTED TAKES BY CONTRACTING GOVERNMENTS

8.1 Comprehensive or In-depth Assessments (IA)

8.1.1 Comprehensive Assessment of North Pacific humpback whales

The Comprehensive Assessment of North Pacific humpback whales began in 2016 (IWC, 2017f) with an intersessional workshop held in 2017 (IWC, 2018a). Since then, the type of assessment model to be applied has been refined (simplified given the nature of the available data; IWC, 2018a), additional analyses of abundance and genetic data have been undertaken, the structure of the areas included in the modelling and data analyses have been modified, and commercial catch series have been updated. In addition, the set of stock structure link assumptions (number of breeding stocks and the feeding areas to which they migrate) have been updated during discussions of the Scientific Committee. SC/68D/IA/02 provided a summary of the areas on which the Comprehensive Assessment will be based, the current set of stock-structure hypotheses, and the data currently available for inclusion in preliminary model runs. Available data include commercial catches, limited bycatch data, indices of absolute and relative abundance based upon photo-ID methods and estimates of mixing rates based on photo-ID and genetic samples.

8.1.1.1 Review Progress from Intersessional Work

IWC (2022a) reported the latest changes to the regions and the boundaries among them, together with the rationale for those changes. At the time of SC68C, there were still questions regarding the location of the boundary between the Mexican and Central American winter breeding grounds, but no changes to the boundaries are proposed at present. Fig. 4 shows all the regions considered in the modelling; how they are combined into strata (combinations of regions that will form the basis for the modelling) is shown in SC/68D/IA/02 table 1.

Two stock structure hypotheses are considered: B1, in which there are five stocks, i.e. all the whales that breed off Mexico are treated as a single stock; including Mainland (ML), the Archipiélago de Revillagigedo (AR) and Baja California (BC); and B2, in which the whales that winter off Mexico are divided into two breeding stocks, MX-AR and MX-ML. The whales found off Baja California are excluded from scenario B2 based on evidence of mixing with MX-AR and MX-ML. There are two hypotheses regarding how the feeding grounds are combined for modelling: F1 and F2. These hypotheses differ

in terms of whether the WGOA region is included with the NGOA region (F1) or with the Bering Sea and eastern Aleutians regions (F2). The hypotheses regarding breeding stocks and feeding grounds lead to four 'cases' (B1F1, B2F1, B1F2, B2F2). Note that the nomenclature for these scenarios differs somewhat from that reported in Lizewski *et al.* (2021b).

Estimates of removals are available by type (commercial, bycatch, aboriginal) by stratum, with a set of 'high' and 'medium' catches for the Asian breeding group and CA-OR feeding ground. The availability of non-whaling bycatch data varies considerably by area. Estimates of removals from sources such as fishing gear entanglements and ship strikes are comparatively good but still very much incomplete for the United States (west coast and Alaska); these data come primarily from U.S. Stock Assessment Reports, although these data do not extend back farther than, at most, the 1990s. A review of large whale mortalities from fishery interactions from 1982 to 2017 was recently published (Saez *et al.*, 2020). This summary will be very useful for the assessment, but it does not include ship-strike mortalities. Allocating bycatch from some US areas to breeding stocks is difficult given the mixing of multiple stocks, although photo-id and genetic data can be used to assume mixing proportions and stratify accordingly. The assessment model is structured to assign catches (commercial and bycatch) to a breeding stock based on estimated mixing rates. Japanese and Korean bycatch data are available for the last several decades, but these require careful parsing (with assistance from local colleagues) to assess the nature of the events. Since the number of removals from non-whaling sources is substantial in some areas, it will be important for the assessment to undertake as much of a review of existing data as is possible.

Aboriginal catches of humpback whales from North America are likely insignificant, though few or no data exist to estimate the degree of any such removals. Midden data showed that the Makah took humpback whales in similar proportions as gray whales. The Nuu-chah-nulth (southern Vancouver Island) had about 80% of their catch as humpback whales and 20% as gray whales. However, projecting the absolute numbers will be difficult for several reasons. The aboriginal catches could potentially be addressed with sensitivity testing as part of the modelling work.

Whaling catches offshore often do not fall spatially within one of the designated areas for the assessment, but for the model are assigned to one or more of these (Ivashchenko and Clapham, 2021).

Several sources of abundance estimates are available based on photo-ID data. Table 3 of SC/68D/IA/02 lists the estimates of abundance for the summer (feeding) and winter (breeding) periods based on SPLASH, which are assumed to refer to the years 2003-06 in the population model. A time-series of photo-ID-based abundance for the OR-CA stratum using the methodology of Calambokidis and Barlow (2020) was extended to 2020 (SC/68D/IA/02, table 4), and estimates of abundance for Mexico were also available (SC/68D/IA/02, table 5).

A photo-ID based dataset of 184,500 identified encounters of 30,100 individuals has been gathered by Cheeseman from a broad research collaboration and public citizen science contributions. This dataset will be used to model population status from 2004, the start of the SPLASH study (Calambokidis *et al.*, 2008), to the present. Photo-ID images have been identified and reconciled using automated image recognition (Cheeseman *et al.*, 2021). A Chapman-Peterson population model will be applied to estimate year-by-year population status for the full North Pacific as well as eastern North Pacific populations where sample sizes are largest. Other available abundance estimates are given in SC/68D/IA/02 table 6.

A key input to the model is the proportion of each breeding stock on each feeding ground (which is assumed in the modelling to be time-invariant), and the proportions that each breeding stock constitutes of the animals on each feeding ground (which can change over time owing to changes over time in numbers by breeding stock). There are two sources of information on mixing rates (photo-ID and genetic). SC/68D/IA/02 also gives estimates of mixing proportions for each case based on photo-ID data (table 7) and genetic analyses (table 8).

8.1.1.2 Review New Information

Previously, photo-ID data were collected by the SPLASH project for three years (2004-06) in winter areas and for two years (2005-06) in summer areas. In addition, the total abundance for the entire North Pacific was estimated by Barlow *et al.* (2011) to be 21,808 (CV=0.04) in this period. SC/68D/IA/03Rev1 provided revised estimates of abundance and migratory destinations/exchange rates for North Pacific humpback whales in summer feeding areas and winter mating/calving areas. Based on genetic analyses (Baker *et al.*, 2013) and an examination of migratory destinations, winter areas were defined to be:

(1) Asia (including Ogasawara, Okinawa, and the Philippines);
(2) Hawai'i;
(3) Mexico; and
(4) Central America.

A second scenario was run specifying five winter areas, with Mexico split into two areas, the Revillagigedo Islands and mainland Mexico. Based primarily on interchange (or lack thereof) between adjacent areas, and an examination of migratory destinations, summer areas were defined to be:

(1) Russia/western Aleutian Islands;
(2) the eastern Aleutian Islands and the Bering Sea;
(3) the Gulf of Alaska;

(4) Southeast Alaska and northern British Columbia;
(5) southern British Columbia and Washington; and
(6) California and Oregon.

A second scenario was run, also with six areas, with the western Gulf of Alaska sampling area (primarily the Shumagin Islands) pooled with the eastern Aleutian Islands/Bering Sea. A multi-state mark-recapture model was fit to the photo-ID data using a six-month time-step, with the four or five winter areas and the six summer areas defined to be the sample strata. Results showed a strong migratory connection between the Russia feeding area (abundance estimated at *n*=1,382, CV=0.23) and the Asia winter area (*n*=1,110, CV=0.09). The feeding areas in Alaska, as well as northern British Columbia, support the majority of the North Pacific population, including the eastern Aleutian Islands and Bering Sea (*n*=7,947, CV=0.21), the Gulf of Alaska (*n*=2,140, CV=0.08), and Southeast Alaska and northern British Columbia (*n*=5,925, CV=0.08). Those feeding areas all have a strong migratory link to Hawai'i (*n*=11,501, CV=0.04), with the link between Southeast Alaska/northern British Columbia and Hawai'i (0.98) particularly high. On their return, nearly all Hawai'ian whales migrate to Alaska and northern British Columbia. The migratory destination of whales that winter in Mexico (*n*=2,943, CV=0.07) is the most diverse, with whales going to all feeding areas. Nearly all Central American whales (*n*=750, CV=0.25) migrate to California and Oregon to feed (0.96), but the California/Oregon feeding area (*n*=1,500, CV=0.13) represents a mix of whales from Mexico and Central America. It was noted that the high precision of many of the CVs associated with the abundance estimates likely only reflect sampling error, where modelling uncertainty has not been accounted for in the analysis.

The Wade multi-strata model fixes parameters for areas of potential interchange where SPLASH found none and the model of SC/68D/IA/06 is based on the linkages on which SC/68D/IA/03Rev1 was based. Potential linkages between breeding and feeding grounds can be based on interchanges detected in the much larger dataset of approximately 184,000 identified encounters of more than 30,000 individuals gathered through the Cheeseman *et al.* North Pacific photo-ID collaboration. Parameters can be fixed as zero for regions that show interchange rates of zero or below a threshold determined to have no significance to the model.

The allocation of catches from the feeding grounds to breeding stocks is one of the objectives of the Comprehensive Assessment of humpback whales in the North Pacific. This catch allocation is complicated by the mixing of individuals from different breeding stocks on shared feeding grounds. Previously (Lizewski *et al.*, 2021b; SC68C/IA/01), mixed-stock analyses of mtDNA haplotypes were used to estimate the apportionment of humpback whales from feeding areas to breeding regions (i.e. source stocks), as a proxy for allocation of historical catches. SC/68D/IA/05 updated the frequencies of mtDNA haplotypes from regional samples collected during the SPLASH project from 2004 to 2006, adding nearly 1,000 additional samples to the 1,800 published previously (Baker *et al.*, 2013). Following a review of initial modelling efforts following SC68C, and subsequent discussion by the Intersessional Steering Group on the Comprehensive Assessment, these mixed-stock analyses were updated to include microsatellite genotypes and to focus on four scenarios: two for stratification of breeding regions and two for stratification of feeding areas. SC/68D/IA/05 also included a 'reverse' mixed-stock analysis with mtDNA, in which the feeding areas were considered to be the source stocks. The results of the mixed-stock analysis using mtDNA replicate results reported previously (Lizewski *et al.*, 2021a) together with the previous data were made available for modelling efforts intended for the Comprehensive Assessment, and results are summarised in SC/68D/IA/02.

The mixed stock analysis in SC/68D/IA/05 recommended that the strata of B3/F2 be proposed as a preferred base case scenario for the Comprehensive Assessment. In particular, when the Bering Sea, the Western Aleutians and the Western Gulf of Alaska are combined in the F2 stratum [BER+WAL+WGOA], all pair-wise comparisons of the feeding areas are highly significant. Meanwhile, the B3 stratum recognises mainland Mexico and the offshore Revillagigedo Archipelago as different breeding stocks based on significant differences in haplotype frequencies from biopsy samples.

In the Wade model (SC/68D/IA/03rev1), F2 (B1/F2) is favoured over F1 because it stabilises the results, and is more consistent with the genetic analysis. It would be useful to investigate the practicality of running the assessment model with five breeding areas, by splitting Mexico into two breeding areas (a B3 strata).

From 1995 to 2019, Oregon State University conducted satellite tagging and tracking studies of humpback whales at several locations in the North Pacific with the goal of describing their movement ecology across foraging grounds from the eastern Aleutian Islands to Southern California, and in the breeding ground of the Hawai'ian Islands. A total of 189 skin biopsy samples were collected from tagged whales for stable isotope and genetic analyses (SC/68D/IA/01). Preliminary results showed the following: (i) high isotopic niche width for samples collected in the Hawai'ian breeding ground compared to the foraging grounds, indicating that this region is visited by a mix of whales from different foraging grounds; (ii) there was little overlap in the niche width among several foraging grounds, indicating regional variation in prey preferences (e.g. trophic level) and/or differences in baseline isotopic values among foraging grounds; (iii) foraging grounds varied in niche width from low (northern Washington) to high (Oregon-northern California), likely a reflection of the extent to which the whales remain within a limited foraging area. These results agree with satellite tagging data in terms of the diversity of migratory routes to foraging grounds followed by animals tagged in Hawai'i, and the regional differences in movement behaviour and patterns of habitat use by whales tagged in the foraging grounds.

It was noted that the turnover rate of skin is an important factor to consider when interpreting the stable isotope results. For blue whales, this rate was estimated at 90-169 days (Busquets-Vass *et al.*, 2017), but a turnover rate has not been determined for humpback whales. Timing of sample acquisition (e.g. early or later in the feeding season) is also important to consider. It is currently not clear how the stable isotope data can be used to help estimate mixing rates, but a qualitative (rather than quantitative) approach might be useful. The Oregon State study will attempt to access a large body of additional stable isotope data from Bree Witteveen to further refine their analysis.

A preliminary run of the assessment model was conducted during the meeting, with results provided in SC/68D/IA/06. The population model is an age-aggregated population dynamics model in which density dependence is a function of the relative abundance by feeding ground. The model also tracks abundance by breeding stock for each feeding ground. The version of the model applied here assumes feeding ground fidelity, although a version of the model exists that allows for straying between feeding grounds. The model assumes that animals are uniformly distributed across feeding and breeding grounds. Catches are consequently removed in proportion to the stocks found in the areas concerned. The analyses are based on the 'medium' catch series. The genetics data on which these analyses are based are the combination of mtDNA and microsatellite data (Lizewski *et al.*, 2021b). The abundance estimates for the OR-CA feeding ground are restricted to years 1989 to 2007 due to convergence issues. Mixing proportions that do not match the presence-absence matrix were ignored during model fitting. New data should be able to help clarify this, and ultimately a decision will need to be made regarding the extent to which 'rare' movements (e.g. Hawai'i to Mexico) should be included or ignored in future work. The data for the model are outlined in full in SC/68D/IA/02.

In general, the model trajectory overlaps with the confidence intervals of the abundance estimates, although this is not the case for the unused estimates of abundance (notably the estimate for Mexico for 2003-06). The model is unable to fit the change in abundance for the OR-CA feeding ground since 2005, and particularly after 2014 when the estimates increase markedly to the point where the rate of increase becomes biologically impossible if the OR-CA is demographically closed. Fits of the model to the mixing proportions are generally adequate but there are some obvious cases in which the mark-recapture-based estimates and the genetics-based estimates appear inconsistent (e.g. the fits to the data on the split of the OR-CA feeding ground to breeding stocks).

The model suggests that the total population was never substantially depleted because the large Hawai'ian component of the population was never subject to catches on the breeding grounds. In contrast to the other breeding stocks, the Mexican and Asian breeding stocks have yet to recover. The Hawaii breeding stock is actually estimated to be larger now than at pre-exploitation equilibrium; this is a consequence of the assumption that density-dependence operates at the feeding and not breeding ground level. There is considerable variation in when and to what extent individual feeding and breeding grounds were depleted and then rebuilt.

The inability of the model to mimic the estimates of abundance for the OR-CA feeding ground, with unrealistic rates of growth exhibited in the results after 2014 potentially highlights a broader issue with regard to North Pacific whales during this time period. Beginning in 2014, a marine heatwave in the eastern Pacific had significant impacts on prey availability and was accompanied by a dramatic decline in sightings of humpback whales in Southeast Alaska (Gabriele *et al.*, 2022) where many known individuals disappeared despite often very long histories in the area. Unusually low sighting rates were also observed in Hawai'i. The mortality rate from this event is unknown, but will likely become clearer over the next few years from long-term studies in Alaska and elsewhere. Some individuals very likely died, while others may have shifted foraging grounds to unstudied areas (notably to offshore waters in the Gulf of Alaska, which were once the site of large whaling catches). The event had known impacts on humpback whale reproductive rates and probably on survival, particularly among calves and yearlings.

8.1.2 Comprehensive Assessment of North Pacific sei whales

The Comprehensive Assessment of North Pacific sei whales has been structured around attempts to integrate information from the following sources of data: (a) historical commercial catches; (b) estimates of recent absolute abundance from POWER and other surveys; (c) indices of relative abundance derived from other surveys and scouting vessels extending back to 1965; and (d) data from Discovery marks and recoveries. A multi-area age-structured population model has been developed by Punt that integrates the above sources of data into a common likelihood framework. The work to date has proceeded on the basis of two working hypotheses regarding the population structure: (i) a single stock of sei whales distributed throughout the North Pacific; and (ii) five stocks, centred on five designated sub-areas, but with some overlap in their summering grounds (Fig. 5). The sub-areas are Western Coastal, Aleutian, Pelagic, Eastern North Pacific and Eastern Coastal. A mixing sub-area was also defined in the Gulf of Alaska containing whales from Aleutian, Pelagic and Eastern North Pacific. There has not been a consensus on the relative plausibility of the two hypotheses.

In 2021, the Committee agreed that the catch series can now be considered sufficiently complete for assessment purposes. Furthermore, the Committee agreed that no further refinements to the catch, marking and relative abundance data were required. The Committee also agreed that it may not be possible to find an assessment that reconciles all the available information due to fundamental conflicts in the data, identified by the Committee in previous years, i.e. the

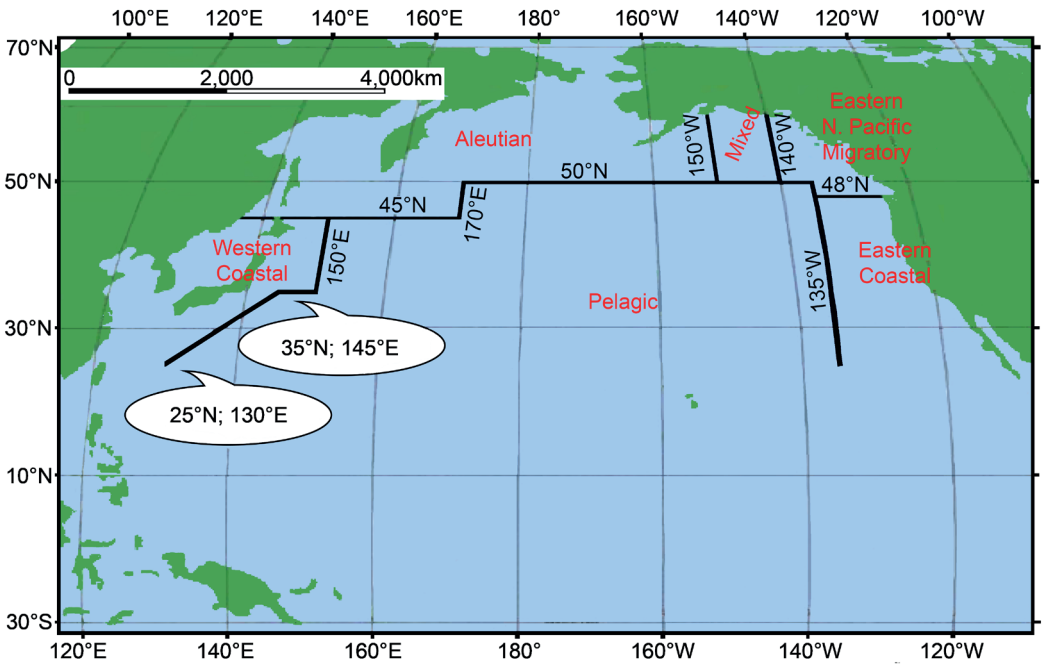


Fig. 5. The 6 sub-areas used in the Comprehensive Assessment for North Pacific sei whales.

absolute recent abundance for the Pelagic sub-area suggests a population that is much less depleted than indicated by the relative abundance and mark-recapture data. The point estimate of abundance for the Pelagic sub-area (approx. 30,000 whales) exceeds the inferred pre-exploitation size of the population in that sub-area.

The Committee reiterates that it is important that: (1) the input data and the model fits that were explored be documented in one place; and (2) the available information on sei whales in each area of the North Pacific be summarised to provide a general picture of the status of the historical and current status of the species in each sub-area.

8.1.2.1 Review Progress from Intersessional Work

The Intersessional Steering Group reported that work on the summary document is not yet complete and work will have to be continued during the next intersessional period. The Committee agrees frequent virtual meetings of the Intersessional Steering Group are required to progress this work in the intersessional period.

8.1.2.2 Review New Information

SC/68D/IA/04 reported on systematic distance sampling surveys conducted in offshore waters of the Canadian Exclusive Economic Zone in 2018, 2019 and 2021. During these surveys, four groups of sei whales (five individuals) were observed in 2018 and 37 groups (93 individuals) were observed in 2021, while no sei whales were sighted in 2019. A large, dispersed aggregation of 25-30 sei whales was observed during the 2021 survey and skin samples were collected from two individuals. Most sightings in 2018 and 2021 were made in an area characterised by the presence of large seamounts. Differences across years are reminiscent of observations from whalers that sei whales could abruptly appear or disappear from certain areas.

The Committee welcomes this new information representing proof of sei whale summer presence in Canadian coastal waters. It was noted that the expansion of the surveys into Canadian waters a little further offshore than previous surveys probably led to sightings of sei whales. The Committee encourages abundance analysis of the survey data to provide an estimate for use in the assessment.

Furthermore, in discussion it was noted that until now genetic samples had only been available for analysis from the Pelagic area and that genetic information from coastal areas could provide valuable insights. The Committee strongly recommends that samples from coastal areas of Canada and Japan be made available for genetic analysis to help progress the Comprehensive Assessment.

The abundance estimates by Hakamada *et al.* (2009) and Hakamada and Matsuoka (2016b) were reviewed by the ASG group (Item 3.8. ASG pre-meeting report) and the ASI group (Item 11.1.6). The ASG initially proposed to recommend endorsement as Category 1A for all of the estimates, including those given by subarea and their subdivisions, while emphasising that these estimates are only representative of specific locations and periods. Subarea-yearly estimates are the level needed for the assessment model. During discussions in ASI, concerns were raised regarding the appropriateness of combining survey data from multiple years especially when based on small sample sizes with the potential biases due to migration. The Committee created an Intersessional Correspondence Group under ASI to investigate these issues and noted

that continued revisions could change the final input data for the assessment. Due to the importance of the conclusions of this group to the North Pacific sei whale assessment, this Intersessional Correspondence Group has now been assigned to the In-depth Assessment sub-committee.

In discussion, a discrepancy between delineations of survey strata in Hakamada *et al.* (2009) and Hakamada and Matsuoka (2016b) and those of the sub-areas of the assessment was noted. It was explained that for assessment purposes data often had to be aggregated differently than originally provided by a survey analysis. It has previously been concluded that re-organising the information from the surveys for purposes of the assessment was appropriate as long as the original input data were reviewed and approved by ASI. Furthermore, it was noted that abundance estimates in both papers reviewed by ASI referred to different years than those currently used in the assessment and that some clarification was needed. The Committee agrees that a check for consistency between the numbers and years from the surveys and those currently used in the assessment should be part of the work towards the summary document. Furthermore, the Committee strongly recommends documentation of all data manipulation and steps taken towards the assessment for future replicability be included in the assessment summary paper.

The Committee was informed about the ongoing efforts to obtain information on bycatch and strandings of North Pacific sei whales and encourages detailed time series to be developed intersessionally so they can be used in the assessment.

Environmental change as a potential cause for a change in habitat use of sei whales was discussed. It was noted that a project under Kitakado had looked into environmental factors affecting the distribution of sei whale sightings in the Pelagic area. Kitakado agreed to summarise the latest status of the project for presentation during the next meeting. The Committee welcomes this information and looks forward to receiving the update in 2023.

8.1.3 Western North Pacific common minke whales

The In-depth assessment of western North Pacific common minke whales is based on three stock hypotheses (see Fig. 6 for a map of the sub-areas):

(1) there is a single J-stock distributed to the west of Japan (sub-areas 1W, 1E, 5, 6W, 6E, 10W and 10E), the Pacific coast of Japan (sub-areas 2C, 7CS, 7CN) and the Okhotsk Sea (sub-areas 11 and 12SW), and a single O-stock in sub-areas to the east and north of Japan (2C, 2R, 3, 4, 7CS, 7CN, 7WR, 7E, 8, 9, 9N, 10E, 11, 12SW and 12NE) (referred to as hypothesis A);
(2) as for hypothesis A, but there is a third stock (Y) that resides around the Korean peninsula (sub-areas 1W, 5 and 6W) and overlaps with J-stock in the southern part of sub-area 6W (referred to as hypothesis B); and
(3) there are four stocks, referred to Y, J, P, and O, two of which (Y and J) occur to the west of Japan, and three of which (J, P, and O) are found to the east of Japan and in the Okhotsk Sea (referred to as hypothesis E). Stock P is a coastal stock.

The operating models for western North Pacific common minke whales were originally developed as part of an RMP *Implementation Review*, but following Japan leaving the IWC, the Committee had agreed that it was appropriate to continue the work in the form of an In-depth Assessment (IWC, 2021c, p.22) that will include a focus on the effects of bycatch, particularly on the J-stock, whilst recognising that Japan could continue whaling using domestically-set catch limits. During the intersessional period Allison, de Moor and Katara continued to finalise the development of the operating models on which the In-depth assessment will be based, including conducting preliminary fits of base-case versions of these models for each of the three stock hypotheses. The work was assisted by a Steering Group established at last year's (2021) annual meeting.

The changes recommended at last year's meeting (item 8.1.3 of IWC, 2022a) were implemented as agreed. These involved:

(1) treating estimates of abundance for areas with less than 70% survey coverage as 'minimum abundance estimates' (except in sub-areas where there are no other estimates);
(2) changing how the 'minimum abundance estimates' are generated;
(3) refining the maximum sizes for each survey estimate for sub-areas 5 and 6W;
(4) revising how zero abundance estimates are included in the likelihood function;
(5) updating the data on effort used when calculating historical bycatches off Japan and Korea; and
(6) revising the way that projections of bycatch are conducted.

The Committee had also requested that the model expectation for an abundance estimate based on a survey conducted during multiple months should be based on weighting the model predictions using the proportion of the months during which the survey occurred. However, this was not possible owing to a lack of data in some cases. Consequently, in all cases, if fewer than 20% of the days of any survey occurred during a given month, that month was not used as part of the survey-time-period in the likelihood equation.

Allison reported that the abundance estimates for sub-areas 10E (2002, 2003, 2005 and 2007), 12SW (1990), 12NE (1990, 1992) and 9 (1990) were revised based on updated information received from Japan on sub-area size (sub-areas 10E, 12SW, 12NE) and an inconsistency between the agreed total estimate for the northwest Pacific of 5,841 (Buckland and

Cattanach, 1992) and the abundance estimates computed for sub-areas 7, 8 and 9. Allison advised that some abundance estimates used for the 2003 and 2007 *Implementation Simulation Trials* had been omitted from those used in the 2013 trials (sub-areas 6 and 10 in 1992; sub-area 10E in 2007), but are now used, following endorsement of their inclusion by the Steering Group. Any estimates that are new or revised are being or will need to be reviewed by the sub-committee on ASI (see Item 11). Updates of the numbers of nets and bycatches off Japan received at SC68C have been incorporated into the assessment.

de Moor summarised key changes to the model structure, the model fitting process and how the data sets are generated (see SC/68D/IA/07 appendix A for the latest specifications for the trials). Specifically, the actual rather than model-predicted bycatches are now removed from the population when actual estimates of bycatch are available. The mixing matrices have been updated to improve the fits to the data and introduce constraints to implement an upper bound on the abundance in sub-areas 2C, 2R, 3 and 4 (sub-areas for which there are no abundance estimates and for which abundance is inferred based on the mixing matrices). The constraints implemented were a maximum of 300 individuals (all months in 2009) for sub-area 2C and 500 individuals (August and September in 2009) for sub-area 2R. The model-predicted proportions are now based on the 1+ (rather than recruited) population when the basic data are based on bycatch samples. The approach for generating pseudo abundance estimates now involves setting the mean of the overdispersed Poisson distribution assumed to the expected (model-predicted) abundance (based on the fit of the deterministic operating model to the actual data) rather than to the observed value when the actual abundance estimates are zero.

de Moor provided summaries of the model fits to the data for hypothesis B. All model estimates of abundance that relate to minimum abundance estimates are now above or within the 90% intervals for the data. The Committee noted that there were some cases where fits are not ideal, but that the fits are generally adequate. It was noted that the abundance estimates and mixing proportions are fitted ignoring additional variance. The need to account for additional variance in survey estimates will be revised once final conditioning results are available, but the results for stock hypothesis B provide little evidence to suggest that incorporating additional variance is required. In contrast, the preliminary fits to the mixing proportions for stock hypothesis B are either suggestive of appreciable additional variance or of model misspecification (see Appendix B in SC/68D/IA/07). While the fits to these data may improve with further work, the Committee agrees that mixing proportions by year (the model is fit to genetic assignment data aggregated over multiple years) should be included on the plots (achieved during the meeting) and that the data based on bycatch samples and scientific permit catches should be distinguished in the plots. The data on mixing proportions should be used to: (1) estimate additional variance if the mean proportions vary over time and allow for additional variance during conditioning and when generating bootstrap data sets (perhaps using a beta-binomial distribution or by fitting to the annual proportions); and (2) determine if there are trends in mixing rates over time.

Allison, de Moor and Katara developed new diagnostic plots to assist with the review of whether the distributions of abundance spatially and over time match expectations. The Committee agrees that the maps of pie charts showing the numbers of age/sex categories were useful to understand the model predictions of changes over time and will provide a useful basis to assess the plausibility of the model outputs (see Appendix B in SC/68D/IA/07 for examples). The Committee noted that the population model did not fit some of the proportion data well, partially due to changing the mixing matrices to impose constraints on the size of the populations in sub-areas 2C, 2R, 3 and 4. It was agreed that some (limited) further modification to which of the parameters of the mixing matrix parameters are estimated should be undertaken to attempt to improve the fits to the mixing proportion data.

The Committee agrees that the population model should be fitted to mixing proportions in sub-area 11 that are disaggregated between samples from bycatches and from special permit catches to assist the Committee to evaluate model fit. It noted that this evaluation should account for sample sizes, which can be low. The Committee agrees that the trial specifications for Hypothesis E should be updated to allow P-stock to be found in sub-area 11 from October-December, given data that suggest this is the case (3 of 10 male and 1 of 11 female bycatch samples in Oct.-Nov. assigned as P-stock).

Once conditioning is complete, the results of the projections of the operating model should be summarised using the relevant performance statistics for *Implementation Simulation Trials* along with summaries of total removals and those due to bycatch. Projections should be conducted for: (1) no future removals; (2) future Korean bycatch only; (3) future Japanese bycatch only; (4) future Korean and Japanese bycatch; (5) as for (4) plus the current annual catch limit by Japan of 167 minke whales; and (6) as for (5) except that the commercial catch limit by Japan doubles over the 100-year projection period. The Committee agrees that additional removal scenarios could be explored (e.g. levels of reduction in bycatch, Japanese catch limits linked to abundance) once the first set of results become available.

The Committee noted that substantial progress has been made towards completing the In-depth assessment and thanked Allison, de Moor and Katara for their considerable work during the intersessional period as well as during the current meeting in response to requests from the Committee for revisions to the diagnostic plots. It expressed appreciation to the Steering Group for reviewing material during the intersessional period and reviewing proposed changes to the data and model structure.

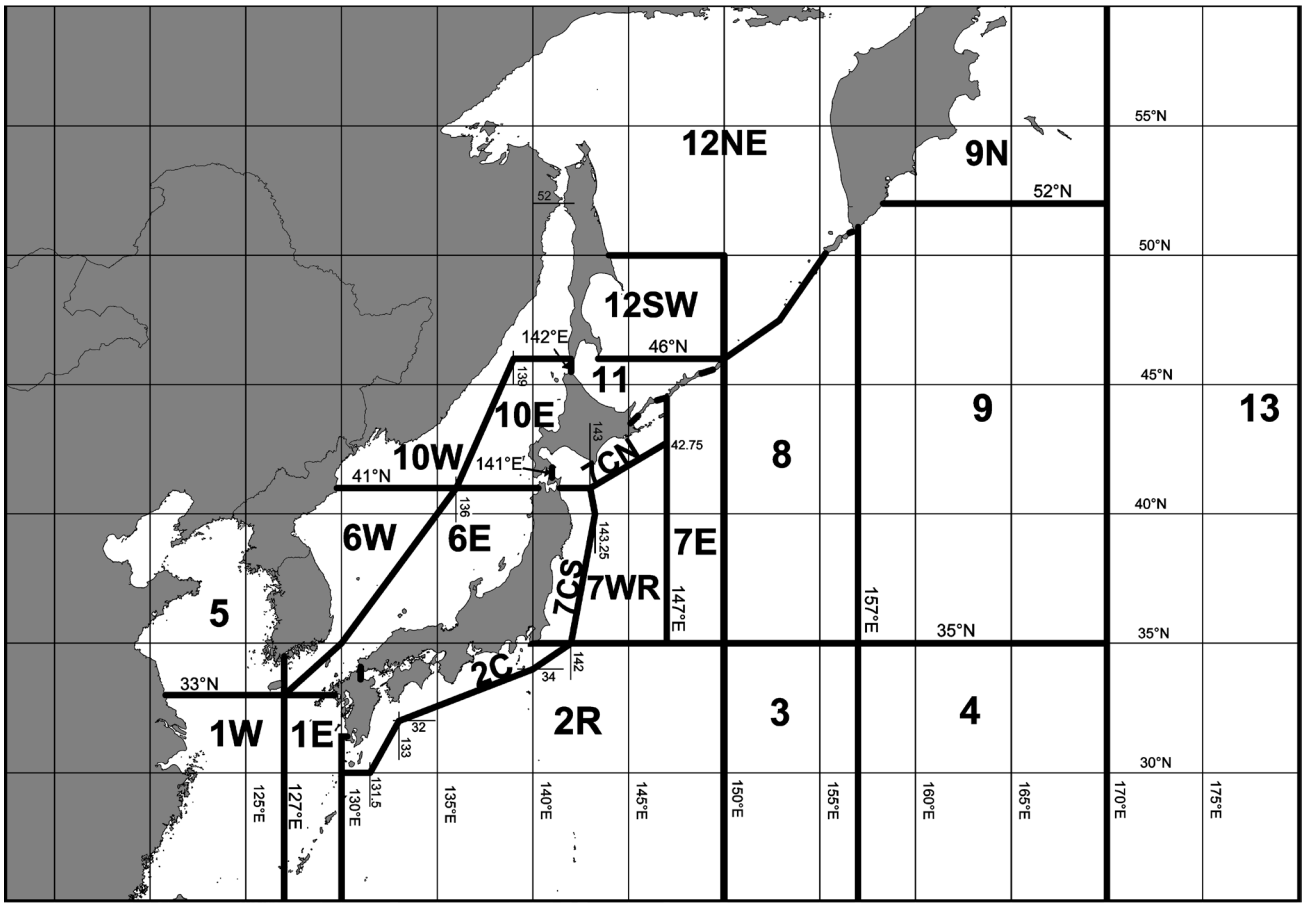


Fig. 6. The 22 sub-areas used in the In-depth assessment for western North Pacific common minke whales.

The next steps for the In-depth assessment are as follows.

- Finalise the conditioning and check that this has been achieved satisfactorily.
- Assess if there are any data, not used for conditioning, that could be used to assess whether the results are realistic/plausible.
- Project the population forward under scenarios for realistic levels of future bycatch and commercial removals.
- Determine the statistics and plots to be used to review the results of the projections and to develop advice on the status and the need, if any, for provision of bycatch management advice.

Three years ago, the Committee had approved funds to hold an intersessional workshop to further this In-depth assessment, but it had not been possible to hold the workshop this year prior to the Scientific Committee meeting. The ideal way to complete the In-depth assessment is through an in-person meeting during which it will be much easier to efficiently and effectively review the many diagnostic plots and tables related to conditioning, finalise plots and tables to summarise model outputs, and draw conclusions regarding the consequences of alternative removal scenarios. The Committee, therefore, reiterates its support for holding the workshop prior to the next SC meeting provided sufficient intersessional progress has been made to warrant holding the workshop before the next Annual Meeting. The workshop should also examine evidence regarding dispersal rates among stocks for stock hypothesis E, including information from parent-offspring pairs and the results of the BayesAss analyses. Bayesian posterior distributions for assignments can be used to estimate contemporary migration, but such estimates need to be understood within the context of the strength of assignments using Geneland. Taguchi reminded the Committee that if new analyses using ICR data are to be undertaken the ICR Data Sharing Protocol must be followed.

The Committee agrees that progress on the In-depth assessment will be enhanced by virtual meetings of the Steering Committee before the intersessional workshop. It further agreed that after the meeting and prior to the proposed workshop, priority should be given to conditioning the baseline trials. These trials should each be based on 100 parameter vectors obtained by bootstrapping. Whether it is necessary to capture parameter uncertainty using bootstrapping for the sensitivity tests should be decided by the Steering Group during a virtual meeting by comparing results for the fits to the

actual data and those based on the 100 parameter vectors for the baseline trials. The Committee also agreed that the Steering Group should prioritise the current set of sensitivity tests using the differences in the estimates of current J- and O-stock depletion from the 2013 *Implementation*.

The Committee noted that the resulting distributions by stock, age and sex generally matched the qualitative patterns expected from existing data on changes in catches and length frequency. However, there was insufficient time during the meeting to explore the distribution plots in detail and the Committee agreed that the distributions for the three baseline stock hypotheses for the two MSY rates based on fitting to the actual data (not the 100 bootstrap data sets) should be examined further by the Steering Group in roughly a month from the present meeting at a virtual meeting. Involvement by Japanese and Korean scientists familiar with the population dynamics and distribution of western North Pacific minke whales would assist in the review progress. Unrealistic model predictions of stock distributions by sex and age could lead to a stock hypothesis being assigned a low plausibility. The Steering Group may advise that the focus of work for the intersessional workshop (running sensitivity tests and the fitting to bootstrap replicates) should be on those stock hypotheses that appear to be consistent with the actual data and the general understanding of movement and distribution patterns, but the final decisions regarding the plausibility of stock hypotheses will be made by the Committee at the next meeting based on recommendations from the intersessional workshop.

8.1.4 Biennial workplan and budget requests

The IA sub-committee is currently assessing three species (Items 8.1.1-8.1.3), where the status of the assessments are at different stages of completion. The Northern Hemisphere (NH) and Southern Hemisphere (SH) sub-committees are compiling and reviewing data from many species that may be used in future assessments (Item 8.2). Sufficient progress within these sub-committees has been made such that several species may be candidates for assessments within the next few years (Table 1). In other parts of this report, the Committee recommended the work needed to be completed to ensure the start of the assessment process. Some of this work has funding implications (Item 8.2).

To complete the Comprehensive Assessment of the North Pacific humpback whale by 2024 the Committee recommended that the Intersessional Steering Group be re-established under Cheeseman (Annex M). The terms of reference are to further the work towards the assessment, organise an in-person intersessional Workshop in late 2022 or early 2023 (location to be determined), and complete the assessment modelling. The intersessional workplan over the next two years would be aimed at further refining the input data, addressing outstanding issues for the assessment, and completing the development of the assessment model, including:

(1) gather better data on bycatch from as many areas and from as far back as possible, as described above (Palka, Wade, Brownell, Scordino);
(2) consider the incorporation of other abundance estimates, notably those to be developed by Cheeseman from the large-scale photo-ID collaboration (Cheeseman, Wade);
(3) refine the presence/absence matrix and assess how to deal with low but non-zero rates of exchange;
(4) determine how much additional model structure is required, and develop the model accordingly;
(5) assess the satellite tagging data to inform the assessment model regarding the presence/absence matrix among strata, the timing of occurrence, residency times and travel speed (Palacios);
(6) further the development of the assessment model and sensitivity scenarios (Punt and Privitera-Johnson); and
(7) arrange a Workshop in 2022 to further the assessment (Cheeseman).

Attention: SC, R

The Committee is undertaking a Comprehensive Assessment of North Pacific humpback whales. To complete the matching of the large-scale photo-ID effort, the Committee ***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.*

The Committee ***agrees*** *that to complete the Assessment by 2024 the input data should be finalised, reviewed, and incorporated into the assessment model.*

To facilitate this work, the Committee:

- ***re-establishes*** *an Intersessional Steering Group, convened under Cheeseman and* ***endorses*** *its workplan;*
- ***reconfirms its previous endorsement*** *for holding an intersessional workshop to complete or appreciably advance the progress of the assessment using funds allocated previously; and*
- ***endorses*** *the funding request for the assessment model analyses that are essential to this assessment.*

To complete the Comprehensive Assessment of North Pacific sei whales by 2023, the Committee recommends that the Intersessional Steering Group be re-established under Palka. The terms of reference are to further the work towards the assessment and document the previous work in the form of a synthesis document. The intersessional workplan would be aimed to create a synthesis document by:

(1) checking and documenting all input data;
(2) checking and documenting the final results of the model fitting;
(3) summarising the hypotheses explored to account for the lack of model fit; and
(4) summarising the status of sei whales in each area of the North Pacific, as possible.

Attention: SC
*The Committee **agrees** that to complete the Comprehensive Assessment of North Pacific sei whales by 2023 the input data and model fits previously explored be documented and the available information on sei whales in each sub-area of the North Pacific be summarised to provide a general picture of the status of the historical and current status of the species in each sub-area.*

To facilitate this work, the Committee:
- ***re-establishes** an Intersessional Steering Group, convened under Palka and **endorses** its workplan; and*
- ***reconfirms its previous endorsement** that the remaining budget allocation for the North Pacific sei whale population modelling work be carried over to allow Punt to complete and document the modelling work.*

To complete the In-depth Assessment of western North Pacific common minke whales by 2023, the Committee recommended that the Intersessional Steering Group be re-established under Donovan (Annex M). The terms of reference are to further the work towards the assessment, organise an in-person intersessional Workshop in late 2022 or early 2023 (location to be determined), and complete the assessment modelling. The intersessional workplan is detailed in Item 8.1.3.

Attention: SC
*The Committee **reiterates** the need to conduct an In-depth assessment of western North Pacific common minke whales with a focus on bycatch levels and the status of J-stock(s). Recognising the difficulties in holding the workshop agreed last year prior to SC68D, the Committee **reiterates** the importance of the workshop and:*

(1) ***recommends** that the funds allocated two years ago are used to hold a workshop by spring 2023;*
(2) ***agrees** that the primary objectives of the workshop are to: (a) build upon the work undertaken thus far on finalising and conditioning the operating models; (b) confirm or update levels of dispersal to include in the trials; (c) review the results of the conditioning and determine the necessary scenarios for future projections; and (d) develop a workplan that will allow for results to be presented to the 2023 Committee meeting, ideally enabling the In-depth assessment to be completed at that time;*
(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 of the workshop that will be held by spring 2023, and the list of invited participants; and (b) coordinate the pre-workshop work, including commenting on trial specifications and conditioning results; and*
(4) ***establishes** an Intersessional Correspondence Group under Kitakado to: (a) review the applicability of the accepted g(0) estimate from one cruise to other cruises; (b) investigate the possibility of estimation of additional variance; and (c) develop robust estimates for use in the In-depth assessments and/or provide management advice and/or to provide broader estimates for the public.*

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

8.2.1 Non-Antarctic blue whales in the Southern Hemisphere (SH)

The Committee is preparing for an In-depth assessment of non-Antarctic Southern Hemisphere blue whales. The pre-assessment was originally intended to be finalised in 2022 for handover to IA in 2023. Due to mainly pandemic-related difficulties in completing required actions, currently a completion in 2023 is envisaged for a hand-over to IA in 2024.

Table 11

Status of current and future Comprehensive and In-depth Assessments.

Species	Previous assessment	Subgroup currently working on species	Expectation where assessment will be completed	Expectation of when to start assessment	Report sections with more information
North Pacific sei whale	-	IA	2023	-	8.1.2
North Pacific humpback whale	2005	IA	2024	-	8.1.1
western North Pacific common minke whale	2013[a]	IA	2023	-	8.1.3
Antarctic blue whale	-	SH	-	2023	8.2.2
North Atlantic humpback whale	-	NH	-	2023	7.1.7, 7.1.8, 8.2.7
non-Antarctic blue whales	-	SH	-	2024	8.2.1
Southern right whales	2011/2012[b]	SH	-	2025 or 2026	8.2.3

Table 12

Workplan for Comprehensive and In-depth Assessments.

Item	Intersessional	Next Meeting	Intersessional	Subsequent meeting
Comprehensive Assessment of North Pacific humpback whales (Item 8.1.1)	Re-establish the ISG to further data preparation, development of the assessment model and hold a Workshop	Review progress of intersessional work and finalise/continue the assessment	If needed, re-establish the ISG to further data preparation, development of the assessment model	Review progress of intersessional work and finalise the assessment
Comprehensive Assessment of North Pacific sei whales (Item 8.1.2)	Re-establish the ISG to finalise assessment model, summarise the assessment process and status in a single synthesis document	Review progress of intersessional work and finalise the assessment		
In-depth Assessment of western North Pacific common minke whales (Item 8.1.3)	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	If needed, re-establish the ISG to further development of the assessment model and hold a Workshop	If needed, review progress of intersessional work and finalise the assessment
Comprehensive or In-depth assessment of other species		Determine for which species have sufficient available data to start an assessment	Establish ISG to commence the assessment process	Review progress of recently started assessments and determine if other species are ready to start an assessment

In the Southern Hemisphere and Indian Ocean, non-Antarctic blue whales are currently distinguished primarily by song-type and occur in the north-west Indian Ocean (NWIO, Oman), central Indian Ocean (CIO, Sri Lanka), south-west Indian Ocean (SWIO, Madagascar to Kerguelen), south-east Indian Ocean (SEIO, Australia to Indonesia), south-west Pacific Ocean (SWPO, New Zealand) and south-east Pacific (SEPO, Chile to Peru). In 2022, the Committee received new information on distribution, population structure, abundance and photo-ID matching.

8.2.1.1 Distribution

Thums *et al.* (2022) investigated migration and habitat use of SEIO pygmy blue whales (Western Australia to Indonesia) using satellite telemetry and passive acoustic monitoring. Data from 22 satellite transmitter deployments from 2009 to 2021 and from 46 acoustic recording devices (2006 to 2019) were used to quantify spatial and temporal pygmy blue whale distribution and to identify important areas for foraging, potential breeding and migration. Extensive slope habitat use and minimal use of shelf habitat along the West Australian coast were revealed with whales mostly engaged in migration, interrupted by short periods of foraging only. The whales stayed for prolonged periods of time (34% of the annual cycle) in Indonesian waters, where calving grounds may be located.

The Committee welcomed this information which provides valuable insights into spatiotemporal habitat use of SEIO blue whales, and noted that the detailed information on movement and distribution are in line with historical catch allocations which have been developed to support the upcoming blue whale assessment (Branch *et al.*, 2021).

In 2021, the Committee agreed to provide partial funding towards a field expedition to gather information on blue whales in the poorly studied low latitudes of the southwest Indian Ocean, organised by Cerchio (IWC, 2022a, item 8.2.1.3). This was intended to be an offshore expedition between Mayotte and Madagascar, including transect-based surveys as well as collecting acoustic, biopsy and photo-ID data and satellite tracking individuals with implantable tags. Due to a severe delay of co-funding, the team had to make major adaptations to their research plan. Instead of supporting an offshore expedition, the funds will now go towards coastal surveys (within a 30-40km range offshore of the northwest coast of Madagascar) within the migratory range of Antarctic and SWIO blue whales during the documented period of overlap of the two subspecies. The expedition is also collecting the acoustic, biopsy and photo-ID data described above, as well as satellite tracking individuals for shorter periods with LIMPET tags.

The Committee endorsed this revision to the survey design and considers this an effective way to maximise the use of limited resources.

New information was presented to the Committee about blue whale research being conducted off the Santos Basin in south-eastern Brazil. The monitoring program includes photo-ID, biopsy samples, and satellite tag deployments. Within the data collection period (2017 to 2021) ten blue whales were sighted along the shelf break, and five biopsy samples and six photo-IDs were collected. Comparison of photographs of four of the IDs to the Antarctic Blue Whale Catalogue did not reveal any matches. Two adult females were tagged with satellite transmitters during the austral winter (July). Both tagged individuals maintained trajectories parallel to the continental margin. One of the tagged whales stayed for some days in the area before beginning its migration south until ~30°S. The other whale began its migration south just a few days after being tagged, reaching ~45.2°S by the end of August, after which both tags stopped transmitting. Acoustic data has also been collected using sensors on gliders in different years in the Santos Basin region. The genetic samples collected by this program are expected to be analysed to determine the most likely population of origin by Sremba at Oregon State University.

The Committee welcomed this information from a region where information on blue whales is rare, and the subspecies identity is unknown. It was noted that the acoustic data presented on blue whales from Brazil is most suggestive of the presence of Antarctic blue whales, given the 'Z' calls detected in the study site. The sub-committee strongly encouraged the continuation this research, the contribution of photo-ID data to the Antarctic blue whale catalogue and presentation of a full report to the Committee at the next meeting.

8.2.1.2 Population Structure

A good understanding of population structure and migration patterns is necessary to conduct population assessments.

SC/68D/SH/10 reviewed the movements of blue whales from the Chilean coast and into the Eastern Tropical Pacific (ETP) using 872 photo-identified blue whales collected by six different research groups working in southern and northern Chile and the ETP, as well as opportunistic sightings. This effort provided 38 re-sightings within and between regions. One match was made between southern Chile and the southern ETP. Other matches were found within southern Chile (*n*=22) and within northern Chile (*n*=15, including 7 intra-seasonal matches), providing further evidence for strong site fidelity within feeding areas off Chile. No matches were found between northern and southern Chilean waters. The longest period between re-sightings was 18 years and one animal was seen 11 times in six different years, both times in southern Chile.

The Committee thanked the authors for this update and commended them on the additional matches, particularly in northern Chile, where previously only two matches had been found (Torres-Florez *et al.*, 2015). The matches between Chilean waters and the ETP, along with recent genotype matching and satellite tracking of whales between both locations (Hucke-Gaete *et al.*, 2018; Torres-Florez *et al.*, 2014b), add further support to the hypothesis that the southern ETP is an important wintering ground for Chilean blue whales. The Committee agreed that the continued lack of matches between northern and southern Chile and high number of resights within each of these two regions support strong site fidelity of Chilean blue whales during their feeding season (IWC, 2022a, item 8.1.2.1). The Committee encourages collection of biopsy samples off northern Chile for analyses (genetic, stable isotope, contaminants) to further clarify the relationships between blue whales in northern and southern Chile.

Attention: SC, R
To test if southeast Pacific blue whales exhibit persistent site fidelity to local feeding grounds, the Committee ***reiterates*** *that they* ***encourage*** *further collection of biopsy samples off northern Chile, as well as analysis of stable isotopes and contaminant profiles of individual whales off northern and southern Chile.*

8.2.1.3 Abundance

Intersessionally, the ASI Standing Working Group reviewed four available abundance estimates for SEPO Chilean blue whales and agreed abundance categories for each estimate (Item 3.10, Annex E).

Of the abundance estimates reviewed, three were approved for use in upcoming In-depth assessments as indicated by assigned ASI category 2 (Table 13):

(1) the Bedriñana-Romano *et al.* (2021) 2009 estimate of 356 (95% CI 191-625) for blue whales in Chilean Northern Patagonia, noting that the survey region was unlikely to cover the summer geographic extent for this stock;
(2) the Williams *et al.* (2011) 1997/98 estimate of 303 (95% CI 176-625) for blue whales along the Chilean coast (18°30´S to 38°S, between the 12n.mile boundary out to a boundary delineated by a combination of historical catch limits, the 200 n.mile EEZ and time limits of the survey), noting that the estimate is likely to be substantially negatively biased for the full population due to the location of the survey area; and
(3) the Cooke and Jackson (2017) estimate of 450 (CV=0.17) blue whales around Isla Chiloé and Isla Chañaral, noting that a review of the full details of the modelling will be required before this abundance estimate can be used for management advice.

An ASI category 3 was assigned to the Galletti Vernazzani *et al.* (2017) estimate, reflecting a concern that transient whales (whales encountered once, a large proportion of the encounter histories) had not been distinguished from residents within the mark-recapture analysis. The Cooke and Jackson (2017) estimate represents a re-analysis of the Galletti Vernazzani *et al.* (2017) data, addressing this problem by using a model differentiating between resident and transient whales.

The Committee thanks its ASI Standing Working Group for the advice and categorisation provided and agreed that the Cooke and Jackson (2017) estimate currently represents the best available estimate for population modelling, because this long-term photo-ID dataset is likely to encompass more of the population than the line-transect estimate (Williams *et al.*, 2011), and the Cooke and Jackson (2017) estimate is an improvement on Galletti Vernazzani *et al.* (2017) to account for resident and transient whales. However, an updated mark-recapture estimate with a larger Chilean mark-recapture dataset is anticipated for the 2023 meeting.

8.2.1.4 Progress towards In-Depth Assessment

In preparation for the In-depth assessment of non-Antarctic Southern Hemisphere blue whales, the Committee has supported ongoing work compiling the Southern Hemisphere blue whale catalogue (SHBWC) to identify re-sightings of use in mark-recapture analysis of abundance. SC/68D/SH/04 presented an update on the SHBWC. The SHBWC currently

Table 13

ASI categories agreed for Southern Hemisphere blue whales.

Population	Location	Method	Time series	Abundance	ASI category[1]	Reference
Southeast Pacific Ocean	Chilean Northern Patagonia 41°00'S-45°30'S	Line transect survey	2009	356 (95% CI 191-625)	2	Bedriñana-Romano *et al.* (2021)
	Isla Chiloé 42°00'S-43°00'S	Mark recapture analysis	2004-12	762 (left side) (95% CI 638-933) 570 (right side) (95% CI 475-705)	3	Galletti Vernazzani *et al.* (2017)
	Isla Chiloé	Mark recapture analysis	2004-12	450 (CV = 0.17)	2	Cooke and Jackson (2017)
	Chilean waters 18°30'S-38°S	Line transect survey	1997	303 (95% CI 176-625)	2	Williams *et al.* (2011)

[1]Abundance estimates are categorised in terms of their intended use, following the procedure described in Item 4.3 of the ASG report. Category 1: acceptable for use in In-depth assessments or for providing management advice. Category 2: An estimate for a stock or study area for which conservative management is acceptable but is likely negatively biased. Category 3: An estimate which is potentially informative but not acceptable for use in an assessment context. This category includes estimates with a bias which is too severe to allow inclusion in Category 2

comprises 2,209 blue whales (1,584 right sides, 1,630 left sides, 90 flukes). From April 2021 to March 2022, new photo-IDs (+80 IDs) have been received from the Costa Rica Dome, Galapagos, and New Zealand. Intersessional work has focussed on matching within populations off Australia, New Zealand and Chile – Eastern Tropical Pacific, to be used for assessment purposes. All matching and quality control of photographs uploaded before January 2018 (Australia) and March 2021 (New Zealand and Chile-ETP) for these regions have been completed.

The Committee welcomed these updates, congratulated Galletti and contributors on the large amount of work conducted and noted that the SHBWC is a long-term initiative financially supported by the Committee in order to deliver regional photo-ID based mark recapture estimates of blue whale abundance. The Committee noted that the presented work addressed recommendations made previously by the IWC (completion of matching of SEPO and SWPO (IWC, 2021c, item 9.2.1.1).

In relation to SEPO datasets, the sub-committee recalled that in 2021, Torres-Florez *et al.* (2021) reported the compilation of a photo-ID dataset from northern Patagonia (Chile) from 2003-2015, comprised of 206 individuals. The lead author intends to submit these data to the SHBWC by the end of May 2022, matching and quality coding within the SHBWC will then be completed before the next Scientific Committee meeting. The Committee endorses: (1) inclusion of these new data within the agreed time frame; and (2) their reconciliation prior to the next meeting, so that these data can be included in a combined mark-recapture abundance estimate for the In-Depth assessment.

In relation to SEIO datasets, photo-ID matching and quality control is nearly complete for the Australian datasets submitted to the SHBWC up until 2018. Additional metadata from Australian catalogue holders are urgently required in order to complete this dataset (Item 8.2.1.3; this work will proceed via an intersessional correspondence group). However, there are an additional 100+ photo-IDs submitted from Timor Leste (a lower-latitude part of the SE Indian Ocean population) which have yet to be matched. The Committee was also informed that the Centre for Whale Research in Australia has updated its database with 115 new photo-IDs and plans to submit these to the SHBWC.

In relation to SWPO datasets, photo-ID matching and quality control is complete for the New Zealand datasets submitted to the SHBWC. All catalogue holders contributing to this dataset have agreed to proceed with a combined mark recapture analysis of whale abundance using these data, to be done through a data sharing agreement. Mark recapture analysis will be conducted intersessionally by Professor Rachel Fewster at the University of Auckland, and reported at the 2023 meeting.

In discussion, the Committee agreed that, in order to proceed with timely assessments of the SEPO, SEIO, and SWPO blue whale populations, only photo-ID data collected up to 2018 will be used, and priority will be given to matching within-region photo-IDs that will provide mark recapture data for abundance estimation, rather than those from connected areas, and that will further understanding of population connectivity and migratory destinations. The Committee therefore endorses the following priorities for finalising photo-ID matching: (1) for SEPO, catalogues within Chile, with lower priority for matching new photos from the Costa Rica Dome, Eastern Tropical Pacific and Galapagos; (2) for SEIO, catalogues within Australia, with lower priority for matching with new photos from Timor Leste. No new priorities for SWPO were identified, as this dataset is now ready for mark recapture analysis.

Insufficient data are currently available in the SHBWC for abundance estimates to be generated for the CIO (Sri Lanka), SWIO, or NWIO (Oman) populations. The Committee re-iterated their encouragement for submission of data from these populations to the SHBWC.

To complete pre-assessments of Southern Hemisphere non-Antarctic and southeast Pacific blue whales, the Committee previously encouraged regional catch scenarios for non-Antarctic Southern Hemisphere blue whales (Branch *et al.*, 2021) to be finalised, to be able to proceed to an In-depth assessment of these populations. These scenarios will be reported at the next meeting.

Attention: SC, R
To complete pre-assessments of Southern Hemisphere non-Antarctic and southeast Pacific blue whales, the Committee ***reiterates*** *its recommendations (IWC, 2022a, item 8.2.1.6):*

(1) *that the new photo-ID catalogue from Chilean Patagonia is submitted to the Southern Hemisphere Blue whale catalogue (SHBWC) (IWC, 2022a, item 9.2.1.1) by May 31st 2022;*
(2) *that development of the Southern Hemisphere Blue Whale Catalogue continue, with a priority focus on: (i) finalisation of photo-ID matching and quality control within the southeast Pacific Chilean datasets (ii) addition of southeast Indian Ocean (Australian) metadata to associate photo-IDs with sighting date and location; and*
(3) *that the regional catch scenarios for non-Antarctic Southern Hemisphere blue whales be finalised, in order to proceed to an In-Depth assessment of these populations.*

The Committee ***encourages*** *intersessional mark-recapture analysis of the NZ blue whale dataset for endorsement of an abundance estimate at the 2023 meeting.*

The Committee also ***encourages*** *submission of new photo-IDs from the Central Indian Ocean, southwest Indian Ocean and Northwest Indian Ocean areas to the SHBWC, to support future mark recapture analyses of regional abundance.*

8.2.2 Antarctic blue whales

The Committee is preparing for a new population assessment of Antarctic blue whales; the last assessment (Branch, 2008) concluded that, whilst increasing, in 1997 Antarctic blue whales were only at 0.9% (95% Probability Intervals 0.7-1.0%) of their pre-exploitation level (IWC, 2009b, item 3.2). In 2019, the Sub-Committee developed a four-year timeframe for a new Antarctic blue whale assessment (IWC, 2020e, item 3.1.4). This is now due to be handed over to IA after 2023.

The Committee was informed about a sighting of an Antarctic blue whale cow-calf pair in the South-East Atlantic Ocean (30°05’02.4’S, 14°24’53.2’E) off the continental shelf of South Africa in November 2019. Photo-ID images of the calf were compared to the Antarctic blue whale catalogue but revealed no match. This is the first sighting of an Antarctic blue whale cow-calf pair in South African waters post whaling, indicating that animals might still use this area as a calving or nursing ground.

The Committee welcomed this information, especially given the paucity of recent information on breeding off the west coast of southern Africa.

Drinkwater and Branch (2022) investigated the rate of twin pregnancies in 16 cetacean species using whaling data held by the IWC. They found that overall 0.87% (2,197 out of 252,651) pregnancies included multiple foetuses, 0.81% in blue whales (244 out of 30,969). To infer survival rates of twins to term, models were fitted to the proportion of twins by foetal length, finding that the probability of surviving twins declined exponentially to near zero with increasing foetal length. The authors conclude that few multiple pregnancies (<1 in 500) end in live birth, and even these pregnancies experience high mortality after birth.

The Committee welcomed this information and noted that the low proportion of twins at near-birth lengths suggests that twin pregnancies do not need to be accounted for in population models.

8.2.2.1 Population Structure

A good understanding of population structure and connectivity is necessary to conduct population assessments. Whether the population structure of Antarctic blue whales consists of one or multiple populations is unresolved. Breeding grounds have not been identified, although they are assumed to be in lower latitudes, with Antarctic blue whale song heard throughout the Southern Hemisphere during winter months. Antarctic blue whales produce a single song type (McDonald *et al.*, 2006; Rankin *et al.*, 2005), lending support to the hypothesis of a single population. The song type is detected throughout the Southern Ocean in summer (Branch, 2007) and has also been detected in the lower latitudes of the Atlantic, Indian, and Pacific Oceans during the winter months (Buchan *et al.*, 2021; Samaran *et al.*, 2019).

A project led by Buchan and funded by the Committee (IWC, 2021c, item 8.2.1.1) is currently comparing the characteristics of Antarctic blue whale song calls from mid- and low-latitude regions in order to assess any regional variation in blue whale song calls as potential signs of population structuring. To date, data from Chile have been compiled and analysed. Full Z-calls were manually annotated from three study sites off the coast of Chile (Juan Fernandez and two sites in Chilean Patagonia), and measurements were made for Signal-to-Noise ratio of each unit of the Z-call, as well as duration (s), frequency bandwidth and peak frequency (Hz). Datasets from other sites (Australia, the Indian Ocean, New Zealand and South Africa) are currently being analysed in preparation for the comparison between sites. Further information is detailed in this year’s IWC-SORP report (SC/68D/SH/07 and SC/68D/SH/08).

The Committee commended the project group on their progress, recognising the importance of this work for insights into population structure. The Committee looks forward to receiving further updates at the 2023 meeting.

SC/68D/SH/09 presented an analysis of a dataset combining Discovery tag (45) and photo-ID (17) inter-seasonal recaptures to investigate ocean basin fidelity and evidence of separate populations. The majority of Antarctic blue whales

were recaptured within the ocean basin where they were marked (50-79%) except for the eastern Indian Ocean sector where only 20% of marked whales were recaptured. Six of seven whales with locations north of 60°S were marked and recaptured in the same ocean basin. Four of seven whales with both intra- and inter-seasonal recaptures were always recaptured within the same ocean basin as the original mark. The Antarctic Peninsula may represent a barrier of some sort in the movement patterns of blue whales south of 60°S, based on the shortest distance between mark and recapture points. Only one whale was linked between the Atlantic and the Pacific Oceans. The mark-recapture distances for individual Antarctic blue whales on the summer feeding grounds were highly variable. Both short and long distances between locations were exhibited by intra-seasonal recaptures. Two satellite tagged whales moved extensively during the summer season, despite periods of area-restricted search behaviour assumed to be foraging. Overall, while there was a trend for ocean basin fidelity, due to small sample size these results do not discriminate between a single or multiple population structure for Antarctic blue whales.

SC/68D/SH/13 analysed historical Discovery mark data with Bayesian mark-recovery models to test the hypothesis of a single population of Antarctic blue whales by estimating inter-season movement rates among the three ocean basins in the Southern Ocean (Atlantic, Indian, and Pacific). The study found high probabilities of inter-season movement in almost all directions (median 0.08 to 0.28 yr-1). An estimated 59% of blue whales in the Atlantic Ocean remained there while 16% (95% interval: 1-33%) moved to the Indian Ocean and 27% (11-34%) to the Pacific; 58% in the Indian Ocean remained there, 16% (5-31%) moved to the Atlantic and 26% (13-34%) moved to the Pacific; and 65% remained in the Pacific Ocean while 28% (18-34%) moved to the Indian Ocean, and 8% (1-19%) to the Atlantic Ocean. The authors conclude that these high rates of movement suggest little evidence for population structure arising from geographic separation between Antarctic blue whales in the Southern Ocean.

The Committee welcomed the information presented in both papers, which addressed recommendations made previously by the IWC (IWC, 2021c, item 8.2.2.1). The Committee agrees that these data strongly support limited population structuring across Antarctic blue whale feeding grounds, as concluded in a previous review (Lang *et al.*, 2020), and endorses conducting assessments that assume a single circumpolar population of Antarctic blue whales.

No agreement was reached on whether additional hypotheses for population structure should also be advanced for consideration in an In-depth assessment. As yet, no genetic, Discovery mark, or photo-ID recaptures directly link Antarctic blue whales to low-latitude breeding sites in the Southern Hemisphere. However, there is very little known about Antarctic blue whale breeding sites in general. An intersessional working group was created to consider options for proposing alternative population structure hypotheses, including the possibility of a migration barrier at the Antarctic Peninsula, and separate breeding populations in Atlantic, Pacific and Indian ocean basins that fully mix in the Antarctic.

8.2.2.2 Population Abundance

The Committee previously noted that an updated population assessment requires the IWC endorsement of a new abundance estimate for Antarctic blue whales. In the intersessional period, the ASI Standing Working Group reviewed five available abundance estimates of Antarctic blue whales and agreed abundance categories for each estimate (Item 3.11, Annex E). These discussions were summarised in Item 11.1.10.

All the abundance estimates reviewed were approved for use in upcoming In-depth assessments as indicated by assigned ASI category 1A (Table 14): the two abundance estimates by Matsuoka and Hakamada (2014) for the area 35°E-145°W south of 60°S, of 300 (CV=0.308) for the 1995/96 summer season and of 1,223 (CV=0.345) for the 2008/09 summer season; and the three abundance estimates by Branch (2007) for the circumpolar region south of 60°S of 453 (CV=0.40) blue whales for CPI (1978/79-1983/84; mid-year 1981), 559 (CV=0.47) for CPII (1985/86-1990/91; mid-year 1988) and 2,280 (CV=0.36) for CPIII (1991/92-2003/04; mid-year 1998).

Table 14

ASI categories agreed for Antarctic blue whales.

Population	Location	Method	Time series	Abundance	ASI category[1]	Reference
Antarctic blue whales	35°E-145°W south of 60°S	Line transect survey	1995/96	300 (CV=0.308)	1A	Matsuoka and Hakamada (2014)
			2008/09	1,223 (CV=0.345)	1A	
	Circumpolar south of 60°S	Line transect survey	1981 (CPI)	453 (CV=0.40)	1A	Branch *et al.* (2007)
		Line transect survey	1988 (CPII)	559 (CV=0.47)	1A	
			1998 (CPIII)	2,280 (CV=0.36)	1A	

[1]Abundance estimates are categorised in terms of their intended use, following the procedure described in Item 4.3 of the ASG report. Category 1A: suitable for use in the Sub-Committee's Revised Management Procedure for commercial whaling. 1: acceptable for use in In-depth assessments or for providing management advice. Category 2: An estimate for a stock or study area for which conservative management is acceptable but is likely negatively biased. Category 3: An estimate which is potentially informative but not acceptable for use in an assessment context. This category includes estimates with a bias which is too severe to allow inclusion in Category 2.

The Committee thanked the ASI Standing Working Group for their advice and categorisation of the abundance estimates and noted that, given their 1A categorisation, these abundance estimates are now ready for use in an updated assessment. The sub-committee agreed that in an assessment the Branch (2007) estimates be used as absolute estimates of abundance, while those in Matsuoka and Hakamada (2014) be treated as relative estimates since they covered about half of the longitude range of the Antarctic.

SC/68D/ASI/10 reported the results of 2021/22 JASS-A dedicated sighting survey programme, which was conducted in the eastern part of Area IV East (130°W-120°W; south of 60°S). The total searching distance was 1,333.5 n.miles during which five schools (six individuals) of Antarctic blue whales were observed. In total (including transit) seven individuals were photographed and a total of two biopsy samples (from different individuals) were collected. Data obtained will be analysed to provide abundance estimates and for stock structure studies at the Institute of Cetacean Research.

The Committee welcomes this update and noted the value of the information in relation to the upcoming In-depth assessment, highlighting that photo-IDs collected on these expeditions are contributing toward a new circumpolar wide abundance estimate for Antarctic blue whales (IWC, 2021c, item 8.2.2.2).

The Committee received an update on the intersessional work of the Acoustic Trends Working Group (ATWG, IWC-SORP Report SC/68D/SH/07). During a revision and standardisation of new Terms of Reference and the Mission statement, the group has broadened the spatial scope of its work to include the entire distribution range of Southern Hemisphere blue and fin whales. Previously the ATWG had restricted the scope of work to acoustic data south of 60°S. When taken together, the improved detection algorithms, development of a data analysis framework, continued long-term data collection, and other work of the group represent a step-change in the ATWG's ability to deliver on the promise of using passive acoustics to monitor trends in Antarctic blue and fin whales throughout the Southern Hemisphere.

The Committee welcomes this information, recognising that the broadened spatial scope of the work of the ATWG will deliver trend information on non-Antarctic Southern Hemisphere blue whales as well as Antarctic blue whales.

8.2.2.3 Progress Towards Population Assessment

In 2020, the Committee agreed to progress two Items to help understand possible sub-structuring of Antarctic blue whales around the Southern Hemisphere. These were: (1) a quantitative review of Discovery mark deployment and recovery patterns to assess inter-oceanic movements; and (2) a quantitative comparison of Antarctic blue whale songs from different low-latitude regions using recordings with high signal-to-noise ratios, to evaluate if there are inter-oceanic differences in song. SC/68C/SH/09 and SC/68C/SH/13 presented the results towards objective (1), and work towards objective (2) is ongoing, with a progress report presented to the Sub-Committee this year (Item 8.2.2.1).

A project led by Shabangu is collecting acoustic data off the South African coast with the objective to use contemporary blue whale detections to infer level of occurrence of both sub-species and therefore help apportion historic blue whale catches among Antarctic and pygmy blue whales. One AURAL-M2 hydrophone was successfully deployed off the South African coast (off Durban; at 30°08'55.5'S, 31°50'12.2'E) at a water depth of 284m on 7 February 2022. The device is programmed to record the first 17 minutes of every hour of the day at a sampling rate of 32kHz and will be retrieved in February 2023.

The Committee welcomes this information and noted the importance of this work in separating historical catches caught off Durban (to date it has been uncertain which sub-species these catch data refer to). The Committee looks forward to receiving a report on this study at its next meeting.

In 2023, the Committee also anticipates receiving a revised mark-recapture abundance estimate (from Olson *et al.*, 2021) for ASI review, as well as the reports mentioned above. Antarctic blue whales will then be ready to be handed to IA to conduct a population assessment in 2024.

8.2.3 Southern right whales not subject of CMP

The Scientific Committee agreed in 2016 to commence gathering pre-assessment information (e.g. catch data, population abundance, structure, trend), to progress towards a regional In-depth assessment of southern right whales (IWC, 2017g, item 10.8.1.5). In 2021, the Committee received new information on southern right whale body condition and how this can provide proxy information on foraging conditions, and therefore relate to population dynamics (IWC, 2022a), Item 8.2.3.6; this work is still ongoing - see Annex K). In 2022, the Committee was provided with updates on regional population trends, habitat use and offshore distributions.

8.2.3.1 South Africa

SC/68D/SH/02 presented the results of the 2021 annual aerial survey of southern right whales as part of the long-term monitoring of the South African population. A total of 191 cow-calf pairs were recorded during the survey, which represents a slight increase from the numbers of cow-calf pairs seen in 2020, but still far below the numbers to be expected based on the projected population growth rate. Low numbers of unaccompanied adults were seen (n=31), the fifth-lowest count since the start of these surveys in 1979. The analysis indicated that, like in 2020, the largest proportions of cows calving in 2021 had a 3-year (19%), 6-year (17%) and 7-year (16%) calving interval. Additional survey data continues to indicate a shift in peak presence to September, earlier in the year than the historical peak observed in October.

The Committee welcomes this update and noted that the data continue the trend of extreme fluctuations in the coastal prevalence of cow-calf pairs along the South African coast since 2015. They were informed that a similar departure from historical trends has been observed on the calving ground in Península Valdés, Argentina, with longer calving intervals and an earlier peak in the occurrence of the individuals (Crespo and Coscarella, 2019). The Committee reiterated the importance of continued long-term studies to monitor population parameters and identify the factors influencing the observed changes over time.

The Committee was informed that the population dynamic model described in Brandão *et al.* (2021) has been updated intersessionally (Item 3.7 of Annex E) and is in review for publication. It encourages the authors to provide, as soon as practicable, the publication of this model for review and endorsement by the ASI Standing Working Group.

8.2.3.2 South and Southwest Australia

Smith *et al.* (2021) provided southern right whale abundance and trend estimates from the long-running aerial surveys for southern right whales along the south-west coast of Australia (Cape Leeuwin to Ceduna). This report was previously discussed in 2021 (Item 8.2.3.2; IWC, 2022a) and reviewed by the ASI Standing Working Group (Item 3.7 of Annex E).

The Committee encourages the authors to conduct a consolidated analysis of Australian southern right whale abundance and trend, for review in ASI and endorsement by the Committee. It also looks forward to the estimates of abundance and connectivity resulting from a recent photo-ID analysis of movements between calving areas (Item 8.2.3.3; IWC, 2022a), see workplan).

Attention: SC, CG, R
*The Committee **encourages** Australian researchers to address comments made by the ASI Standing Working Group (Item 3.7 of Annex E) and generate consolidated estimates of Australian right whale abundance and trend for endorsement by the Scientific Committee.*

8.2.3.3 New Zealand

The Committee received a report on the habitat use of southern right whales in Port Ross, Auckland Islands, with data collected in 2020 and 2021, and a comparison to similar data collected in 1998 (Carroll and Jackson, 2020). The study highlighted Port Ross as a key habitat for all demographic classes of New Zealand southern right whales, with an increase in the proportion of cow-calf pairs being observed over time, from 20% in 1998 to 50% in 2020/21, consistent with a growing population undergoing strong recruitment.

The Committee welcomes this update, and recognised the importance of this long-term monitoring, as habitat use is known to shift with increasing density, which can affect data collection relevant to population assessments. The Committee further noted the observed increase in cow-calf pairs in the area, in contrast to the decreasing numbers of cow-calf pairs observed in recent years in other calving grounds e.g. South Africa (SC/68D/SH/02, Vermeulen *et al.*, 2021) and Argentina (Crespo and Coscarella, 2019).

SC/68D/SH/12 reports on a collaboration established with the developers of SPACEWHALE to assess the effectiveness of automatically detecting southern right whales in satellite images. The study showed the same number of whales was detected by both the satellite and boat-based surveys of Port Ross, Auckland Islands, despite a 12-hour difference between the timing of data collection. The authors explained the algorithm is very sensitive for the automated detection of southern right whales, with a higher number of false positives compared to false negatives, both of which are removed manually in a second step.

The Committee welcomed this report, recognising the potential of the approach for remotely monitoring the presence of southern right whales. However, the Committee noted the challenges related to the use of satellite imagery for the detection of whales, including the costs of satellite tasking and the influence of adverse weather conditions on the quality of images and detection of whales. It was further noted that multiple research groups are developing projects with this tool (Corrêa *et al.*, 2021; Fretwell *et al.*, 2014; Houegnigan *et al.*, In review), and that a large open-access dataset of southern right whale sightings in satellite imagery will shortly be published (Cubaynes *et al.*, 2017).

The Committee therefore encouraged collaboration among the different groups, including data and code sharing, to facilitate open access development of the approach where possible, while minimising duplication of effort (see workplan). In this regard, it was commented that the technology is increasingly being used in wildlife research across the globe[12], and that coordination between research groups when approaching satellite imagery providers may lead to a substantial reduction in associated costs. The suggestion of developing partnerships with satellite providers has previously been encouraged by the Committee (IWC, 2022a, item 14.3.2).

[12]For example, the Remote Sensing Action Group of the Scientific Committee for Antarctic Research SCAR.

Attention: SC, R
Recognising the value of Very High Resolution satellite imagery for monitoring whales in remote habitats, the Committee ***encourages*** *coordinated data and code sharing among active research groups where possible, to facilitate development of automated methods, avoid duplication of effort, and negotiate better tasking opportunities with satellite providers.*

SC/68D/SH/11 investigated the use of carbon and nitrogen isotopes of amino acids (AA) in skin samples of southern right whales to identify reproductive status in female southern right whales. A Linear Discriminant Analysis (LDA) of AA $\delta^{15}N$ showed that the classification success rate was 87% for cows and calves, 62% for adult females without calves, and 67% for adult males. The LDA of AA $\delta^{13}C$ showed a classification success rate of 73% for cows, 75% for calves, 27% for adult females without calves and 37% for adult males. In contrast, both $\delta^{15}N$ and $\delta^{13}C$ of bulk tissue and its constituent AA did not differ between adult females without calves and adult males. This classification method could be used to identify periods of reproduction, including in baleen plates or other metabolically inert tissue, and is based on the hypothesis that the identified patterns are associated with differences in energetic requirements and nutrient allocation.

The Committee welcomed the information presented and noted continued work on the classification system is needed to fully specify the reproductive physiology of the whales and identify nutrient allocation strategies. The Committee further noted its relevance as a potential new monitoring tool to assess reproductive state and monitor the effects of environmental change on reproduction and population dynamics (IWC, 2019b, item 9.2.4.5 and item 8.2.3.6).

8.2.3.4 Southwest Atlantic

This population is subject to a Conservation Management Plan, see Item 9.1.2.

SC/68D/CMP/02 estimated population increase rates, relative abundance and distribution changes of southern right whales at Península Valdés and Golfo San Matías, Argentina between 2007 and 2021, and identified a substantial reduction in population growth in Península Valdés from 7% to 0.5% (all individuals), and from 7.5% to 2.91% (numbers of calves), with associated changes in distribution and density along the Argentine coast.

The Committee also received a report on the historical reconstruction of the population dynamics of southern right whales in the Southwest Atlantic (Romero *et al.*, 2022). The report used a Bayesian state-space approach to estimate population trends and recovery level after depletion, based on the modelling of the whaling catch history for the period 1670-1973. The model estimated the pre-exploitation levels for the Southwest Atlantic at ~58,000 individuals, with model-predicted abundance in 2021 at less than 10% of pre-exploitation levels. The model predicted that close to 36% of the current population visits Península Valdés each year.

The Committee welcomes both reports which represent significant progress in understanding regional southern right whale recovery. In discussion, it was noted that in the standard IWC population dynamic framework for reconstructing historical abundance, only low r_{max} (maximum population growth rate) values (r_{max} <0.05) are compatible with the extended bottleneck experienced by southern right whales, and that a model incorporating an Allee effect (allowing r_{max} to vary) may provide a better fit (IWC, 2022a, item 8.2.3.8); the Committee noted that such models will need to be considered when constructing population assessments of southern right whale recovery. It was further noted that pre-modern catches are likely to be substantially under-estimated due to missing or patchy data (IWC, 2022a, item 8.2.3.8). This aspect is discussed further under Item 8.2.3.6.

Agrelo *et al.* (2021a) measured the effects of El Niño events on the survival probability of female southern right whales in the Southwest Atlantic over the period 1971-2017. An increased mortality rate after a strong El Niño event was observed, from ~1% in years without El Niño to 4.2% in the 1997/98 El Niño event, and 4.9% in the 2015/16 El Niño event. Predictions of future population recovery under different climate change scenarios (CMIP5 - RCP scenarios) were also presented.

The Committee welcomes this work which relates demographic parameters to environmental drivers, a key topic the Committee has identified as important for upcoming assessments (IWC, 2019b, item 9.2.4.5 and item 8.2.3.6). The authors were asked if they had examined whether the demographic parameters were influenced by time-dependent variability in reproductive parameters (e.g. the female calving cycle, Carroll *et al.*, 2013). The authors clarified that the reproductive success was not considered as the study focussed primarily on examining the influence of climate change on adult survival probabilities. The committee encourages future work taking into account the influence of time-dependent environmental variables on survival probabilities when assessing population dynamics.

In 2021, the Committee received a photo-ID based mark recapture study from Brazil, spanning the period 2004-18 (IWC, 2022a, item 9.1.2). Renault-Braga *et al.* (2021) assessed the probability of survival, capture and recruitment of southern right whales wintering in the area. In total, 520 whales were identified - 345 females and 175 adults; for both datasets, best-fitting Pradel models provided an annual population growth rate of 4.8% ±1.2%. Best-fitting POPAN models provided super-population estimates of 569 (±38) for females and 2,626 (±737) for wintering adults over 2004-2018 (middle year 2011).

Following intersessional review by ASI (Item 11.1.11), the abundance estimates in this paper were allocated ASI Category P, provisional. The authors were encouraged to investigate how variation in individual behaviour (for example the calving

cycle) influences capture probability, to ensure that parameter uncertainty is adequately captured, to explore POPAN models that incorporate both abundance and population growth[13] and to work with the independent ASG reviewers to implement these changes.

The Committee welcomes this review, noting that analysis of regional photo-ID datasets for abundance and trend is a long-term Committee priority (IWC, 2018c, item 3.2.4; 2020d, item 3.2). Matching between photo-ID datasets in the southwest Atlantic is also a Committee priority (IWC, 2020b, item 9.2.4.5), as it can provide a synoptic picture of southern right whale abundance and trend across the wintering grounds. Noting that Uruguayan researchers have not yet compared photographs with Brazil and Argentina, the Committee encourages researchers in Brazil, Argentina and Uruguay to match catalogues between areas where feasible (see workplan). The Committee also reiterates its encouragement that further progress on the workplan discussed in 2021 related to the application of mark-recapture multi-state models to assess movement rates between the Argentine and Brazilian calving grounds (see Agrelo *et al.*, 2021b; IWC, 2022a, item 8.2.3.5), and region-specific survival, as detailed in 2019 (IWC, 2020b, item 9.2.4.5), providing an update at the 2023 meeting.

Attention: SC, R
*The Committee **encourages** researchers to consider the influence of environmental variables in future modelling procedures when assessing southern right whale population dynamics.*

Attention: SC, CG, R
*The Committee **encourages** researchers in Brazil, Argentina and Uruguay to compare photo-ID catalogues for matches and **reiterates** its encouragement to apply a mark-recapture multi-state model to assess movement rates and region-specific survival of southern right whales in the southwest Atlantic.*

8.2.3.5 Offshore Areas

The Committee received results from a desktop study which collated data on the global occurrence of southern right whales offshore and south of 40°S over the period 1980-2020 into a comprehensive review (SC/68D/SH/03) collating 357 sightings of 699 southern right whales, most of which were located in the Southwest Atlantic. Data were mapped per season and region and showed that the majority of sightings were from the Southwest Atlantic and the Antarctic between 90°E and 120°E. Absence data were also presented where possible, indicating survey effort in the Southern Ocean where no southern right whales were sighted.

Recognising the value of this database, the Committee encourages the authors to continue collating sightings, to investigate how environmental conditions on the identified foraging grounds influence southern right whale population dynamics (IWC, 2019b, item 9.2.4.5), and to compare how these grounds relate to historical catch distributions (IWC, 2022a, item 8.2.3.8). In relation to offshore foraging patterns, the Committee reiterates its previous suggestion that the offshore hydrophone networks and voyage data be reviewed (IWC, 2021c, item 8.2.3.4), to identify acoustic detections of right whales south of 40°S, and proposed to re-establish an Intersessional Correspondence Group to progress this discussion (IWC, 2021c, item 8.2.9).

Attention: SC, R
*The Committee **encourages** continued collation of data on southern right whale offshore sightings and acoustic detections, to investigate stock structure and assess how environmental conditions on the identified foraging grounds influence southern right whale population dynamics.*

Matsuoka and Hakamada (2014) used sightings survey data from JARPA and JARPAII to produce abundance and trend estimates of southern right whales in Antarctic Area IV, south of 60°S for the period 1989/90 and 2007/08. This paper was presented to the Committee in 2017 (IWC, 2017g, item 4.2). Blue whale sightings data collected in the same surveys were reviewed in ASI (Item 11.1.10) and assigned category 1A (Item 8.2.2.2, acceptable for use in In-Depth assessments or for providing management advice).

The Committee noted that genetic mark-recapture estimates of abundance from the same area (Pastene *et al.*, 2018) were similar to those obtained by the sighting survey (IWC, 2019e, item 5.1.4), and that genetic and photographic recaptures indicated this area is associated with the Australian calving ground (Pastene *et al.*, 2021). However, it may not necessarily represent the only offshore destination for Australian right whales, and it is not known how much of that population frequent this feeding ground. The Committee agrees to review this abundance estimate again when preparing for an In-Depth assessment of Australian southern right whales.

[13] *https://catchit.co.nz/apps/capow/.*

8.2.3.6 Progress towards In-depth Assessment

In 2018, the Committee encouraged the development of a common modelling framework to integrate southern right whale demographic data from all the calving grounds (IWC, 2019b, item 9.2.4.5). An update in this regard was provided in SC/68D/SH/06 (and in SC/68D/SH/08), which reports that the specifications of the common biological model are now complete and include an 'unsuccessful mother' component to account better for late abortions or early calf deaths. The coding of the final common model is finalised and model-fitting has commenced on the South African dataset. The report advised that the first trial runs will be undertaken using the long-term datasets from South Africa and probably Argentina/Brazil, as these datasets are well known to the modelling team. The following step will be to include the datasets from the Australia and New Zealand wintering grounds (see workplan).

The Committee welcomes this progress update and recognised the importance of this work in obtaining comparative data on population dynamics across wintering grounds. The Committee therefore encourages the inclusion of all datasets for a Southern Hemisphere wide assessment of population parameters, and that an update be provided to the next meeting.

Attention: SC, R
To progress the In-depth regional population assessments, the Committee ***encourages*** *the application of the finalised common modelling framework to all available regional long-term datasets (South Africa, Argentina/Brazil, New Zealand and South Australia), to assess southern right whale population parameters on a hemisphere wide scale.*

El-Gabbas *et al.* (2021b) reported on the use of dynamic Species Distribution Models to capture the dynamic species-environment relationships. There was insufficient time to discuss this document Recognising these models may minimise the temporal mismatch between species distribution and environmental conditions, the Committee noted its possible relevance for the ongoing work on the effects of environmental variability on population recovery of southern right whales (IWC, 2019b, item 9.2.4.5).

In order to progress with an In-depth assessment of southern right whale population demographics, the Committee has agreed in 2016 (IWC, 2017g) that southern right whale catch allocations need to be reviewed together with historical and contemporary breeding stocks of the species. This was encouraged again in 2021 (IWC, 2022a, item 8.2.3.8). Two hybrid (in-person and online) workshops were proposed in order to progress on this matter in 2023 and 2024. The objectives of the first workshop are to: (i) update catch estimates; (ii) identify data gaps; and (iii) identify methods of filling the identified gaps. The second workshop will focus on: (i) reviewing the available historical and contemporary evidence for Southern Hemisphere stock structuring, updating previous reviews of SRW stock identity (1986, 2001, 2013); (ii) developing catch allocation hypotheses for review and ranking, based on available evidence; and (iii) identifying data gaps where further work is required to discriminate hypotheses. This is an Item with funding implications for the Scientific Committee (see workplan).

8.2.4 North Pacific blue whales

There are at least two populations of blue whales in the North Pacific, 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, 2017c). In recent years, the Committee has been evaluating the data available to assess blue whales in the less studied central and western North Pacific. The Committee remains in the pre-assessment stage for blue whales in this large region (the full process is described in IWC, 2019b pp.18-19).

Due to time limitations, discussion of this topic was postponed. However, the Committee did conduct a technical review of two sets of abundance estimates that would be relevant to an assessment (see Item 11.1.12).

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 (Annex T) with updates to be provided at the next meeting.*

8.2.5 North Atlantic sei whales

The Committee is at the pre-assessment stage for sei whales in the North Atlantic (the full process is described in IWC, 2019b, pp.18-19). Given the time constraints of SC68D, detailed discussion of this topic was postponed. However, Cholewiak reported on passive acoustic work initiated in 2021 to provide new information on baleen whale seasonal occurrence off the coast of Senegal which may also inform stock structure of North Atlantic sei whales (see Item 8.2.7). A proposal to continue that work has budget implications for the Committee (see Item 12.3). Information gathering for a future Comprehensive Assessment will continue through the intersessional correspondence group convened by Cholewiak, with progress to be reported at the next meeting.

Attention: SC
The Committee is continuing its work to ascertain the availability of information to assess sei whales in the North Atlantic. The Committee ***agrees*** *that the intersessional correspondence group under Cholewiak (Annex T) should continue to review data for a future Comprehensive Assessment.*

8.2.6 North Atlantic right whales

In response to the Committee's request (IWC, 2021c p.46), the U.S. provided an update on North Atlantic right whale population status and management initiatives.

SC/68D/NH/01 provided an update on North Atlantic right whale population status from the U.S. National Marine Fisheries Service (NMFS). This population continues to decline, with an estimated 340 animals (credible interval 328-352) in the year 2020. The population appears to be at its lowest level in approximately the last 20 years, and the model continues to indicate a decline in survival rates in the period 2011-19. For the period 2015-19, a total of 37 mortalities were observed, with ship strike and entanglement attributed as the cause for 10 of those deaths each; the cause of death for the remaining 17 cases was undetermined. However, based on the abundance model, an estimated 156 animals (121-195) died during this same period, four times the observed number of carcasses. In the 2022 calving season, 15 females were observed with calves, all of whom had calved previously. Based on the population model, only 70 females who are known to have previously reproduced are estimated to still be alive. Two studies were published utilising detailed analyses of mark-recapture sightings data. Crowe *et al.* (2021) examined sightings from the Gulf of St. Lawrence, Canada, during the period 2015-19, and demonstrated high rates of inter-annual return, with approximately 40% of the population using that habitat. Quintana-Rizzo *et al.* (2021) examined sightings in and around wind energy development areas in southern New England, US, and demonstrated near year-round utilisation of that habitat, with 87% of the population sighted in the region during the study period.

At SC68C, the Committee discussed evidence that North Atlantic right whales were declining and that adult females have lower survival rates, and therefore abundance, than males (IWC, 2021c, p.44). This year, the Committee conducted a technical review of abundance estimates of the catalogued population from 1980 through to 2019 (Pace *et al.*, 2017; 2021) and found them to be suitable for management advice. Details of that discussion can be found in Item 11.1.9.

The Committee thanked the U.S. for providing new information on North Atlantic right whales but expressed grave concern about the status of this population and the on-going impact of human activities on its recovery. It further noted evidence that cryptic mortality is potentially four times higher than observed mortality (Pace *et al.*, 2021).

SC/68D/NH/02 reported on U.S. management efforts to recover North Atlantic right whales. NMFS continues to pursue various management approaches to reduce entanglements in fishing gear and vessel strikes and reverse the population decline of this species. NMFS also continues to collaborate with Canada and assess the potential impacts of emerging threats like offshore aquaculture and wind energy development. The latest preliminary estimate suggests there are fewer than 350 individuals and an unusual mortality event (UME), declared in 2017, is ongoing. The UME has documented 50 known cases - 34 dead and 16 seriously injured right whales. SC/68D/NH/02 further highlighted a few notable management efforts including final regulations to amend the Atlantic Large Whale Take Reduction Plan in September 2021. The amendment includes various mitigation measures to reduce risk in Northeast U.S. lobster and Jonah crab trap/pot fisheries, which represent about 93% of the buoy lines in all fisheries addressed by the Plan; gear modifications became effective May 1, 2022. Additionally, the U.S. released the Right Whale Speed Rule Assessment in January 2021 and the findings led to an investigation of potential options to modify the current right whale vessel speed regulations; the US anticipates release of a proposed rule in late Spring 2022. Finally, SC/68D/NH/02 reported that leadership from NMFS, Department of Fisheries Oceans Canada and Transport Canada continue to meet and share innovative techniques and solutions that foster healthy fisheries, reduce the risk of entanglements, and create whale-safe maritime practices.

The Committee welcomes the new information presented in SC/68D/NH/02 but noted that there have been decades-long efforts to mitigate impacts on this population from entanglement and ship strikes, and these measures to date have not been effective. In this light, the Committee inquired what additional management steps might yet be considered. Long stated that there had been some success in reducing vessel strikes and that an iterative approach is being taken to produce a broad-based solution along with a phased approach to fishing regulations which are expected to reduce entanglements. The Committee also discussed the critical importance of bilateral collaboration between the U.S. and Canada to protect North Atlantic right whales.

The Committee went on to discuss that little is known about this species beyond U.S. and Canadian waters and that a full understanding of animal movement and habitat use are critical for effective protection. The Committee discussed existing passive acoustic monitoring efforts that have the potential to collect occurrence data in some areas where animals were historically present. Cholewiak expressed interest in collaborating to enhance and expand such monitoring networks. The Committee also discussed that satellite tagging, although an invasive procedure, has been cautiously employed in other populations of management concern, such as North Pacific right whales (Zerbini *et al.*, 2015), western gray whales

(Mate *et al.*, 2015) and humpback whales in the Arabian Sea (Willson *et al.*, 2015, see also Item 9.2.1). The Committee was updated on work that is underway by Zerbini and colleagues to evaluate the impacts of modern satellite tags and to develop less impactful designs. One such design is currently being evaluated in right whales off Argentina (see details in SC/68C/SH/07Rev1). The Committee noted that stakeholders should consider the potential scientific and management value of satellite tagging North Atlantic right whales, particularly in light of these new developments in tagging technology and information from impact assessments.

The Committee thanked the U.S. for providing updates about North Atlantic right whales, recognising the breadth and collaborative nature of efforts underway to study and protect this species. The Committee welcomed these updates and reiterated its strong concern over the status of this species, which has been declining despite decades of research and management efforts. Given documented changes in the distribution of this species, the Committee agreed that strong transboundary collaboration continues to be essential to fully understand and protect North Atlantic right whales. Further updates on status, management initiatives, and bilateral cooperation were encouraged for next year.

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, the only known viable population of this species; and (2) that the U.S. 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 (IWC, 2020b, p.41; 2021c, p46).*

The Committee:

(1) ***expresses grave concern** that*
   (a) *North Atlantic right whales are declining, despite the significant long-term efforts to understand this species and to mitigate human impacts; and*
   (b) *human-caused deaths are likely under-estimated and are potentially four times higher than observed cases (Pace et al., 2021).*
   (c) *Current mitigation measures are inadequate, and a much larger effort is required to address the severe threats of entanglement and vessel-strike to this species.*

(2) ***recognises** that successful protection depends on understanding of movements and habitat use and therefore:*
   (a) ***strongly encourages** the U.S. and Canada to continue to strengthen trans-boundary collaborations to understand and protect this species in their waters; and*
   (b) ***encourages** stakeholders to consider research techniques such as satellite tagging and passive acoustic monitoring in order to facilitate the detection of unknown habitats and unexpected movements both within and outside of the currently known range.*

(3) ***encourages** the U.S. to provide further updates on its efforts and their outcomes at the next meeting; and*

(4) ***recommends** that the IWC Secretariat invite Canada to present its research and management initiatives at the next meeting.*

8.2.7 North Atlantic humpback whales (and see Items 6.1, 7.1.7 and 7.1.8) (NH)

The Comprehensive Assessment of North Atlantic humpback whales was completed in 2002 (IWC, 2002a; 2003b). In 2018, the Committee agreed that it was timely to consider a range-wide In-depth assessment (IWC, 2019b, p.133) and has since been collecting and evaluating available data.

The intersessional e-mail correspondence group to advance the assessment reported that ocean-scale analyses continue for photo-ID, genetics and telemetry data. Aspects of these studies were delayed by the pandemic, and results are now expected to be available for discussion before the next meeting. The Committee recommends the continuation of the e-mail correspondence group to review this information and continue to gather other data. A virtual intersessional workshop, and a funded in-person meeting (IWC, 2021c, p.176), are anticipated to advance this work.

The Committee also conducted a technical review of several abundance estimates in the context of their use in a future assessment. These included estimates from Eastern Canada (Lawson and Gosselin, 2018), Norway (Leonard and Øien, 2020a; 2020b) and the Cape Verde Islands (Wenzel *et al.*, 2020). Details of those discussions can be found in Item 11.1.12. The Committee agrees that available mark-recapture and line transect estimates for the Gulf of Maine and adjacent waters should be reviewed by the ASI Standing Working Group in preparation for assessment. There is no recent estimate of population abundance for the overall North Atlantic, nor for the West Indies breeding ground. The MONAH project (2003-05) was intended to estimate the latter, but further analysis and interpretation are still needed (IWC, 2019c, Item 5.8.2). Clapham reported that he has identified a mechanism to advance this work intersessionally.

The Committee reiterates the importance of obtaining data in areas that are either under-sampled or at sites of mixing, such as the south-eastern Caribbean and the eastern North Atlantic. In that context, the Committee was advised that photo-ID research resumed this year at the Cape Verde Islands and 2022 data would be available to extend the abundance series

for this small breeding ground in the Eastern North Atlantic. Cholewiak reported that her analysis of passive acoustic data from the south-eastern and western Caribbean had been completed and the results suggested a degree of subpopulation segregation. Detailed results of that study will be available intersessionally. Cholewiak also discussed a new passive acoustic monitoring project that was initiated this past year off the coast of Senegal. The coasts of Mauritania and Senegal are potentially important winter habitats for North Atlantic humpback whales and other baleen whales. In June 2021, two passive acoustic recorders were deployed at the head of the Dakar Canyon. The spatiotemporal occurrence of humpback whale song will be used to determine whether different hemispherical populations may be utilising Senegalese waters at opposing times of year, as well as to inform stock structure within the North Atlantic. In addition, resulting acoustic data will be analysed for the presence of sei, Bryde's and other baleen whale species. The Committee received a proposal from Cholewiak in further support of this work and agreed that it would help to address a data need for the planned North Atlantic humpback assessment. This work has budgetary implications for the Committee (see Item 23).

Finally, last year, the Committee discussed evidence for, and interpretation of, humpback whale presence at high latitudes in winter. Mattmüller *et al.* (2022) provided new information on this topic based on passive acoustic research off Tasiilaq, Southeast Greenland. Humpback whale acoustic presence was recorded mainly during open water conditions from July to December, with a peak in October and November. Non-song social calls were detected in summer, while song fragments were recorded from September until December.

The Committee welcomes this new information and noted that the results add to information on the seasonality of humpback whales along a portion of the Greenland coast that was historically inaccessible to this species due to persistent sea ice.

Attention: C, CG, SC, R

The Committee notes the importance of continued progress toward an In-depth assessment for North Atlantic humpback whales. To this end, the Committee:

(1) ***agrees*** *to the continuation of the intersessional correspondence group under Robbins to compile and evaluate information available for assessment.*

(2) ***reiterates*** *that there are several important ocean-scale analyses (photo-ID, genetic, acoustic and telemetry) still underway and* ***agrees*** *to a virtual intersessional workshop and an in-person meeting, as needed, to receive and evaluate new information in the context of an assessment.*

(3) ***reiterates*** *the importance of new information from the understudied areas in the south-eastern Caribbean and eastern North Atlantic (IWC, 2020b, p.131; 2021c, p.47) and* ***recommends*** *proposed passive acoustic research off Senegal by Cholewiak and colleagues.*

(4) ***encourages*** *plans by the U.S. to conduct further analysis of MONAH project data from the West Indies to estimate humpback whale abundance (IWC, 2019b, p.18, 134; 2020b, p.131; 2021c, p.47), and to receive an update from Clapham at the next meeting.*

(5) ***agrees*** *that, in preparation for assessment, the ASI Standing Working Group should be requested to review abundance estimates for the Gulf of Maine and other areas of the North Atlantic, as needed.*

8.2.8 Rice's whale (Gulf of Mexico Bryde's whales)

In response to last year's request, the U.S. provided updates on Rice's whale (*Balaenoptera ricei*, Rosel *et al.*, 2021), formerly known as Gulf of Mexico Bryde's whale.

SC/68D/NH/03 provided an update on U.S. research and conservation of Rice's whales for the period March 2021 through 2022. There has been no update to the population estimate since the 2017-18 estimate of approximately 50 individuals (Garrison *et al.*, 2020). Because Rice's whales are well documented to occur in the north-eastern Gulf of Mexico, the greatest priority has been understanding their broader distribution in the central and western Gulf where they are most likely to overlap with human activities. The majority of research has focused on passive acoustic monitoring to better understand habitat use and spatial occurrence. Results from passive acoustic monitoring in the north-central Gulf found that Rice's whales were intermittently present on 16% of days with no apparent seasonality. There were notable differences in moan characteristics between Rice's whales in the eastern and western Gulf, which suggests that different individuals may be using different areas. With support from the U.S. Navy, NMFS deployed a sparse passive acoustic array consisting of 17 monitoring units in the Rice's whale core habitat. Units will be deployed for a total of 12 months, and ongoing analyses will be presented at the next meeting. Other highlighted research included: (1) modelling the relationship between Rice's whale distribution and areas of upwelling and high productivity and the development of a spatial density model to predict habitat within the Gulf of Mexico; (2) using a combination of echosounder data, stable isotopes, and trawl data to identify the primary prey base of Rice's whales as *Ariomma bondi*, a demersal fish species; and (3) analysing kinematic tag data to better understand foraging behaviour and energetics. Restoration plans from the *Deepwater Horizon* oil spill include vessel strike and noise mitigation. Finally, management activities included developing a recovery plan and the designation

of critical habitat (as defined under the U.S. Endangered Species Act) as well as incorporating information on Rice's whale occurrence and distribution into the spatial planning process for proposed human activities such as the development of windfarms and aquaculture to better mitigate risks to Rice's whales.

The Committee welcomes this new information from the U.S. and encouraged an update on research efforts in the next meeting. In discussion, Garrison clarified that they are confident that they are correctly assigning vocalisations to Rice's whales based on a validation study in the core habitat; other balaenopterid species are rarely seen and calls associated with Rice's whales have been linked to their physical presence.

The Committee also inquired about future genetics work and plans for collecting additional biopsy samples to examine levels of inbreeding and demographic history. Rosel noted that there is an ongoing collaboration with the Vertebrate Genome Project and the SWFSC to create a fully annotated genome as well as a whole genome to better understand demographics and inbreeding. The Committee discussed the importance of looking at mutation load present in the population, which Rosel confirmed was being explored.

The Committee learned that there is no dedicated funding for the resumption of fieldwork, nor for some on-going and planned analytical work. This applies to both fundamental research on Rice's whales as well as certain other studies that are important for understanding this species. It was noted that one example of the latter was an on-going analysis of large genomic and mitogenomic datasets to test phylogenetic hypotheses and date divergence events within the Balaenopteridae family. The last field season was in 2019, but resuming those efforts would be important for the collection of additional biopsy samples for genetics as well as for a variety of other analyses such as health status and hormonal state. The Committee agreed upon the critical importance of sustained research funding and on-water data collection to advance research on Rice's whales, including photographs and drone-based imagery, eDNA and prey sampling.

Members also inquired about the possibility that there may yet be other cryptic or unknown species to be discovered in the Gulf of Mexico, given the recent 'discovery' of the Rice's whale. It was clarified that Rice's whales were known since the early 1990s and that the recent genetic and morphological work only confirmed that they were a distinct species. With regard to potential additional cryptic species, passive acoustic recordings have detected rare species such as an unknown beaked whale which is currently being investigated. There may also be additional population structure for some oceanic species with multiple populations occurring in the Gulf of Mexico.

Finally, the Committee acknowledged the management actions undertaken by the U.S. to protect Rice's whales but noted that this species also likely occurs in Mexican waters and this highlights the importance of fostering existing and new partnerships with Mexican colleagues.

Attention: SC, CC, CG, R, S

*The Committee has previously **expressed serious concern** about Rice's whale, an isolated population in the Gulf of Mexico with an estimated abundance of only around 50 animals (IWC, 2019b, p.26; 2020b, p.31; 2021c, p.48). This makes Rice's whale one of the world's most endangered large whales. The Committee:*

(1) ***welcomes** the information provided by the U.S. this year and **encourages** further updates at the next SC meeting;*
(2) ***encourages** the continuation and expansion of research efforts, including:*
  (a) *resuming on-water monitoring to obtain data such as photographs, UAS imagery, biopsy, eDNA and prey samples in support of mark-recapture, health/human interaction assessments, genetics and foraging ecology;*
  (b) *understanding the distribution and habitat use of Rice's whales in the western and southern Gulf of Mexico where the overlap with industry is greatest;*
  (c) *using spatial planning tools to better understand how emerging human activities may affect Rice's whales;*
(3) ***encourages** stakeholders to coordinate efforts and to identify long-term support for both the field monitoring and the analytical work, including genetics, that are essential for understanding this species;*
(4) ***recognises** management initiatives being undertaken to protect this species in US waters; and*
(5) ***requests** that the IWC Executive Secretary notify the U.S., Mexico and other range states of its willingness to facilitate international collaborations to better understand and protect these whales across their range.*

8.2.9 Biennial workplans

The Committee plans to review any new information on Rice's whale and North Atlantic right whales in light of concerns about their population status and on-going protective management efforts. Work will continue intersessionally to accumulate data for future assessments of North Atlantic humpback whales, North Pacific blue whales and North Atlantic sei whales. The Committee agrees that passive acoustic monitoring off Senegal is important to its work, and this has budgetary implications (Item 12.3).

The Committee further noted the importance of all of the long-term research efforts that are critical to its work to conduct assessments for whale stocks. The Committee encourages member countries and other stakeholders to prioritise and support field research for such stocks in all parts of their range, as well as the fundamental analytical work that ultimately informs assessments.

Table 15

Workplan.

SC Agenda Item	Intersessional work	Next meeting
Item 8.2.4: NP blue whales	Accumulate data for future assessment	Review new information
Item 8.2.5: NA sei whales	Accumulate data for future assessment	Review new information
Item 8.2.6: NA right whales		Review new information
Item 8.2.7: NA humpback whales	Accumulate data and plan for In-depth assessment	Review new information
Item 8.2.8: Rice's whale		Review new information

8.3 New information for other northern stocks (NH)

8.3.1 North Atlantic blue whales

Aguilar and Borrell (2022) reviewed the blue whale catch data for the companies that operated from the 1920s to 1985 in Spain and provided insight into trends in abundance of the species in the region. Data were compiled from the internal documentation of the main companies that operated locally (catcher boat logbooks, land station logbooks, correspondence) as well as from seven line-transect cruises that had been carried out by the University of Barcelona in the 1980s. Despite IWC protection in 1954, the authors found that a total of 60 catches were made until 1979 with an additional one to two whales likely struck and lost. From these, 29 individuals had been correctly reported to the IWC as blue whales but 31 were mislabelled as fin whales. The data from the 1950s showed some oversized fin whales but it is unclear whether they reflect incorrect species reporting or incorrect measurements, so it is possible that the actual number of blue whales caught was slightly higher than estimated. The mean body length of reported catches was smaller than at higher latitudes of the North Atlantic, probably reflecting geographical stratification with a higher proportion of immature animals in the region. The ratio between catches or sightings of blue whales and those of fin whales was 5.9% prior to exploitation, declined to 0.02-0.18% in the 1920s, and increased thereafter up to 1.6% in the 1980-1990s. Using the population size of fin whales for reference, the abundance of blue whales in the waters off the Iberian Peninsula at the end of the 1980s was estimated at approximately 337-497 individuals, with an apparent increase across the studied period. If the rates of increase observed in the northern North Atlantic are applied to these numbers, it can be derived that the current number of blue whales in the region may be over a thousand individuals. These results appear consistent with the increase in abundance of the species reported in northwest Spain and its progressive occupation of inshore waters.

The Committee welcomes this new information, as well as a proposal from Aguilar to reconcile Spanish catch records for all species with the IWC catch database. The Committee agrees that there would be great long-term value in having the most complete and accurate record of catches possible for future assessments and implementation simulation trials. The proposed work has budgetary implications for the Committee (see Item 12.3).

In further discussion, Víkingsson noted that a blue whale estimate from NASS surveys in Iceland in 2015 (*Pike et al., 2019)* was considerably higher than previous NASS estimates, although not significantly so due to relatively low estimate precision. The Committee recommends that this estimate be reviewed by the ASI Standing Working Group when possible (see procedure at IWC, 2020b, Annex P).

Attention: SC, R

The Committee:

(1) ***recommends*** *work to be led by Aguilar to reconcile records available for Spanish whaling catches with the IWC catch database; and*

(2) ***recommends*** *that the ASI Standing Working Group review the abundance estimate of blue whales off Iceland in 2015 (Pike et al., 2019).*

8.3.2 North Atlantic common minke whales (NH)

Due to time limitations, discussion of this topic was postponed.

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

Mattmüller *et al.* (2022) reported on the occasional acoustic presence of bowhead whales off Tasiilaq, Southeast Greenland. Simple call sequences were detected on three days (in November, January and March), with moderate to heavy daily sea ice concentrations (between 30% and 61%) at the recording location. The authors concluded that the occasional acoustic presence of bowhead whales in their study supports previous observations that bowhead whales do not regularly inhabit the waters of Tasiilaq but move through the area occasionally. Bowhead whales recorded there might belong to the Spitsbergen population which is known to migrate south along East Greenland. They concluded that changing sea ice conditions caused by climate change are likely to affect habitat suitability of the Tasiilaq area and thus bowhead whale occurrence in the future.

The Committee welcomes this new information which has the potential to improve understanding of the distribution and seasonality of Spitsbergen bowhead whales.

8.3.4 Unusual mortality events affecting northern stocks (NH; also see Item 14.3.2)
Due to time limitations, discussion of this topic was postponed.

Attention: SC, R
*The Committee **agrees** to the continuation of the intersessional e-mail group under Cholewiak (Annex M) to review information on Unusual Mortality Events for relevance to potential future assessments of Northern Hemisphere populations.*

8.3.5 North Pacific right whales
The Committee briefly discussed the importance of receiving new information on this small stock and that it would be prioritised in the next meeting.

8.3.6 Workplan
The Committee will continue to receive new information on other Northern Hemisphere stocks that are not subject to directed takes. Specifically, the Committee will prioritise new information on North Pacific right whales, North Atlantic blue whales, and East Greenland-Svalbard-Barents Sea (Spitsbergen) bowhead whales. 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. Proposed work to reconcile Spanish catch records with the IWC catch database was recommended by the Committee and has budgetary implications (Item 12.3).

8.4 New information (if provided) for other Southern stocks (SH)
8.4.1 Southern Hemisphere humpback whales
The first Comprehensive Assessment of Southern Hemisphere humpback whales was concluded in 2016. The Committee agrees to revisit species assessment priorities at the next meeting including those for humpback whales, recognising that substantial new information is available since the last assessment.

The assessment of the breeding stocks D (West Australia), E1 (East Australia) and Oceania was completed in 2014 (IWC, 2015f), but there were difficulties in obtaining a reliable estimate of absolute abundance for breeding stock D (IWC, 2017g; 2018c). Assessment of the feasibility of a new survey is underway in Australia. In 2018, the Committee recommended a review of methods to survey humpback whales migrating along the west coast of Western Australia (IWC, 2019b, p.27). Kelly reported that she had made some intersessional progress on this task but could not complete the planned work due to the COVID-19 global pandemic; a report on this task is anticipated at the next meeting.

Humpback whale breeding stock G spans the northwestern coast of South America, southwestern Central America and feeding grounds around the Antarctic Peninsula and southern Chile. A new mark recapture estimate of abundance was submitted to the Committee in 2021 (Félix *et al.*, 2021) combining mark-resight data from multiple regions across the migratory range of this population. This was reviewed intersessionally by the ASI Standing Working Group (see Item 3.3, Annex E. The ASG recommended that the 1991-2018 abundance estimate for Eastern South Pacific humpback whales (Breeding Stock G) of 11,784 (SE=266) be endorsed as Category 3 (see Item 11.1.12). Noting the extraordinary work involved in collating this dataset and the great potential of the dataset for use in management, the ASI agreed to form a small intersessional group to help the authors of (Félix *et al.*, 2021) improve their analyses, and also to develop expertise within the Committee to advise on similar future work.

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, 2019b, p.27) its recommendation that an evaluation of survey feasibility be completed intersessionally, with a view to implementing a new survey of this population in the future.*

8.4.2 Southern Hemisphere fin whales
The Committee is currently conducting a pre-assessment of Southern Hemisphere fin whales. No updates were invited in 2021 due to the limited discussion time available at the meeting. In 2022, the Committee was provided with updates on analysis of passive acoustic data contributing towards understanding of fin whale distribution and stock structure.

Aulich *et al.* (2022) presented results of the seasonal distribution of fin whales at five Antarctic locations between 70°E and 180°E, two sub-Antarctic locations (53°0.0'S and 76°8.8'E; 53°44.4'S and 141°46.2'E) and seven locations in Australian waters from 2002-19 based on acoustic recordings. Fin whale presence in Antarctic waters was generally seasonal, from late austral summer to autumn (February to June). In Australian waters, seasonal presence from austral autumn to mid-spring (May to October) was noted. Based on spatial patterns in fin whale calling occurrence, notably low detections at

Casey in the Antarctic and along the south coast of Australia, the authors proposed two distinct populations with two distinct migratory pathways: from the Indian sector of Antarctica to the west coast of Australia and from the Pacific sector of Antarctica to the east coast of Australia.

The Committee was informed that song structure analysis is underway for these data and results should be available at the next meeting. The Committee welcomes future updates on this work, specifically regarding detailed song analysis and inter-regional comparisons. The Committee encourages the authors to consider conducting an analysis of fin whale song features in a manner that would make it directly comparable to the results presented in Wood and Sirovic (2022) and SC/68D/SH/01.

Burkhardt *et al.* (2021) reports on the seasonality of fin whales near Elephant Island (EI) over three years (2013-16) from acoustic data. Their acoustic presence lasts from February to August, with a peak in May. The features of the high frequency component of the fin whale songs led to a hypothesis that these whales migrate to the South Pacific Ocean waters off Chile. The authors also noted that three more years of data (2016-19) have been reviewed, with consistent seasonality patterns to those presented in Burkhardt *et al.* (2021). Additionally, acoustic data has been recorded successfully from 2019-22 from the same region. The Committee thanked the authors for this update and welcomed future updates on this work.

Wood and Sirovic (2022) analysed the patterns in fin whale song from the Western Antarctic Peninsula (WAP) from 2001 and 2004 and compared it with song recorded in the same area in 2014-16. A single song type was identified in this location over this period. Even though the interpulse intervals increased slightly and frequency of the higher frequency component decreased slightly over time, the song remained identifiable. It was noted in the discussion that unlike fin whale song in the North Pacific, which tends to vary over time and thus might be challenging to use for determining population structure from non-concurrent recordings, the apparent stability of the song in the Southern Hemisphere will make it easier to develop hypotheses on possible population structure in this region.

SC/68D/SH/01 reported on a difference in fin whale songs (both in interpulse interval and its high frequency component) between those recorded at EI between 2013-15 and those recorded at Greenwich Meridian (59.167°S) between 2009-11, indicating two distinct acoustic populations. The song from EI had features that made it comparable to the song reported in Wood and Sirovic (2022) at a nearby location in the WAP.

It was noted that SC/68D/SH/08 reports on tagging efforts from WAP that show tracks from two fin whales that were tagged off EI traveling northward into the South Pacific, potentially on seasonal migration to lower latitudes. The Committee was also informed of unpublished fin whales tagging efforts off Brazil (approx. 27°S); tagged whales appeared to indicate movement towards central South Atlantic feeding grounds (islands at 54°-55°S, 36°-38°W). The Committee encourages these researchers to present this work in more detail at the 2023 meeting.

The Committee welcomes these updates on fin whale population identity and movements and acknowledged the substantial effort involved. It was noted that data in these studies span Antarctic Areas I-V, constituting a substantial circumpolar effort. In discussion of data gaps, the Committee were informed that new acoustic recordings were being collected in the South Atlantic (associated to Areas I and II), including from South Africa, Marion Island, and off southeastern and northeastern Brazil, as well as additional recordings from islands at 60°30'-60°48'S, 44°25'S-46°43'W. The Committee encourages researchers to analyse the fin whale song characteristics from these locations.

It was noted that patterns of differentiation in acoustic and genetic data are not always concordant, for example acoustics may provide an early indication of stock structure that suggest occurrence of assortative mating not yet resulting in genetic differentiation. Considering this and the new information on long-term song stability, the Committee encourages a multi-area analysis focusing on inter-regional comparisons of fin whale song types. This could use the variation in fin whale song characteristics to guide stock structure hypotheses that could then be tested with other datasets (e.g. genetics, morphometrics, isotopes).

Matsuoka and Hakamada (2014) presented abundance estimates for fin whales based on Antarctic sighting surveys from the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA and JARPAII) in the 1989/90–2008/09 seasons. The abundance estimates for Indian Ocean Antarctic Areas IIIE and IV were 3,087 (CV 0.191) and 2,610 (CV 0.285) at the start and end seasons, respectively. The abundance estimates for Western South Pacific Ocean Antarctic Areas V and VIW were 1,879 (CV 0.226) and 14,981 (CV 0.298) at the start and end seasons, respectively. It was noted that fin whales were widely dispersed in the research area and tended to be found more in Area V than Area IV.

The Committee noted that these surveys span large Antarctic areas and could be very valuable for future regional assessments. They therefore agreed to review these abundance estimates for endorsement, once fin whale stock structuring across these areas is better understood.

SC/68D/ASI/10 reported the results of 2021/22 JASS-A dedicated sighting survey program, which was conducted in the eastern part of Area VI East (130°W-120°W; south of 60°S). The total searching distance was 1,333.5 n.miles during which 44 schools (64 individuals) of fin whales were observed. In total (including transit), 12 biopsy samples (from different individuals) were collected, and nine satellite tags were deployed. Based on preliminary satellite tracks, all tagged whales moved west from their tagging locations, as far as Area V, but none entered Area I. Data obtained will be analysed to provide abundance estimates and for stock structure studies at the Institute of Cetacean Research. The Committee thanked the authors for this new information and welcomed updates at the next meeting.

Table 16

Workplan for SH.

Topic	Intersessional	Next meeting	Intersessional	Subsequent meeting
Southern Hemisphere non-Antarctic blue whales (Item 8.2.1)				
Distribution (8.2.1.1)	Assess the stock identity and movements of blue whales in the Mozambique Channel (Cerchio)	Report		
Progress towards In-depth assessment (8.2.1.4)	Submit the Blue Whale Centre blue whale catalogue from Chile to SHBWC for matching (Torres Florez and Hucke Gaete)	Report		
	Finalise photo-ID matching within the southeast Pacific (Galletti). This Item has financial implications for the Scientific Committee	Report		
	Generate abundance estimate by mark recapture analysis of New Zealand (SWPO) blue whale datasets (Fewster, Galletti, Torres, Olson, Goetz, Barlow, Lundquist, Double, Jackson)	Report		
	Generate abundance estimate by mark recapture analysis of Australia (SEIO) and Chile (SEPO) blue whale datasets (Fewster, Galletti, Salgado-Kent, Jackson). This Item has financial implications for the Scientific Committee	Report		
	Final report on regional catch allocations for non-Antarctic Southern Hemisphere blue whales (Branch)	Report		
Antarctic blue whales (Item 8.2.2)				
Population abundance (8.2.2.2)	Provide regional Antarctic blue whale trend estimates using song density patterns (Miller)	Report 6 weeks ahead of the next meeting for ASI review		
Progress towards population assessment (8.2.2.1)	Conduct passive acoustic monitoring off the west coast of South Africa and off Durban, to characterise the density, distribution and seasonal movements of Antarctic blue whales (Shabangu). This Item has financial implications for the Scientific Committee	Report		
	Compare frequency and temporal features of Antarctic blue whale song at mid to low latitudes to assess regional variation (Buchan)	Report		
	Mark recapture modelling work following recommendations from the ASI Standing Working Group on SC/68C/ASI15 (Olson)	Report 6 weeks ahead the next meeting for ASI review		
			Initiate assessment of Antarctic blue whales (Branch, Rand). This Item has financial implications for the SC	Report
Southern right whales not subject to CMP (Item 8.2.3)				
Population monitoring (8.2.3.3)	Establish a collaborative agreement among marine mammal research groups in regards to coordinated data in regards to the use of satellite imagery to monitoring southern right whales in remote areas (Vermeulen, under SRWC umbrella)	Report		
Population structure (8.2.3.4)	Multi-state mark recapture and population dynamic analysis of Brazil-Argentina photo-ID data to assess movement rates between regions (led by Agrelo, including Groch, Rowntree, Sironi, Vilches, Marón, Renault-Braga, Cooke). This Item has financial implications for the Scientific Committee	Progress report	Continue workplan	Report
	Photo-ID matching between Uruguay with Brazil and Argentina catalogues (Groch)	Progress report	Continue workplan	Progress report
	Continued collation of offshore sightings of southern right whales, and review of offshore hydrophone network and voyage data for southern right whale detections south of 40°S (Vermeulen and Carroll)	Progress report	Continue workplan	Report
Progress towards In-depth assessment (8.2.3.6)	Application of the common modelling framework on South African, and likely South American datasets to assess southern right whale population parameters (Butterworth and Cooke)	Progress report	Continue workplan	Report
	Workshop on southern right whale catch series review, to update regional catch estimates from IWC (2013) (Findlay and Vermeulen)	Meeting report		
			Workshop on the population structure and catch allocation (intersessional 2023/24) (Vermeulen and Jackson)	Meeting report
Southern Hemisphere fin whales (8.4.2)				
Population structure (8.4.2)	Re-assess the use of available published and unpublished Discovery mark data on fin whales (Pastene, Jackson, Mizroch, Olson)	Report		
	Analyse fin whale song from recordings collected by Australian Antarctic Division in Australian, Antarctic and sub-Antarctic locations (Aulich)	Report		
	Analyse fin whale song from recordings collected off South Africa and Marion Island (Shabangu). This is an Item with funding implications for the Committee	Report		
	Working group to conduct inter-regional comparisons of Southern Hemisphere fin whale songs: compile existing analyses (Širović)	Report	Continue Working Group	Report

The sub-committee welcomed an update on the efforts to obtain a sample of the *B. physalus patachonica* holotype from MACN in Buenos Aires (IWC, 2020d, item 4.1). The Committee was informed that the Society of Taxonomy no longer recognises *B. p. patachonica* as a separate subspecies[14], but still encourages continuation of this effort, as this type specimen has never been genetically identified. The museum has agreed to allow the sampling, and logistics and permits are being organised as the museum is just starting to reopen after COVID-19 related closures.

8.4.3 Biennial workplan[15]

See Table 16.

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

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 of scientific work and information) that are either: (1) the subject of existing CMPs; or (2) are high priority candidates for a CMP. This report also addresses 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 SE Pacific southern right whales (CMP, SH)

The Committee received a report on advances made under the implementation strategy 2021-23 of the Chile-Peru southern right whale CMP (SC/68D/CMP/06). Last year, the Committee endorsed a CMP 6+ year review for 2022. Considerable new scientific information has been collected and actions taken by the Governments of Chile and Peru.

A workshop on 'experience exchange' aimed at reviewing whale watching regulations and scientific research permits (for stranded and live animals), as well as entanglement response procedures was initially planned for 2020 but was postponed, in response to COVID-19. It has now been rescheduled as an in-person meeting to be held in August 2022 in Lima, Peru. This workshop has the support of the Whale Watching sub-committee and is focused on exchanging experience among participants, reviewing procedures for responsible whale watching and documenting and reporting, for example, whale entanglements and injury. The 4th in-person coordination meeting to review the entire CMP is planned concurrent with the whale watching workshop in August 2022.

A virtual workshop is also planned for July 2022 to update data on the CMP. This expert workshop will review historical and recent data on Chile-Peru southern right whales to inform and update the scientific information in the CMP. Topics to be covered at the workshop include historical catches, population structure, distribution, migration and movements, basic biology, abundance and trends, as well as their threats, risk assessment and possible mitigation measures. Invited participants include researchers from Chile and Peru as well as other experts that have conducted or are involved with southern right whale research/conservation. Funding for each of these workshops and meetings has been secured. Reports from these workshops will be presented to the next meeting of the Committee.

SC/68D/CMP/06 highlighted new sightings of southern right whales during summer 2022 at northwestern Isla de Chiloé. There was a proposal to utilise new technology to improve photo-ID collection and assess the health status of this population. The Committee has been supporting a Passive Acoustic Monitoring (PAM) project to assist in the identification of possible breeding areas along the coast of Chile and Peru. Six sites have been initially selected. Two of them, Isla de Chiloé and Arauco Gulf have already been monitored. The PAM project is currently being implemented at Antofagasta region, northern Chile, but additional funding is needed to cover its entire year-cycle. Funding has already been secured to monitor southern Peru during 2022-23. A new opportunity to monitor Golfo de Penas, one of the six selected locations and one that is difficult to access is currently becoming available. Centro de Estudios Avanzados en Zonas Aridas (CEAZA) is offering to contribute with a new hydrophone - that requires limited annual maintenance. The Research Centre of Patagonian Ecosystems (CIEP) can provide logistics for the first deployment of the acoustic equipment. The Chilean Navy may also provide logistical assistance to the area.

The Committee received a progress report on the Passive Acoustic Monitoring (PAM) project with Chile-Peru southern right whales (SC/68D/CMP/01). The Committee has provided long-term support for the PAM project since its inception. The Arauco Gulf of Chile was the location of a former whaling station where SRWs were hunted. Cow-calf pairs were also reported in this same area from the whaling operations. Isla de Chiloé has been proposed as part of the breeding area based on the number of sightings, observation of reproductive behaviours in surface-active groups (SAGs), and presence of mothers with calves. Therefore, this area is identified as strategic site for long-term monitoring.

[14] *https://marinemammalscience.org/science-and-publications/list-marine-mammal-species-subspecies/.*

[15] Note that the blue whale pre-assessment work is anticipated to be completed in 2023, hence reporting is mostly in year one of the biennial workplan.

Twelve months of continuous recordings were collected between 2018 and 2019 off northwestern Isla de Chiloé, austral Chile and five months between 2019 and 2020 off Arauco Gulf, southern Chile. A Soundtrap hydrophone deployment was used to acoustically monitor these sites. Acoustic data were analysed using an automatic detector specially developed under this project for right whale upcall vocalisations in the Low-frequency detection and classification system (LFDCS) software. The detections were reviewed and validated by an analyst, and the false negative rate of the detector was calculated by the manual annotation of days with true detections and aleatory days (*n*=100 days) selected from the Puñihuil dataset.

Off Chiloé, 189 true positive detections were recorded in the 2018-19 period, with calls present during the austral summer, autumn and winter with no clear seasonal trend. While in the Arauco Gulf, no true positive detections were found. Gunshot calls were found along with upcalls during March 2019, which is of relevance, because they have been associated with mating or agonistic behaviour between males in other populations. The presence of upcalls in almost all seasons suggest that northwestern Chiloé Island is potentially used by some individuals, as a non-migratory habitat, but this could also mean the population is so small that seasonality cannot be detected. These acoustic findings and behavioural observations (Galletti Vernazzani *et al.*, 2014), highlight the importance of the southern Chile area to this critically endangered Southeast Pacific southern right whale population and for its long-term monitoring. Moreover, recent sightings of mother-calf pairs at Golfo de Penas (approx. 500km south) suggest this remote area could also be part of a larger southern Chile breeding area, so more directed survey efforts should be concentrated here. Due to missing months of data, southern right whales off Arauco Gulf could have been missed so better temporal coverage at this site is necessary. Currently northern Chile is being monitored and future data collection efforts will be centred on southern Peru and Golfo de Penas.

Attention: SC, CC, CG
*The Committee **reiterates** the importance of the CMP for the conservation of the critically endangered Southeast Pacific southern right whale population (IWC, 2019b, p.28). The Committee **welcomes** the progress made and **draws attention** to:*

(1) *the need for funding to continue to conduct the passive acoustic monitoring field work and;*
(2) *notes the importance of increasing information about the presence of the species in southern Chile, especially the Golfo de Penas which could merit funding for additional monitoring efforts.*

9.1.2 SW Atlantic southern right whales (CMP, SH)

The existing CMP was adopted in 2012 and subsequently implemented in 2013. The last review of the Southwest (SW) Atlantic southern right whale CMP occurred in 2016. At SC68C the Report of the Intersessional Workshop on the IWC CMP for the Southwest Atlantic Southern Right Whale (SRW) Population (SC/68C/CMP/20) was reviewed. The workshop reviewed research, monitoring, and mitigation actions, identified the status of each action, including an evaluation of the necessary steps to accomplish incomplete actions, evaluate the continuity of accomplished actions and established new actions as necessary. With this extensive new information and the last formal review occurring over six years ago, a formal review of this CMP is merited. A workshop will be held 1-3 June 2022 in Curitiba, Brazil which is sponsored by the Committee, Fundo Brasileiro para a Biodiversidade/Brazilian Fund for Biodiversity (FUNBIO), and Instituto Chico Mendes de Conservaçao da Biodiversidade/Chico Mendes Institute for Biodiversity Conservation (ICMBio). The main objective is to review the actions (progress, difficulties and, if applicable, propose new actions) and update the CMP for the SW Atlantic southern right whale population.

The Committee encourages the continuation of existing and long-term monitoring efforts which support both SH and CMP priorities (e.g. photo-ID based mark recapture efforts: Item 9.1.2, IWC, 2022a; telemetry efforts from Argentina: See Item 8.2.3.4; SC/68D/SH/07Rev1). Additionally, Agrelo *et al.* (2021a) relates to ongoing work to progress regional assessments of southern right whales and was discussed under Item 8.2.3.4. These long-term monitoring efforts provide support for the Committee's recommendations in support of the SWA SRW CMP.

One paper was received by the Committee, SC/68D/CMP/02, which estimated population increase rates, relative abundance and distribution shifts of SWA SRWs around Peninsula Valdes and in the Golfo San Matias. This paper was discussed in more detail under Item 9.1.2. The need to compare population rates among SRW populations was noted, although the SH and ASI sub-committees are better equipped to handle such a discussion.

The Committee encourages the continuation of all existing long-term studies on SRWs in Brazil and Argentina that are valuable to the work of the CMP sub-committee. In discussion, it was noted that additional satellite telemetry studies would continue to provide important data regarding movements, migration routes, and the location of feeding grounds. The Committee encourages the continuing this work.

A budget proposal to assess movement rates of SRWs between regions (see Item 8.2.3.4 and Item 22) using multi-state mark recapture models was assessed by both the SH and CMP sub-committees. This work supports actions of the SW Atlantic SRW CMP and the SH sub-committee's work, by developing theoretical models for population growth and abundance assessment and a better understanding of movement between countries. Data from photo-ID catalogues of

SWA-SRW off Peninsula Valdés and Brazil and matching between both regions brings an opportunity to increase knowledge on SWA-SRW movement rates. Expected outcomes include estimating movement probabilities between calving grounds in Argentina and Brazil, estimating survival and recapture probabilities, the influence of biological processes on movement probabilities (e.g. gull harassment, calf mortality, and density-dependence), and encouraging future SRW parameter assessments using this method.

Attention: SC, CC, CG

*The Committee **reiterates** the importance of the CMP for Southwest Atlantic southern right whales and welcomes the progress made since its implementation. To support the Actions outlined in the CMP and continued progress on these actions, the Committee:*

(1) ***recommends** continued collaboration among range states to generate new information and encourages additional effort from Brazil given the additional funding received;*
(2) ***reiterates** the importance of continuing the long-term monitoring programmes, 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;*
(3) ***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;*
(4) ***encourages** the continuation of telemetry studies in Argentina and recommends satellite tagging in Brazil and Uruguay;*
(5) *respectfully requests that the IWC Commissioners for these countries (Brazil, Uruguay and Argentina) continue facilitating the internal permit process for right whale tagging programmes;*
(6) *highlights the importance of research utilising baleen from stranded whales to investigate stress hormone profiles, **encourages** future studies and the presentation of results to the Committee when they become available; and*
(7) ***encourages** comparisons of photo-ID catalogues between Argentina, Brazil, Chile, and Uruguay, especially Argentina and Brazil.*

9.1.3 North Pacific Gray Whales (CMP, IST, ASW)

In February 2022 a gray whale was sighted on two consecutive days off Hawai'i Island (SC/68D/CMP/05). This is the first record of this species in Hawaiian waters and in the central tropical Pacific. Images from Hawaii were compared to several photo-ID catalogues from the eastern and western North Pacific, but no matches were found.

Information on research and conservation of gray whales off Japan for the period from May 2021 to April 2022 was presented in SC/68D/CMP/07. No sightings, strandings or anthropogenic mortality due to entanglement or other causes were reported from the coast of Japan during the reporting period.

During the winter 2022 breeding season in Laguna San Ignacio, Baja California Sur, Mexico, 788 gray whales were photographed, of which 626 individuals (male or female without a calf) and 42 mothers with calves (Mc) were evaluated for body condition (SC/68D/CMP/08). The proportion of individuals with 'good' body condition was 43%, 'fair' 37.5% and 'poor' 19.5%. The body condition of mothers with calves in 2022 was 'good' 90.5%, 'fair' 9.5% with 0% 'poor'. The percentage of Mc pairs with 'good' body condition was similar to those observed during the UME period 2019-21. Finally, the number of Mother calf pairs observed in 2022 was very low, similar to numbers reported in 2019-2021.

SC/68D/CMP/09 provided an update on the movements of gray whales identified in western North Pacific (WNP) feeding areas and eastern North Pacific (ENP) wintering lagoons in Baja California, Mexico. Images of 378 whales identified on the WNP feeding areas off Russia (229 from Sakhalin; 63 from Kamchatka and 86 registered in both areas) were compared to 11,000 individuals photographed in the ENP wintering areas. A total of 48 matches of individuals between the WNP and ENP were found, including 21 females, 14 males, and 13 whales of unknown sex. These matches included 13 Sakhalin-Kamchatka-Mexico, 28 Sakhalin-Mexico and seven Kamchatka-Mexico. Movements between the WNP and ENP represent about 12.6% of gray whales identified off Sakhalin Island and Kamchatka and 0.4% of the gray whales identified in the wintering lagoons. Sixteen of the 48 grey whales observed migrating between the WNP and the ENP (Mexico) did so in at least two years (range=2 to 5 years).

Weller advised the Committee that substantial progress had been made since the last meeting with using machine learning/artificial intelligence for photographic matching of gray whales. This effort is being undertaken by NOAA/SWFSC in collaboration with Wild Me[16] and several external data contributors. The objective of this initiative is to increase efficiency of matching between and within photo-ID catalogues (e.g. Mexico to Sakhalin) by way of automated computer routines and thereby to aid in projects such as that described in SC/68D/CMP/09.

[16] *https://www.wildme.org*.

Strandings of at least 47 gray whales were reported along the Pacific coast of Baja California, Mexico between 1 January and 7 April 2022 (SC/68D/CMP/10). As in previous years, most of the strandings (*n*=32) occurred in Laguna Ojo de Liebre (LOL) and the surrounding areas. Of the 47 documented strandings, 26 were males, 19 females and two of undetermined sex. The age classes of the dead whales were: 33 adults, six subadults, 5 yearlings and 3 calves. The number of strandings in 2022 is lower than 2021, but the winter season and associated field search effort had not yet concluded when this summary was completed.

The winter of 2022 was the fifth consecutive gray whale winter season (2018-22) in Laguna San Ignacio and Bahía Magdalena, with whales leaving both areas approximately two weeks earlier than expected (SC/68D/CMP/12). The highest number of individual adult whales counted during vessel surveys in Laguna San Ignacio was 172 whales on 19 February, which was similar to counts observed in previous winters. Counts of females with calves remained low throughout the 2022 winter season, with the highest count of 18 pairs observed on 9 March 2022. The highest counts in Bahía Magdalena were obtained on 9 February in the most southerly aggregation area of Bahía Almejas with 173 adult whales and no female-calf pairs observed. In central Bahía Magdalena, counts were greatest on 23 January with 42 adult whales and no calves. In the northern Canal de Santo Domingo, 36 single whales and two female-calf pairs were counted on 7 February.

As indicated at the 2021 SC meeting, the IUCN Western Gray Whale Advisory Panel (WGWAP) was to be dissolved at the end of December 2021 (Reeves *et al.*, 2021). SC/68D/CMP/13 reported that the panel's final meeting was held at IUCN headquarters in Gland, Switzerland, on 9-10 November 2021. An extension of the closure date to 31 March 2022 was meant to allow panel members time to bring several documents closer to completion and to continue supporting the development of a mechanism within Minprirody (Ministry of Natural Resources and Environment of the Russian Federation) that would continue at least some of the WGWAP's assessment and oversight functions in relation to impacts on gray whales of industrial activities on the Sakhalin Shelf. Unfortunately, the Russian invasion of Ukraine, which began 24 February, disrupted IUCN's and the panel's efforts and plans.

Although the report of the panel's November 2021 meeting (WGWAP-22) was finalised, as of 28 April 2022 it had not been posted on the IUCN website[17]. It is impossible to know at this point which outcomes and materials from the 17 years of western gray whale panel activities will remain available, and where they will be archived, given that IUCN is undergoing a major overhaul of its online capabilities and priorities. The WGWAP-22 report states, in regard to potential alternate sites:

One potential repository site for at least portions of WGWAP materials is the IWC Secretariat, which Staniland (attending WGWAP-22 virtually) noted has considerable experience with, and the capability to organise and manage, scientific and conservation-related data and literature. He offered to assist as much as possible in any future discussions.

The WGWAP-22 report also states:

> *'The IWC is currently updating the joint IWC/IUCN western gray whale Conservation Management Plan (CMP)[18], to be based in part on the outcome of a postponed Scientific Committee workshop to finalise rangewide considerations into an updated CMP. The workshop is now planned for 2022. This will in turn feed into a stakeholder workshop (including country representatives, NGOs, businesses) and consideration at the upcoming Commission meeting in October 2022 (IWC68). After working closely with the WGWAP throughout its existence, the IWC will continue its work on gray whales through its various committees.'*

Finally, the WGWAP-22 report states the panel's belief that an updated[19] and revitalised 'Memorandum of Cooperation concerning Conservation Measures for the Western Gray Whale', initially developed in 2014 and signed so far by the IWC Commissioners of five of the eight or nine range states (Japan, Republic of Korea, Russian Federation, USA and Mexico), could become a valuable mechanism for supporting range wide work.

Considering the WGWAP is no longer being convened by IUCN and the further geopolitical complications caused by the Russian invasion of Ukraine, the Committee discussed potential impacts on the science, and in turn conservation, of WNP gray whales. Three central themes were raised: (1) the possibility that at least some of the work carried out by the WGWAP would be taken up by Minprirody with continued input from some past members of the WGWAP and advisory support from IUCN. Given the Russian invasion of Ukraine, at present it seems questionable that this will happen; (2) the foreign oil and gas companies operating near the WNP gray whale feeding areas off Sakhalin had long funded a research and monitoring programme (2002-22) but in response to the Russian invasion of Ukraine, these companies ceased their business interests at Sakhalin and elsewhere in the country. With that, the Committee expressed concern that industry-funded research on gray whales off Sakhalin will be seriously affected and quite possibly end. This same concern was expressed by the Committee regarding the ability of independent groups, like the Russian Gray Whale Project, to continue conducting research. Scordino raised the issue of how future population modelling, such as that conducted by Justin Cooke et al., would be handled if the

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

[18] *https://iwc.int/western-gray-whale-cmp.*

[19] The update is necessary *inter alia* given the many references to the WGWAP in the existing document.

traditional sampling effort (industry plus Russian Gray Whale Project) is disrupted. By way of example, he mentioned that sensitivity tests on estimates of abundance, in terms of accuracy and precision, may be necessary. It is possible that no research on WNP gray whales occurs in summer 2022 and beyond, making future population modelling impossible; and (3) in light of the geopolitical implications caused by the Russian invasion of Ukraine, the Committee expressed great concern that conservation actions and especially international collaborative scientific studies in Russia, including those related to marine mammals will be seriously compromised and permanently damaged and result in intractable consequences on population assessment.

Finally, it was agreed that the workshop to incorporate scientific considerations in an updated western gray whale CMP should be held in La Jolla before the next SC meeting.

SC/68D/CMP/14 reported on the 2019-22 Unusual Mortality Event (UME) of eastern North Pacific (ENP) gray whales. While this UME has continued in 2022, the numbers of stranded whales appear to be decreasing compared with the same period in 2019 and 2021. From 17 December 2018 through 06 April 2022, a total of about 534 stranded ENP whales was documented along the Pacific coast across three countries (Canada, Mexico, and United States). Two hundred and fourteen dead whales were reported in 2019 (including two whales from December 2018), 172 in 2020, 114 in 2021, and 32 in 2022 as of 06 April. Strandings occurred along the entire ENP range of gray whales, including wintering, migratory and feeding areas, with most of the dead whales in the U.S. documented in spring and early summer when gray whales are near the end of their seasonal fast. The abundance estimates of ENP gray whales showed a ~24% decrease between 2016 and 2020, which spans the UME (Stewart and Weller, 2021a). Total calf production in 2021 was estimated at 380 individuals (95% CI 296-493) – among the lowest calf production estimates on record (Stewart and Weller, 2021b). Two of the three recorded periods of low calf production have coincided with UMEs, the 1999-2000 UME and the current event. This suggests that the factors driving or mediating gray whale fecundity and mortality rates are similar.

The most recent surveys conducted by NOAA/SWFSC took place in 2020 and 2022 for abundance (southbound migration observed from Granite Canyon, California) and 2021 and 2022 for calf production (northbound migration observed from Piedras Blancas, California). Data from these surveys will continue to be important for understanding population-level impacts of the current UME. Weller informed the Committee that personal communications with Russian scientists working off Sakhalin and Chukotka indicated that no signs or symptoms of the aforementioned UME were being observed in the western North Pacific.

The Russian Gray Whale Project (RGWP) has provided a long time-series of photo-id and genetic data used in the assessments by the Scientific Committee and others. In 2021, research on gray whales off northeastern Sakhalin Island and off the southeastern coast of Kamchatka (Kronotsky Bay) was conducted by the project (SC/68D/CMP/15). Off Sakhalin, research was conducted from 7 July to 8 September during which time 20 boat surveys were completed. A total of 146 whale groups was encountered (with repeated sightings) and 42 unique whales were identified. Fourteen mother-calf pairs and three new whales (older than one year) not previously seen in the study area were observed in the nearshore feeding area off Sakhalin. The catalogue of whales summering off Sakhalin between 1994-2021 includes 331 individuals (SC/68D/CMP/16).

In 2021, a survey of gray whales off the Kamchatka Peninsula (Olga Bay, Kronotsky Gulf) was conducted on 23 August, encountering nine whales of which three were known to have occurred off Sakhalin in at least one previous year.

Photo-ID of gray whales feeding off northeastern Sakhalin Island in summer and autumn has been a principal component of two long-running (1995-2021 and 2002-21) scientific projects (SC/68D/CMP/16). The RGWP (formerly called the Russia-US Research Program) was the first to initiate photo-ID studies off Sakhalin in 1995. A second photo-ID project, funded directly by offshore oil and gas companies, was initiated in 2002. These two research projects have collected photo-ID data on gray whales from small boats, large vessels, shore and more recently aerial drone systems.

Recognising that information derived from the datasets of these two research projects is critical for population assessment, the Scientific Committee of the IWC has highlighted for more than a decade the importance of combining these two photo-ID (and genetic) data holdings. While those involved in western gray whale research and conservation have expected for many years that a common (joint) photo-ID catalogue and database would become available, to be controlled and managed under the auspices of the IWC, this objective has not been met. Clearly, failing to combine the two catalogues works to counter the concept of using all available science (and data) to support conservation.

As a good faith gesture and to partially offset the effects of the aforementioned lack of progress in integrating western gray whale photo-ID data, the 1994-2021 catalogue maintained by the Russia Gray Whale Project (Dr. Alexander Burdin, PI) will be made available via the IWC Secretariat following SC68D. It is the intent of the authors to follow the guidelines set out in Olson *et al.* (2017), including a data availability agreement that facilitates access to the catalogue for Scientific Committee members. As an initial step, the catalogue will be provided to the IWC Secretariat in PDF form, followed in time with more complete sighting information and related digital type-specimen images.

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

(1) ***commends** the work in the wintering areas of Mexico, **urges** its continuation and **expresses concern** about the high number of strandings, poor body condition and low calf counts observed in Mexico in 2019-2022 as related to the UME event;*
(2) ***welcomes** the continued provision of information from Japan and encourages researchers there to continue to collect as much information on sightings and strandings as possible, including attempting to obtain biopsies or tissues and photographs whenever feasible;*
(3) ***recommends** that every effort be undertaken to enable continuation of the Russian Gray Whale Project in order to maintain the several-decades-long time-series upon which assessment of the population relies;*
(4) ***commends** the Russian Gray Whale Project for making available its 25+ year photo-ID catalogue, providing access for Scientific Committee members, and **recommends** that other research programmes focused on WNP gray whales make their catalogues and related data available via the IWC, with particular emphasis on the industry funded-effort (2002-21) off Sakhalin; and*
(5) ***highlights** the importance of data collected by NOAA/SWFSC on abundance and calf production off central California, particularly in light of the ongoing 2019-2022 unusual mortality event, and **strongly recommends** that these two surveys and related investigations on the UME continue in 2022/2023 and into the future.*

9.1.4 Franciscana (CMP, SM)

In 2020, the Committee established two intersessional correspondence groups (ICGs) to: (1) review population structure of the franciscana (*Pontoporia blainvillei*), including the level of support for each of the proposed stock subdivisions based on genetic and other lines of evidence (e.g. morphology and contaminant); and (2) review abundance estimates and factors to correct for potential sources of bias in these estimates. As part of these activities, the review of the species continues.

Aerial surveys, partly funded by the SC, were conducted in 2019 and 2022 to estimate abundance of franciscana dolphins in Buenos Aires Province, Argentina (SC/68D/CMP/17). A total of nine coastal surveys were flown in visibility conditions allowing for the sighting of several species of cetaceans. The two series of surveys (2019-2022) were carried out separately due to the COVID-19 pandemic. In 2019, 41 sightings of franciscana dolphins were made, totalling 68 individuals. During the 2022 survey, 55 sighting were recorded comprising 80 franciscana dolphins. The preliminary abundance of franciscana within the Buenos Aires Province was estimated at 13,598 (95%CI 5,392-33,683) dolphins considering the estimation obtained in 2022. In 2004 abundance in the southern area was estimated at 5,896 dolphins. This area was not surveyed during 2019 and 2022 flights, however, under the assumption that the southern area remained constant – which is the most conservative hypothesis, it was estimated that the abundance between the coast and the 30 metres isobath could be roughly 20,000 individuals. Franciscanas beyond the 30m isobath were not considered here. As the flights were not all carried out during the same season the results obtained here cannot be directly compared to those from 2003/04 (Crespo *et al.*, 2010). It was not possible to investigate possible trends with only two estimates of density. More surveys would be necessary to estimate a trend. However, it is believed that the population did not decline and that at least 20,000 animals inhabit Argentine waters. In discussion, the importance of continued surveys to estimate trends in abundance was noted. The work described in SC/68D/CMP/17 adds to previous research presented at SC and addresses partially the Committee's previous recommendations specifically monitoring abundance, trends, and bycatch. The estimate of abundance provided in SC/68D/CMP/17 should be reviewed by ASI intersessionally as part of the Committee's effort to conclude the review of the status of the franciscana and to update the franciscana CMP actions.

Last year, the plan to conduct a joint Uruguay-Brazil aerial survey in Uruguay waters was discussed. A survey, partly funded by the SC, to estimate abundance of franciscana in Uruguay could not be carried out, in part due to COVID-19. In discussion, it was noted that a special permit is required for the aircraft from Brazil to survey Uruguayan waters and that efforts are being made to expedite this process by the governments of Brazil, Uruguay and the CMP coordinator.

An information dissemination campaign 'Our Neighbour the Franciscana' has been one of the priority actions identified from the inception of the CMP. Various multi-lingual (English, Portuguese and Spanish) outreach materials (e.g. infographics, videos, and posters) were produced for use by the three range countries increasing the campaign's reach and impact. The Committee was shown a sample of an infographic and praised the efforts and products available to visually articulate the franciscana's conservation challenges in multiple languages. These materials will be uploaded to the IWC website. The campaign is expected to launch during the 68th Meeting of the IWC.

A book on the franciscana, edited by Paulo Simões-Lopes and Marta Cremer, will be published in the coming months. The book's 19 chapters compile information on the ecology and conservation of the species in Argentina, Brazil and Uruguay. This information will be useful for future CMP updates because several of the actions identified by the IWC have

been addressed in this book. In addition, to commemorate the 75th anniversary of the IWC, an article on the franciscana CMP was prepared for publication in the ECO magazine (*Environment, Coastal & Offshore* magazine, which showcases 'international ocean science, innovation, and exploration' stories).

A workshop is planned for June 2022 in Curitiba, Brazil, to discuss the population structure and abundance estimation of franciscana. Once the species review is completed, the actions identified in the CMP, which has been in place for six years, will be updated. The IWC, FUNBIO, and ICMBio all contribute financially to it.

Attention: SC, CC
The Committee:

(1) ***agrees*** *that the review of the franciscana continue during the intersessional period and updates be presented at the next meeting;*
(2) ***welcomes*** *updates from the Curitiba Workshop report at the next meeting;*
(3) *applauds progress made under the information dissemination campaign 'Our Neighbour the Franciscana', and welcomes any updates at the next meeting; and*
(4) ***recommends*** *that the proposed aerial survey off Uruguay be completed prior to the next meeting, if possible, and respectfully requests the government of Uruguay to issue a permit for the Brazilian aircraft to conduct the survey.*

9.1.5 South American river dolphins (CMP, SM)

The Governments of Colombia, Brazil, Peru and Ecuador appointed Fernando Trujillo as coordinator of the South American river dolphin CMP. The Committee received information from the South American River Dolphin Initiative (SARDI) on *Inia spp.* and *Sotalia fluviatilis* from eighteen scientific expeditions conducted last year in Bolivia, Brazil, Colombia, Ecuador, Peru and Venezuela. The surveys focused on assessing habitat use and threats, and on estimating river dolphin abundance. Information and progress on actions proposed by the CMP was consolidated from all participating countries. The experimental use of pingers to reduce dolphin bycatch, satellite tagging of eight *Inia spp.* dolphins, and contaminant studies assessing levels of mercury in these cetaceans were reported as updates on progress during SC68D. Additionally, a workplan has been developed for the period 2022-23, which focuses on consolidating scientific information relevant to river dolphins to meet the goals proposed in the CMP. As part of this process and to address recommendations from SC68C, efforts are underway to elucidate how many species, subspecies or subpopulations exist to inform and track progress on conservation priorities. It will also identify national and regional policies that allow linking the CMP with concurrent goals of deforestation control and tackling challenges related to climate change, fisheries management, hydro-energy development, mining and prohibition of mercury use.

The Committee was informed that the piracatinga fishing ban in Brazil will be lifted in June of 2022. This was a topic of concern for the Committee because of the intentional killing of river dolphins for use as bait in the piractinga fisheries. The ban initially was implemented for five years (2015-20), and since then working groups were established to renew the ban annually in 2020-21 and 2021-22. The Committee recognises the importance of this ban for the conservation of Amazon river dolphins and recommended it be extended.

Attention: SC, CC
The Committee ***recognises*** *the range States revisions following the Committee's recommendations from SC68B and SC/68C for the CMP for South American river dolphins and* ***commends*** *the range States for the appointment of a full-time coordinator.*

The Committee:

(1) ***encourages*** *the range states to work with the IWC's Bycatch Mitigation Initiative (BMI; SC68D, Item 12.1) since bycatch was identified as a key threat for river dolphins;*
(2) ***recognises*** *the importance of the piracatinga fishing ban to the recovery of the Amazon River dolphin populations and strongly* ***recommends*** *a renewal of the piracatinga fishing ban for more than one year; and*
(3) ***encourages*** *the proponents to explore potential funding opportunities within the IWC (e.g. Voluntary Fund for Conservation[20], joint Conservation/Small Cetacean Research Fund2[21], through the BMI) to help support the SARDI and the CMP development.*

9.2 Progress with identified priorities

9.2.1 Humpback whales in the northern Indian Ocean including the Arabian Sea (CMP, SH)

SC/68D/CMP/04Rev1 provides an overview of activities undertaken by the Arabian Sea Whale Network (ASWN), collectively at a regional level and by ASWN members at national and local levels. Formed in 2015, the ASWN is an informal collaboration

[20] *https://iwc.int/voluntary-fund-for-conservation.*
[21] *https://iwc.int/sm_fund.*

of researchers and conservation bodies interested in the conservation of whale populations throughout the Northern Indian Ocean[22]. The Arabian Sea humpback whale acts as a flagship species, but members collaborate on all aspects of cetacean research and conservation. This progress report includes updates on regional-level collaborative activities undertaken between May 2021 and April 2022, as well as updates on project- or national-level activities undertaken by partners in the region. Regional-level activities have been limited due to the lack of funding for coordination, as well as world events that demand more immediate attention. In particular, there has been little progress on the formal establishment of a joint CMS-IWC Conservation Management Plan. However, ASWN members are in regular communication and provide continued technical support to each other through an email forum. A webinar held in July 2021, focused on the regional Flukebook platform for ASWN members, and one working group is focusing on the development of region-specific resources for stranding response, while another planned working group will focus on regional support for passive acoustic research.

Summaries of national-level activities in Oman, Pakistan, India, Sri Lanka, the Maldives, Iran, the United Arab Emirates and Kuwait provide insight into ASWN members' efforts to advance cetacean research and conservation throughout the ASHW range. In addition to the work from Oman and Pakistan reported in SC/68D/CMP/03 and SC/68D/CMP/11, there is ongoing acoustic research in India, where acoustic recorders have been deployed on the Arabian Sea coast and analysis of collected data is currently underway. In general, the national and project-level updates demonstrate a clear trend toward increased capacity for systematic cetacean research in most ASWN member countries, with several peer-reviewed publications emerging from the region over the past year. The updates also demonstrate that many ASWN partners are applying knowledge gained from cetacean research to outreach, awareness raising, threat-mitigation and engagement with the relevant stakeholders responsible for conservation policy and management. These efforts will help to advance management and conservation throughout the region until such time as an effective regional conservation management plan can finally be implemented.

SC/68D/CMP/03 reviewed whale sightings in the northern Arabian Sea along the coast of Pakistan reported in 2021 from observers previously engaged in the observer programme for tuna gillnet operations. In 2012, WWF-Pakistan initiated an observer programme to monitor tuna gillnet operations in the coastal and offshore waters of Pakistan. In addition to collecting information about tuna and tuna-like species, observers were assigned to report observations of whales encountered during fishing operations. Funding for the programme expired in September 2019. However, some of the observers are still providing information on a voluntary basis, enabling WWF-Pakistan to document sightings of whales in the coastal and offshore waters of Pakistan, in the northern Arabian Sea. During 2021, four sightings of humpback whales, one sighting of a blue whale, one stranding of a Bryde's whale and 28 sightings of unidentified whales were reported. The number of whales reported during 2021 (34 reports) is higher than reported sightings from 2019 (26 reports) and 2020 (19 reports). These differences could be attributed to more active outreach among volunteer observers and/or a major shift in tuna gillnet vessels operating in coastal waters over the continental shelf during 2021, as compared to previous years, when most vessels were operating in deeper oceanic waters. Since the start of this program in 2016, 256 sightings of whales including 237 baleen whales have been reported from northern Arabian Sea. This also includes 83 confirmed sightings of humpback whales, presumed to be Arabian Sea humpback whales.

Document SC/68D/CMP/11 presented the updates on research and conservation activities in Oman for the 2021-2022 period, and their alignment with previous IWC recommendations and the CMP sub-committee agenda. Activities are motivated by the requirement for urgent action given the small population size (n=82, 95% CI 60-111), genetic distinctiveness and endangered status of ASHW's, as well as the evidence of increasing threats from maritime industries (Baldwin *et al.*, 2010; Convention on Migratory Species, 2017; Minton *et al.*, 2011a; Minton *et al.*, 2008). UAV and vessel based photographic methods were used to investigate body condition and conduct health assessment (partially funded by the IWC) of whales encountered over a 17-day period in November 2021. These surveys resulted in over 20 encounters with individual whales and the body condition metrics will contribute to interannual assessments. Results from previous studies (Minton *et al.*, 2022) and those in the publication process at the time of the SC68D meeting (Leslie *et al.*, In Prep.) demonstrate techniques that contribute to assessment of key ecological attributes for ASHWs, addressing important components of the CMS Concerted Action for ASWH.

SC/68D/CMP/11 also reported on IWC-funded field deployments of archival recorders and analysis of passive acoustic monitoring (PAM) data aimed at detecting ASHW and blue whale (*Balaenoptera musculus*) song off the coast of Oman, which continued in 2021-22. An In-depth analysis of 10 years of ASHW song from archival and boat-based recordings between 2010 and 2020 is currently being finalised; results indicate consistency in song phrase lineages and a general lack of introduction of novel song material across the decade, strengthening the conclusion of isolation of ASHW from the Southern Hemisphere populations. Initial evaluation of the 2020 and 2021 archival data indicated extensive presence of Northwest Indian Ocean blue whale and intermittent periods of Central Indian Ocean blue whale song detected off Hasik, Hallaniyat Bay. Analysis has also been expanded to characterise and evaluate temporal variation of sperm whale codas from Oman acoustic data

[22]*https://arabianseawhalenetwork.org/.*

archives (Ashok *et al.*, 2022). Ship strike risk assessments derived from previous satellite telemetry studies have been used to engage authorities in Oman to address management mitigation measures for ASHWs and were also used to inform global priorities of threats to large whales on migratory pathways (Johnson *et al.*, 2022; Willson, 2021). Satellite-based, remote sensing risk assessment of artisanal fisheries for bycatch related work (funded by IWC SC in 2020) is still underway.

The authors of SC/68D/CMP/11 have also begun behaviour change experiments with artisanal fishing communities in a core ASHW habitat near Masirah Island, Oman to address lost and abandoned nets that are considered a threat to AHSWs (Sarrouf Willson *et al.*, 2021). Multi-taxa fisheries risk assessments and mitigation experiments are also planned, guided by expertise from previous studies in the Indian Ocean, including those from Pakistan bycatch reduction experiments (Hines *et al.*, 2020; Kiszka *et al.*, 2021; Verutes *et al.*, 2020). Awareness-raising materials published in the reporting period include the Marine Mammal Atlas of Oman (5OES and Environment Society of Oman, 2021) a whale and dolphin field guide produced by the Environment Authority, and distribution of whale and dolphin viewing guidelines for tour operators.

UAV-guided body condition surveys, visual health assessment and PAM deployment activities will continue in the 2022-23 period and include field survey training exercises with NGOs, governments, and private entities (partially funded by the IWC). Funding has also been secured by the Environment Society of Oman to host an Oman-based national-level CMP workshop in 2022/23. This will be supported by dedicated engagement with authorities and industry to evaluate shipping and fisheries threats and mitigation options.

Technical guidance is requested from the SC and IWC Secretariat to support CMP workshop activities and to evaluate options to address threats in areas of critical habitat. Additionally, financial support is requested from the IWC SC Research Fund for continuation of PAM studies. Proposed costs include the analysis of recordings from three sites where recorders are currently being deployed from May 2022 to April 2023 (partially funded by IWC in 2021) to document the occurrence of ASHW and blue whale song, and the continued deployment of recorders along an approximately 1,000km stretch of Oman coast during April 2023 to April 2024.

The committee welcomed the rationale presented by Willson to recommence satellite telemetry studies (tagging) of ASHW along the Arabian Sea coast of Oman to address temporal and sex biases evident in the existing dataset of 14 whales tagged between 2014 and 2017. It was proposed that outputs of this work would support updates to species distribution modelling and associated ship strike and bycatch risk assessment work that is currently under discussion with government authorities. Tagging of ASHW in Oman was first proposed at SC65A with recommendations to limit tagging to 20% of the population, to engage experienced tagging experts and to await final review of a health assessment of proposed tagging instruments that was due at the time (IWC, 2013b; Robbins *et al.*, 2013). For future studies, the proponents requested the support of SC members to initiate a proposal review process as outlined in Andrews *et al.* (2019). It was agreed that an intersessional group, composed of ASHW experts, veterinarians and tagging practitioners would be convened by Willson, and that the review process would be completed by end of June 2022. This would enable sufficient time to mobilise for a tagging survey in November 2022.

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

*The Committee **reiterates** that the Arabian Sea humpback whales are priority candidates for a CMP and **welcomes** efforts to encourage range states to develop a joint CMS-IWC CMP, and to consider its benefits for other whale populations, such as Northern Indian Ocean blue whales, which may be similarly distinct and threatened. It commends the efforts of scientists within the region and especially the Arabian Sea Whale Network for developing a strong scientific basis to guide the development of a CMP and recommends continuation of those studies. The Committee commends members of the Arabian Sea Whale Network for having achieved important conservation work despite the challenges of the pandemic over the past year. The Committee **encourages** continued regional collaboration among ASWN members, particularly the work proposed being conducted by the stranding working group and the acoustics working group.*

Furthermore, the Committee:

(1) ***recommends** that ASWN members and relevant ASHW range states, undertake and support the work proposed in the CMS Concerted Action, especially those actions needed to address knowledge gaps and assess the Key Ecological Attributes (KEAs), and apply them to practical management measures;*

(2) ***recommends** that the work of the crew-based observer programme in Pakistan (SC/68D/CMP/03) continue, and where possible, be replicated throughout the region, especially in areas where systematic cetacean surveys are not feasible;*

(3) ***recommends** that: (a) once the Pakistan gillnet fleet has been mapped and characterised, the map(s) be overlain with models of ASHW distribution based on WWF Pakistan crew-based observer data (e.g. SC/68D/CMP/03 and similar papers from previous years) and models derived from satellite tracking of whales off the coast of Oman (e.g. SC/67A/CMP/15) to determine potentially high-risk areas for fishery interactions; (b) where and if species-specific bycatch data from WWF-Pakistan and other Arabian Sea fishing nations allow, humpback whale bycatch rates be calculated; and (c) this approach be applied to other Arabian Sea gillnet fisheries, including those in the Gulf of Aden and off Somalia, to generate coarse bycatch estimates where data allow, especially for humpback whales;*

(4) ***encourages:*** *(a) that research include continuous and simultaneous passive acoustic monitoring in identified ASHW habitat in both the western Arabian Sea (different parts of Oman's waters, Socotra and the Gulf of Aden) and eastern Arabian Sea (Pakistan, India, Sri Lanka and the Maldives) to improve current understanding the population's spatio-temporal distribution and potential connectivity across a larger area of suspected range, as well as to understand if range or distribution shifts begin to emerge as a result of climate change and other threats (noting that this technique also yields valuable data on other whale species, e.g. blue whales); (b) that research include the use of UAVs to assess body condition, and that body condition indices be used together with other metrics to assess seasonal and annual variation and to evaluate health, scarring, and foraging success (e.g. Ramp et al., 2021); (c) that future research include further satellite telemetry studies and methods to assess (model) whale distribution in relation to shipping traffic, oceanographic variables and data on fisheries and likely prey species, to better understand the drivers of distribution for ASHW, as well as the risk associated with anthropogenic threats; (d) that revised abundance and trend estimates are completed with the most updated available mark-recapture data; and (e) that genetic analyses to provide clarity on the taxonomic status of ASHW be completed;*

(5) ***recommends*** *that continued efforts are made to simultaneously collect humpback whale song samples from the western and eastern Arabian Sea to allow further analysis of: (a) how Arabian Sea humpback whales change their songs over time on both sides of the Arabian Sea; and (b) yearly variation in song similarity between the subregions, and what that might imply about long-term trends in exchange of animals across the Arabian Sea;*

(6) ***encourages*** *the opportunistic collection of sightings data, acoustic recordings, and genetic samples and/or the implementation of cetacean surveys in regions in the suspected ASHW range where little or no current data is available on distribution or abundance. These areas include (from West to East) the Horn of Africa and the Gulf of Aden, the Arabian/Persian Gulf, the Arabian Sea coast of Iran, Arabian Gulf and the Arabian Sea coasts of Pakistan and India; and*

(7) *applauds the planned stakeholder engagement workshop being held in Oman to discuss ASHW conservation and the potential benefits of a CMP, and also* ***encourages*** *scientists in the region to use the results of research conducted to date to develop resources and conduct activities that enhance capacity and support for the design and implementation of national-level management measures as well as a regional CMP. These resources and activities should take into account the economic and social costs and benefits of management options in relation to intensification of fisheries, shipping and coastal development in the region.*

9.2.2 Central American humpback whales (CMP)

A CMP workshop, organised by Mexico with representation from eight countries (US, Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama), was held virtually on 6-7 April 2021. The objective of the workshop was the preparation of the IWC Template nomination for the endangered Central America humpback whale (CAHW) population. The CAHW CMP nomination was presented to the Committee in Government of Costa Rica *et al.* (2021). The main objective of the CMP is to conserve the CAHW population and its habitat through collaborative regional actions to reduce anthropogenic threats throughout its range. Additional objectives include improving habitat connectivity and conservation and improving knowledge about population size, trends, movement patterns, and habitat use of CAHWs. There was broad support for the comprehensive information included and the nomination of the CAHW CMP. In addition, IA is continuing their work on an assessment of all North Pacific humpback whales, including CAHW.

The CMP will include the recommendations made during SC68C and SC68D along with comments made by the participating governments. After revision the CMP will be submitted to the Conservation Committee´s meeting in October 2022 for endorsement.

A third workshop was planned for March 2022 at La Paz, Mexico with the objective of reviewing and updating available information on the population biology of CAHWs throughout its range. Considering the: 1) important research effort dedicated during the winter season in Central America and Mexico (mainly supported by the Project SPLASH 2 from NOAA); and 2) travel restrictions in some countries within the region due to the COVID-19 pandemic, the workshop was postponed until October 2022 in the same venue (La Paz) to discuss the biological aspects of this stock.

Attention: SC, CC, CG

At SC68B and SC68D, the Committee ***reiterated*** *the recommendation that the Central American humpback whale population be treated as a '****priority population'*** *for the purpose of the CMP development process. Therefore, the Committee* ***recommends*** *the continuation and increased collaboration of the Range States and continues to* ***recommend*** *its suitability for endorsement. The Committee also* ***recommends*** *that the revised CMP be presented at the next meeting.*

9.2.3 Mediterranean sperm whales (CMP)

Mediterranean sperm whales are considered as 'Endangered' under the IUCN Red List. The IWC Scientific Committee has recommended in 2020 and 2021 that Mediterranean sperm whales be treated as a 'priority population' for the purpose of the CMP development process. In addition to ship strikes, anthropogenic noise, and bycatch, it has been noted that

sperm whales may be also particularly vulnerable to marine litter. The range states include Albania, Algeria, Cyprus, Egypt, France, Greece, Italy, Libya, Malta, Monaco, Morocco, Spain, Tunisia and Turkey. Progress has been all but impossible due to COVID-19. In discussion it was noted that the sperm whale CMP development is about to start its drafting stage but after the November 2022, Meeting of the Parties (MOP), additional effort/progress will be made.

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. The Committee **reiterates** the recommendation from SC68C (SC2149) 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 - and other Mediterranean species (CMP)

In accordance with ACCOBAMS Resolution 6.2.1, the ACCOBAMS Scientific Committee has devoted significant effort during the past triennium (2020-22) to develop draft CMPs for Mediterranean fin whales, Risso's dolphins, common dolphins and bottlenose dolphins. Despite delays due to COVID-19, the drafts have been completed from the perspective of the Scientific Committee at a workshop in March 2022 (bottlenose and common dolphins) and in December 2019 (Risso's dolphins and fin whales).

In discussion it was noted that ACCOBAMS currently recognises four CMPs. A draft resolution is in place to move the CMP development process forward and provide support (and hopefully funding) to organise two stakeholder workshops. The plan is to start organising and planning two stakeholder workshops in 2023 for fin and Risso's dolphin CMP development.

The ACCOBAMS Scientific Committee has highlighted the importance of full-time CMP coordinators acting under the guidance of CMP Steering Groups that represent key stakeholders. The need for stakeholder workshops to finalise each CMP is an essential part of the process, since reaching agreement amongst the primary stakeholders is key to the effectiveness of CMPs and the successful implementation of the actions.

The ACCOBAMS Scientific Committee recommends that Parties support the holding of such workshops, if possible before the 2022 Meeting of Parties (MoP8) or soon after. Participation should include relevant IGOs, especially the IWC who developed the CMP approach, local and national authorities, industry and NGOs.

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 recommendation of last year (SC2150) 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 members and ACCOBAMS parties to work towards finalising a draft CMP for fin whales for presentation at the next meeting.*

The ACCOBAMS Scientific Committee recognises that whilst ideally there would be CMPs for all species and coherent units of the ACCOBAMS regions, priorities must be set. The Committee draws attention to recent IUCN Red List assessments in this context. Based upon this, the Committee recommends that the Parties consider that the species/populations listed below would benefit from CMPs for the upcoming triennium (2023-25) and recommends that the relevant range states consider proposing them through ACCOBAMS for the CMP process. The inclusion of additional species aligns with an earlier IWC recommendation.

Mediterranean Cuvier's beaked whales

Mediterranean Cuvier's beaked whales are considered 'Vulnerable' under the IUCN Red List. Threats include anthropogenic noise, habitat degradation, chemical pollution, bycatch and ingestion of marine litter. The range states include Albania, Algeria, Croatia, Cyprus, France, Greece, Israel, Italy, Monaco, Montenegro, Morocco, Spain, and Turkey.

Black Sea cetaceans

Harbour porpoises and bottlenose dolphins in the Black Sea are listed as 'Endangered' by the IUCN Red List, and common dolphins are considered 'Vulnerable'. The Black Sea Commission (Sub-Regional Coordination Unit) recommended in 2021 to develop the updated Conservation Plan for Black Sea Cetaceans as separate Conservation Plans for each of the three species. Their threats include bycatch (particularly for the harbour porpoise), habitat degradation (including prey depletion), illegal takes of bottlenose dolphin from the wild to captivity and consequences of bio-invasions by alien species. The range states include Bulgaria, Georgia, Romania, Russia, Turkey and Ukraine.

9.3 Budget requests

Budget requests are discussed under Item 23.

9.4 Biennial workplan

The workplan is detailed in Table 17.

Table 17

Workplan for CMP.

Item	Intersessional	Next meeting
Southeast Pacific southern right whale	Continue Passive acoustic monitoring; and scientific workshop - July 2022, and coordination meeting to review CMP - August 2022	Review workshop reports and progress on scientific aspects of CMP
Southwest Atlantic southern right whale	Workshop June 2022 to review and update CMP actions	Review intersessional workshop report and new information
Gray whale	Scientific workshop in La Jolla or Seattle	Review progress on scientific aspects of CMP
Franciscana	Workshop June 2022 on continue review of the status of the species, conduct aerial surveys in Uruguay	Review 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	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 the development process	Review new information
South American river dolphins	Continue work on CMP	Review new material for CMP
Central American humpback whale	Workshop on population, in La Paz, Mexico, October 2022	Review revised CMP proposal

10. STOCK DEFINITION AND DNA TESTING (SD-DNA)

During the meeting, the Stock Definition and DNA Testing Working Group received voluntarily submitted information on the DNA registers maintained by Iceland and Japan (Item 10.1.1); provided advice on stock structure to other sub-committees (Item 10.1.2), discussed updating and supplementing the genetic data quality and analysis guidelines (Item 10.2), considered recommendations to avoid the depletion of tissue samples in existing collections (Item 10.3), and discussed whether newly proposed terminology for describing the stock structure of baleen whales might be useful to the Committee's work (Item 10.4).

10.1 DNA Testing and advice on stock structure to other groups as required

10.1.1 DNA registers

The Committee received voluntary updates of the DNA registers from Iceland and Japan that cover the period up to and including 2021. Details are given in Annex O. Almost all samples in both registers have been analysed for mitochondrial DNA (mtDNA) and a standard set of microsatellites.

Representatives of Iceland and Norway submitted a statement reasserting the position of the Governments of Iceland, Norway and Japan on DNA registers (see Annex O).

Attention: CG-A

*The Committee **thanks** Japan and Iceland for providing updates to their DNA registers using the standard format agreed in 2011 and providing the detailed information contained in their DNA registers. The Committee **looks forward** to receiving the voluntary update from Norway in 2023.*

10.1.2 Providing advice on stock structure to other groups

The SD-DNA Working Group has been tasked with reviewing 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 data quality and genetic analysis guidelines (see Item 10.2).

10.1.2.1 North Pacific Gray Whales

Two stock structure hypotheses (4a and 7a in Fig. 7 below with additional details in IWC, 2022a, Annex G) are currently considered high priority for inclusion in the modelling framework used to evaluate the status of North Pacific gray whales. These result from the Rangewide Workshops on the Population Structure and Status of Gray Whales in the North Pacific that were held between 2014-18 (IWC, 2018b) as well as subsequent discussion by the Committee (IWC, 2019f; 2021c; 2022).

In Hypothesis 4a, two breeding stocks of gray whales exist: an eastern breeding stock (EBS) that consists of the northern feeding group (NFG) and Pacific Coast feeding group (PCFG), both of which overwinter in the lagoons and coastal waters of Mexico; and a second unnamed breeding stock that consists of the western feeding group (WFG) of whales, which also overwinter off Mexico. Under this hypothesis, the southern Kamchatka and northern Kuril Islands feeding area (SKNK) is used by both WFG and NFG whales.

In Hypothesis 7a, a third breeding stock (the Western Breeding Stock, WBS) exists that includes some whales feeding in the western North Pacific feeding areas (including SKNK, which is also used by the WFG and NFG whales) that migrate to the waters off Vietnam and the South China Sea (VSC). Additional hypotheses (detailed in IWC, 2022a, Annex G) are included with medium priority and have been considered as sensitivity tests.

As part of the Committee's discussion on these gray whale stock structure hypotheses, an intersessional correspondence group (ICG) was formed at SC68B to re-evaluate the plausibility of all hypotheses under consideration and to consider issues relating to the terminology being used in discussions of gray whale stock structure (IWC, 2020b). During SC68C the Committee received a report of this ICG but did not have time to consider some of the issues raised. Thus, the Committee considered these additional issues during SC68D.

One of the issues flagged by the ICG relates to how the WFG is defined in the stock structure hypotheses versus how it is implemented in the modelling framework. The WFG is defined as including the whales that feed off Sakhalin Island (SI), Russia, according to photo-ID data. Based on this definition, under some hypotheses (e.g. Hypothesis 7a), the WFG could include members of two different breeding stocks (the unnamed breeding stock of whales that migrate between feeding areas in the western North Pacific (WNP) and wintering areas off Mexico and the WBS). However, in the stock structure diagrams and mixing matrices that inform the modelling framework, the WFG includes only those whales that migrate between the western North Pacific feeding areas and the Mexico wintering area (i.e. only a single breeding stock).

It was suggested that replacing the feeding group terminology with the newly proposed migratory herd terminology (see Item 10.4 below) could be helpful. This would not change the breeding stock terminology, as the breeding stocks would then be defined by which migratory herds they include. While the results of the modelling effort have primarily been reported by area, the modelling framework that currently exists is able to provide output by migratory herd and/or breeding stock(s). In addition, given that within the modelling framework the WFG includes only those whales migrating between WNP feeding areas and the Mexican wintering ground, using the migratory herd terminology would not change the interpretation of the modelling outcomes that were considered under the Rangewide Review. The Committee agrees that this should be discussed further by the Intersessional Correspondence Group.

The report of the ICG also discussed whether additional stock structure hypotheses should be considered under the modelling framework. Cooke (2018) estimated the abundance of the WBS and the WFG under various stock structure hypotheses, noting that none of the hypotheses under consideration include the possibility that all whales seen off Kamchatka belong to the WFG (i.e. in all cases NFG whales also fed off Kamchatka). Thus, Cooke (2018) put forward two hypotheses to account for this possibility. In the first (Hypothesis 8 in Cooke, 2018), all of the whales that feed off SI and SKNK are part of the WFG and form a single breeding stock.

Cooke (2018) does not explicitly specify what the migratory destination of this breeding stock is, and consequently this hypothesis could be modelled either as a variant of hypothesis 4a, where all WFG whales migrate to Mexico; and/or as a variant of hypothesis 6b, where the whales feeding off SI and SKNK may use either of the two wintering areas (showing no fidelity to either). If modelled as a variant of 6b, this hypothesis would seem equivalent to the way that western gray whales are defined under the IUCN assessment of western gray whales and in the joint IWC-IUCN CMP, where 'western' gray whales are considered to be gray whales that spend all or part of their lives in the western North Pacific – the IUCN/CMP approach considers the animals that feed off Sakhalin as demographically independent but notes that the proportions of animals that migrate to the west or to the eastern North Pacific are unknown although there is some evidence to suggest that the majority migrate at least some of the time to Mexico.

In the second hypothesis put forward by Cooke (2018) (hypothesis 9), a WBS exists that overwinter off VSC and feeds off SI and SKNK, where they overlap with whales that are part of the WFG that overwinters off Mexico. This hypothesis could be modelled as a variant of hypothesis 7a, which differs from the original hypotheses only in that no NFG whales feed off Kamchatka.

The Committee noted that with respect to the parameterisation of the modelling framework, these new hypotheses would differ from those currently under consideration primarily with respect to an increase in the abundance of the WFG given that NFG whales were no longer included in abundance estimates for the WFG. In referring to Table 5 of Cooke (2018), which provides estimates of abundance of the WFG and the WBS by stock structure hypothesis, the increase in abundance is seen only in the WFG whales (the WBS estimate is the same for both hypothesis 7a, which is denoted as 5a in Cooke 2018, and hypothesis 9), which in 2015 increases from 200 (±6SD) under hypothesis 5a (denoted as hypothesis 3a in Cooke 2018) to 287 (±12SD) under the Cooke hypothesis 8 and from 132 (±14SD) under hypothesis 7a (denoted as hypothesis 5a in Cooke, 2018) to 218 (±19SD) under Cooke hypothesis 9. Although the population dynamics are expected to be adequately captured under the stock hypotheses currently included in the modelling framework, the Committee noted that additional testing would be needed to confirm that incorporating the new hypotheses would not change any of the outcomes.

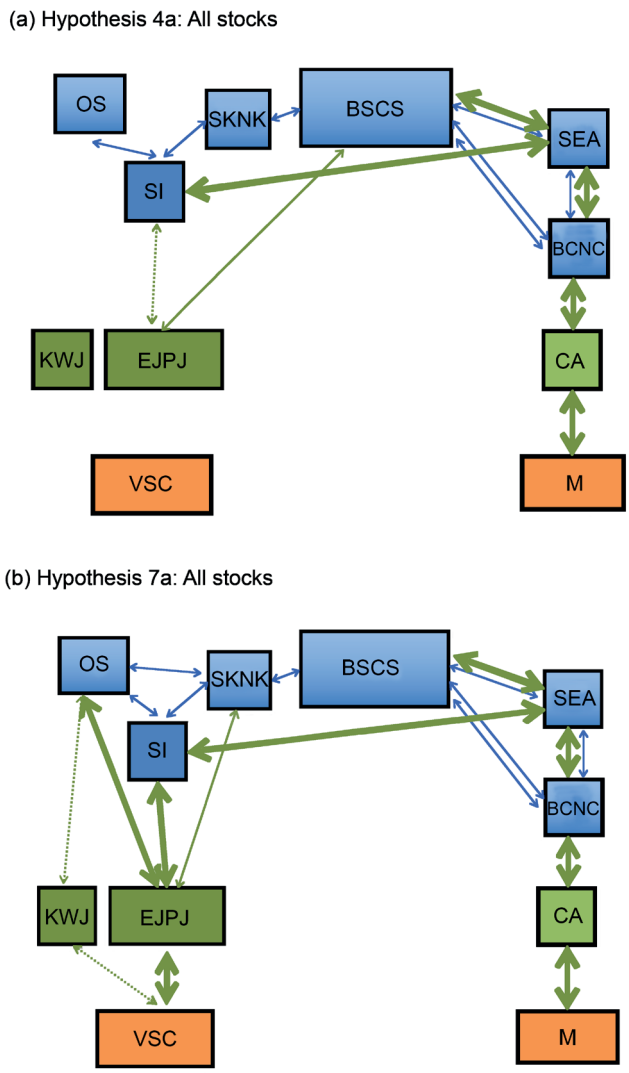


Fig. 7. Stock structure diagrams of the two hypotheses (4a and 7a) considered high priority for inclusion in the modelling framework used to evaluate the status of North Pacific gray whales. Sub-areas shown include Mexico (M); California (CA); British Columbia to northern California (BCNC); southeastern Alaska (SEA); northern Bering Sea and Chukchi Sea (BSCS); southern Kamchatka and northern Kurils (SKNK); Sakhalin Island, Russia (SI); areas of the Okhotsk Sea not otherwise specified (OS); eastern side of the Sea of Japan and the Pacific coast of Japan (EJPJ); Korea and the western side of Japan (KWJ); and Vietnam-South China Sea (VSC). Arrows denote movements of individuals between sub-areas, with thick solid lines indicating movements of a significant proportion of whales, solid thin lines indicating limited movements, and dashed thin lines indicating occasional movements of a small number of individuals. Blue arrows represent movements between feeding areas and green arrows represent migratory movements.

Attention: SC
In considering the hypotheses used to describe the stock structure of North Pacific gray whales within the modelling framework used in the Rangewide Review of the Status and Population Structure of Gray Whales (IWC, 2015g), the Committee ***agrees*** *that the intersessional correspondence group that was formed in 2020 will continue its work and will focus on:*

(1) *evaluating the utility of the migratory herd terminology in descriptions of the gray whale stock structure hypotheses; and*
(2) *describing and creating mixing matrices for the new stock structure hypotheses put forward in), for further consideration as sensitivity tests within the Rangewide Review.*

10.1.2.2 North Atlantic Common Minke Whales

The Committee last discussed the stock structure of North Atlantic common minke whales in 2018, when the report of an intersessional workshop focused on the development of SLAs (Strike Limit Algorithms) for the Greenlandic hunt (IWC, 2019a) was reviewed. While four stock structure hypotheses were initially considered during this Workshop, two were determined to be inconsistent with the results of genetic analyses that were presented during the workshop (Tiedemann *et al.*, 2018). The remaining two hypotheses include the base case scenario where three breeding stocks (Eastern, Central, and Western) exist, two of which (Eastern and Western) are subdivided into two sub-stocks (Hypothesis I); and a second scenario where only the Eastern breeding stock is subdivided into two sub-stocks (Hypothesis II).

The Committee received an update (SC/68D/SDDNA/04) on the analyses in Quintela *et al.* (2014) at SC68D. The updated analysis included 7,775 samples collected from five small management areas in the central and eastern North Atlantic between 2004 and 2020. Samples were genotyped at ten loci. Similar to previous results, significant temporal or spatial differentiation was not detected when samples were stratified a priori by small management area. Further, PCA and DAPC did not detect any clustering among the genotype data. Thus the updated results continue to support panmixia throughout these areas.

In discussion, the Committee noted that a strength of this analysis is the large number of samples that were analysed. However, additional samples are available, including some from West Greenland and areas not covered in the updated analysis, and are held by other research groups (e.g. Anderwald *et al.*, 2011; Tiedemann *et al.*, 2018). Inclusion of these samples in a range-wide comprehensive analysis would increase the power to detect subtle or cryptic stock structure should either exist. Genomic approaches could be used to generate datasets that would be straightforward to combine across labs. Such collaboration could be achieved most efficiently and cost-effectively by conducting whole genome resequencing on a representative subset of the available samples and then using these data to design an informative panel of SNP loci that could be genotyped on all available samples. Such a project is beyond the scope of what could be achieved prior to the current *Implementation Review* (IR) of North Atlantic common minke whales. However, it may be feasible to complete prior to the following IR, scheduled for six years' time.

The Committee noted that the results of the updated analysis in SC/68D/SDDNA/04 were very similar to those previously reviewed in Quintela *et al.* (2014) and thus were consistent with previous evaluation of the stock structure hypotheses. It was noted, however, that the data suggest a lack of subdivision within the eastern breeding stock. While hypothesis II includes a western breeding stock that is not further subdivided, both hypotheses (I and II) currently under consideration assume two sub-stocks of the eastern breeding stock. While this scenario would be more conservative when assessing potential depletion, the addition of a stock structure hypothesis incorporating a single eastern breeding stock may be worth additional consideration at the upcoming Workshop.

Attention: SC

*The Committee **welcomes** the new information regarding stock structure among North Atlantic common minke whales. After reviewing the results of the updated genetic analysis of a large number of samples collected in the eastern North Atlantic, the Committee **agrees** that the results are similar to those reviewed previously and thus do not require consideration of additional hypotheses in the upcoming IST Workshop that includes the next* Implementation Review.

To advance understanding of the stock structure of North Atlantic common minke whales prior to future assessments, noting that additional samples from other geographic areas (e.g. West Greenland) are available, the Committee:

(1) ***recommends** that genomic approaches be used to identify a panel of informative SNP loci, which would facilitate production of datasets that can be easily integrated across laboratories and over time; and*

(2) ***encourages** collaboration among sample holders in the design of such a panel and in efforts to provide an updated range-wide analysis of stock structure.*

10.1.2.3 Small Cetacean Stock Structure

The Committee formed two intersessional correspondence groups in 2020 that were focused on understanding stock structure among small dolphins inhabiting the Southwestern Atlantic (IWC, 2021c). One of the focal species is the franciscana (*Pontoporia blainvillei*), a small dolphin endemic to the Southwestern Atlantic classified as vulnerable by the IUCN due to fishing-related mortality at levels believed to be unsustainable (Zerbini *et al.*, 2017). The objectives of this intersessional correspondence group are to: (1) summarise the data available from genetic and other (i.e. non-genetic) lines of evidence that could be used to infer population structure; (2) evaluate the level of support for each of the proposed subdivisions based on these combined data; and (3) provide advice on future work to address remaining questions. During a Workshop on the Review of the Status of the franciscana (IWC, 2022b) that was held in April 2021, genetic evidence compiled by the ICG was reviewed. The Workshop participants agreed that a review of other (non-genetic) lines of evidence was needed before drawing any conclusions about the newly proposed management units. Intersessionally, the ICG members drafted text summarising the data available from these non-genetic lines of evidence. This summary was not reviewed by the Committee during SC68D, but it will be reviewed as part of an upcoming workshop to be held in Curitiba, Brazil, in June 2022.

The second small cetacean species whose stock structure is being evaluated by an intersessional correspondence group is the Guiana dolphin (*Sotalia guianensis*), a small coastal delphinid that ranges from Nicaragua to southern Brazil (Flores and Da Silva, 2009). This species is listed as Near Threatened by the IUCN (Secchi *et al.*, 2018) and faces anthropogenic threats throughout most of its distribution. In 2020, the Committee received a proposal to identify 12 management units within the Guiana dolphin's range (Cunha *et al.*, 2020). A review of the support for these proposed management units, including that outlined in Cunha *et al.* (2020) is being conducted through an Intersessional Correspondence Group (ICG) formed in 2020 (IWC, 2021c). The ICG's terms of reference are to review the genetic and other evidence relating to population

structure in *Sotalia guianensis* and to provide advice on the proposed management unit delineations. Intersessionally, the ICG updated a list of references that may have implications for understanding population structure in this species, but summaries of the relevant data have not yet been completed.

Attention: SC
The Committee recognises the need to better understand the population structure of the franciscana and the Guiana dolphin, two species of dolphins that are found in the southwest Atlantic. For both species, the Committee ***agrees*** *to continue its evaluation of the available genetic and other (e.g. stable isotopes, contaminants) evidence pertaining to population structure via intersessional correspondence groups (ICGs) in order to provide advice on proposed management unit delineations. In addition, the Committee looks forward to further evaluating the population structure of franciscana during a workshop to be held in June 2020 and to reviewing the report of the Workshop at the next SC meeting.*

10.1.2.4 Southern Hemisphere Blue Whales

The Committee discussed the population structure of non-Antarctic blue whales in the Southern Hemisphere, including a review of the movements of blue whales from the Chilean coast and the eastern Tropical Pacific based on photo-ID data (SC/68D/SH/10). Details of this discussion can be found under Item 8.2.1.2.

The Committee also discussed the population structure of Antarctic blue whales, including an update on the comparison of Antarctic blue whale calls from mid- and low-latitude regions, an evaluation of the fidelity of Antarctic blue whales to ocean basins based on analysis of Discovery mark and photo-ID recaptures (SC/68D/SH/09), and an analysis of historical Discovery mark data with Bayesian mark-recovery models (SC/68D/SH/13). Details of this discussion can be found under Item 8.2.2.1.

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. Both documents are intended to be 'living documents' that are updated as analytical approaches and technologies evolve.

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 on the IWC website[23]. In past years, the Committee identified a need to update these guidelines to address issues related to the generation of data using Next Generation Sequencing approaches (e.g. Single Nucleotide Polymorphisms, Whole Genome Sequencing and Resequencing). The Committee agrees to continue such work intersessionally.

10.2.2 Updates to data analyses guidelines

Guidelines for genetic data analyses relevant to the management of cetacean species were published in the J. Cetacean Res. Manage. (Waples *et al.*, 2018). This document includes valuable information in support of genetic data collection and analysis that can help ensure clear interpretation and high quality. However, it is a substantial document and necessarily reflects the technology available at that time. Last year the Committee proposed that a relatively short 'bridge' document be generated that would: (1) provide a checklist of key aspects of data quality and analysis that could aid interpretation of documents reviewed by the Committee; and (2) update aspects of the guidelines, particularly with respect to genomic methodologies and analysis. An intersessional correspondence group (ICG) was formed to discuss and generate this document (IWC, 2022).

Intersessionally, the ICG put together an outline of the methodologies that will need to be updated, particularly with reference to advances in genomic approaches. In discussion, the Committee identified additional topics for consideration in the update and potential strategies for increasing the visibility of both sets of guidelines in the future.

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) ***agrees*** *to continue the intersessional correspondence group to review revised sections of the DNA data quality guidelines that apply to data generated from next generation sequencing platforms, including SNPs and whole genome sequencing;*
(2) ***agrees*** *to continue the work of the intersessional correspondence group to produce a short document containing a checklist of key aspects of the genetic data analysis guidelines in order to facilitate their use; and*
(3) ***agrees*** *to consider approaches to increase the visibility of both sets of guidelines as part of the terms of reference for both ICGs.*

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

10.3 Recommendations on the avoidance of sample depletion

This agenda Item was established based on concerns about the depletion of tissue samples collected from Antarctic blue whales during the SOWER surveys, which were subject to requests from multiple researchers for their use in a variety of studies (IWC, 2019f). Since that time, discussion has primarily focused on providing advice on genomic approaches, such as Whole Genome Sequencing, that would maximise the value of the tissue used.

During SC68D, the Committee broadened the scope of these discussions to evaluate approaches to best maximise the value of collected tissue samples prior to their use in analyses. SC/68D/SDDNA/03 summarises best practices for the collection, preservation, curation and archiving of tissue samples for use in 'Omics studies of marine mammals. While 'gold standard' methods of preservation (e.g. cryopreservation) are highlighted, the authors also note the strengths and limitations of a wide range of sample preservation strategies, as some preservation methods are not logistically feasible in all situations. This paper provides a resource for scientists interested in exploring collaborative studies and preserving samples in a suitable manner for a broad spectrum of analyses.

The Committee noted that the Data Quality Guidelines (see Item 10.2.1 above), which deal primarily with the awareness, minimisation and control of DNA typing errors, do include a section on assessing sample quality prior to genetic analyses. However, they do not provide advice on 'best practices' for collecting and storing samples, which are key factors influencing sample quality.

The Committee discussed the value of storing samples in replicate – i.e. subsampling tissues so that each subsample is stored in more than one vial. This approach has a number of advantages, including: (1) creating redundancy, such that if a tissue stored in one vial is compromised, a second tissue exists; (2) allowing for storage in different media and/or conditions (e.g. RNAlater, ethanol, ethanol + freezing), some of which may be more advantageous for one application versus another; and (3) minimising the number of freeze/thaw cycles that each subsample is exposed to, which may compromise tissue quality or sample data (as noted in SC/68D/SDDNA/03).

Attention: SC

*The Committee **welcomes** the new information summarising the best practices for the collection, preservation, curation and archiving of tissue samples for use in 'Omics studies of marine mammals. The Committee:*

(1) ***agrees** that this information represents a good resource for researchers planning sample collection efforts as well as for those storing tissue samples, and that a reference to the advice provided should be included in the DNA data quality guidelines (see 10.2.1);*

(2) ***encourages** sample collectors to consider subsampling tissue prior to archiving in long-term storage, with consideration given to maintaining redundant resources that have broad utility for a range of 'Omic and other (e.g. stable isotopes, contaminants) applications; and*

(3) ***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.*

10.4 Review terminology used for stock structure related terms used within the IWC

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, 2014b).

At SC68D, the Committee was apprised of terminology that has been proposed to describe units-to-conserve among migratory large whales. SC/68D/SDDNA/02 defines the term 'migratory whale herd' as including conspecific whales that migrate between the same wintering and feeding grounds, not as a single cohesive group but simply sharing the same destinations. Recruitment into migratory whale herds is based on maternally directed learning of the migratory route. Thus in cases where individuals show strong fidelity to both migratory destinations, dispersal between migratory whale herds may be low enough to render them demographically independent, suggesting that the migratory herd may be the appropriate unit for management over ecological time scales (as described in Waples and Gaggiotti, 2006). This terminology is particularly useful in species where individuals from different feeding grounds use the same wintering ground, or those from different wintering grounds use the same feeding area, thereby limiting the ability to geographically stratify individuals based on either the feeding or wintering area alone. Of note, given that multiple migratory herds may share the same breeding ground, they are not presumed to be reproductively isolated. In these cases, recruitment through learned migratory behaviour from the mother will still result in demographic independence. SC/68D/SDDNA/02 describes how the terminology could be applied to humpback and gray whales, both of which are subject to assessment by the Committee.

The Committee noted that this concept is in effect being applied in the assessment of North Pacific humpback whales (see Item 8.1.1). The hypotheses describing stock structure in gray whales (see Item 10.1.2.1) also define units with reference to their feeding and wintering destinations. Thus modelling efforts are already converging on this concept, highlighting its utility to the Committee.

It was noted that one challenge in applying this concept is that identifying migratory herds requires that sufficient data has been collected on both the feeding and wintering areas that define each herd. In cases where there are few or no data from one of the migratory destinations (e.g. the Vietnam-South China Sea wintering ground used by the Western Breeding Stock of gray whales), assigning individuals to a migratory herd may be difficult. However, the advent of rapid image processing algorithms, such as those currently implemented in Happywhale (*http://www.happywhale.com*), have allowed data collected via citizen scientists to be integrated into understanding of connections between areas. As use of this or similar technology increases, defining migratory herds may become more broadly feasible.

Changes in the historical versus contemporary use of an area could also represent a challenge to applying the migratory herd concept. For example, a feeding area may have been used by two migratory herds historically, with one herd subject to greater depletion than the other while on unshared wintering areas or migratory routes. In such a case, allocation of catches may have varied greatly over time, but there are no direct data to assess that change. Comparison of historical and contemporary mtDNA, where available, might provide some insight into temporal changes in herd composition, but historical data are not available from most areas.

It was noted that the influence of cultural traditions in shaping genetic structure in migratory baleen whales has been discussed previously by the Committee (e.g. discussion of Carroll *et al.*, 2015 in IWC 2017 Annex I). The interaction of social learning and animal culture with processes important to conservation management of baleen whales has also been discussed as part of other platforms (e.g. the Convention on Migratory Species Expert Group on Culture and Social Complexity, see Brakes *et al.*, 2021). Consideration of this broader range of literature may be warranted in the future.

Attention: SC
*The Committee **welcomes** discussion of the how the migratory whale herd terminology could be useful in the work of the Scientific Committee. The Committee **agrees** that the intersessional correspondence 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 how the migratory whale herd terminology relates to existing terminology used in Committee discussions.*

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

No papers on new genetic approaches were received.

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.*

10.6 Annual workplan

See Table 18.

11. CETACEAN ABUNDANCE ESTIMATES AND STOCK STATUS (ASI)

The Standing Working Group on Abundance Estimates, Stock Status, and International Cruises (ASI) has evolved since its inception in 2016 and continues to evaluate how it can best serve the Committee. ASI describes its role as follows.

> *'ASI was established to provide consistent, rigorous reviews of abundance estimates submitted to the Committee. It was also instructed to provide a broad overview of the abundance and status of whale stocks for the Commission and the public. Finally, ASI offers advice on survey design, new technologies, data collection and analysis for abundance surveys coordinated by the IWC (e.g. POWER and SORP) and national research programmes. ASI provides an advisory service for other sub-groups of the Committee upon request by individual Convenors. Not all abundance estimates require review by ASI. Primarily, ASI will review estimates that need to be endorsed for a specific purpose such as: (i) inclusion in the IWC Table of Accepted Abundance Estimates, including those on the IWC website; (ii) use in an assessment, other mission-critical modelling, or with RMP/AWMP calculations; (iii) informing the Commission on the status of stocks/species; or (iv) use as the basis for providing management advice and Scientific Committee recommendations. However, there are circumstances where information on abundance can be used by the Committee's subgroups to progress their work without review by ASI.'*

ASI developed further guidance for Convenors of subgroups of the Committee who intend to submit abundance estimates for ASI review (Item 11.3.5), which also serves to clarify ASI's role:

> *'Abundance estimates are submitted to ASI for review by Convenors. It is the responsibility of the Convenor to ensure that the estimates submitted cover geographical areas that are of sufficient size, appropriate location and surveyed during a suitable time period to be useful to the Scientific Committee in the context of the endorsement categories used by the Committee (see 11.3.1). Therefore, estimates that do not cover the full range of the population are acceptable in all categories. The request for review from the Convenor should specify the area to which the estimate(s) are intended to apply, and, if appropriate, the population(s) to which the estimate(s) pertain. The task of ASI is to review the estimates themselves, and not to consider the implications of those estimates which is the responsibility of the relevant sub-committees. Convenors may wish to request a review of estimates for smaller areas when this would improve the capacity for local management, e.g. of potential human-induced mortality, entanglement, or whale watching impacts.'*

Table 18

Workplan for SD-DNA.

Topic	Intersessional	Next meeting
10.1.2.1 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
10.1.2.3 Franciscana population structure	Intersessional email group to evaluate stock structure in franciscana.	Report and provide advice
10.1.2.3 *Sotalia guianensis* population structure	Intersessional email group to evaluate stock structure in *Sotalia guianensis.*	Report and provide advice
10.2.1 DNA quality guidelines	Intersessional email group to review recent revisions to the DNA quality guidelines that pertain to data produced using next generation sequencing (NGS) approaches.	Report and finalise updated guidelines
10.2.2 Analysis guidelines checklist	Intersessional email group to generate a short document providing a checklist of key aspects of the genetic data analysis guidelines and to identify aspects of these guidelines that may need updating, particularly in the context of genomic methodologies and analysis.	Report and provide advice
10.3 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
10.4 Terminology	Intersessional email group to continue discussions of the use of stock structure related terms within the SC.	Report

11.1 Review of Abundance Estimates

ASI review of abundance estimates was greatly aided by reference to the report of the pre-meeting of the Abundance Steering Group (ASG) (Annex E), which is referred to hereafter as the ASG Report. For each abundance estimate reviewed, the ASG Report contains a summary of the paper, a list of concerns and comments from independent reviewers, and the ASG's discussion and recommendation about the paper. Decisions in the ASG Report are considered to be recommendations to ASI.

The Committee agrees that all papers endorsed below should be assigned an Evaluation Extent of 1 (estimate was considered in detail by the sub-committee) in the IWC Table of Accepted Abundance Estimates, except for Cooke and Jackson (2017), which should be given an Evaluation Extent of 4 (estimate was partially considered by the sub-committee and a new method was used). The Evaluation Extent metric is discussed further by IWC (2014c).

The classification system used by the Committee to categorise abundance estimates is explained in Item 11.3.1. The Committee noted that although the categories have numeric labels (and one is 'Not Suitable'), they are not intended to rank the scientific quality or importance of studies. These categories are used only to identify how estimates can be used most appropriately by the Committee and its subgroups since many of the studies reviewed were not designed explicitly to inform the tasks undertaken by the Committee. Section 3 of the ASG Report lists several examples illustrating how studies yielding estimates with diverse category assignments have all been very useful in the appropriate contexts and represent important scientific advancements. All estimates accepted by the Committee are included in the Table of Accepted Abundance estimates.

11.1.1 Bering-Chukchi-Beaufort Seas bowhead whales

SC/68D/ASI/01 provides an abundance estimate for Bering-Chukchi-Beaufort Seas (BCB) bowhead whales based on aerial line transect survey data collected in the Beaufort Sea and the Amundsen Gulf during August 2019 and analysed with a density surface model. Estimates of bowhead whale abundance by activity state, fully corrected for availability and perception bias, were derived using a hierarchical generalised additive model, with full variance propagation from the detection functions to the spatial model.

The Committee discussed the number of bowhead whales that might have been outside of the covered area at the time of the survey, which represented a source of downward bias for the abundance estimate, and how this compared to the number of whales missed by the spring ice-based surveys conducted near Utqiaġvik (e.g., Givens *et al.*, 2021). Neither survey encompasses all the whales, both surveys miss a small number of whales that occasionally migrate along Chukotka, and each survey likely includes some whales that are missed by the other survey. It is unclear which survey includes a greater percentage of the overall population. Further discussion pertained to the potential use of satellite telemetry data to estimate this bias and derive a correction factor. Large interannual variability in the distribution of satellite-tagged whales implies that telemetry data in a given year might not be appropriate to correct for another year. However, the data accumulated by the North Slope Borough over several decades could help improve the estimation of a correction factor and quantify the corresponding uncertainty.

The Committee agrees that the 2019 abundance estimate of 17,175 (CV=0.237, 95% CI 10,793-27,330) should be endorsed as Category 1A. It noted that this means there are two entirely independent endorsed Category 1A estimates of 2019 abundance for this stock, a situation discussed in Item 11.7.

11.1.2 North Atlantic common minke whales

Solvang *et al.* (2021) presented abundance estimates of common minke whales in the northeast Atlantic based on Norwegian survey data collected over the period 2014-19, the fourth survey cycle after a synoptic survey of the area in 1995. Cetaceans were searched for by naked eye from two independent platforms each manned by two observers following the protocols established for these surveys and also used in previous survey cycles. Estimation relied on a hazard probability model parameterised using a GLM approach (Skaug *et al.*, 2004), with variance estimation based on the delta method for combining uncertainty in the detection function and the encounter rate. The latter variance was estimated using a Markov modulated Poisson process (MMPP) model, as described by Skaug and Solvang (2015).

Additional information about the evolution of the variance estimator method used in the analyses was presented after queries were raised by the ASG. Initially, variance estimation was based on parametric bootstrap, which accounted for fine-scale spatial clustering (via a Neyman-Scott process), encounter rate variance, and uncertainty in the detection function (Skaug *et al.*, 2004). The variance estimation approach was then updated to replace the Neyman-Scott process with an MMPP, as described in Skaug and Solvang (2015); the update was reviewed and endorsed by the Committee in 2015 (item 6.2.3; IWC, 2016b). The Committee thanked the authors for this helpful information and encouraged that all components of the hazard probability approach, in addition to the new variance estimation methods, be published to document the Norwegian approach for surveying and estimating the abundance of North Atlantic common minke whales.

In discussion, it was noted that abundance results will be included in the upcoming *Implementation Review* (*IR*) for North Atlantic minke whales, which is starting in 2022 (IWC, 2022a, item 11.1.11). The authors clarified that the total abundance estimate for the combined *Medium Area* E, and the *Medium Area* E + *SMA* CM area, both contain additional variance, but that the abundance estimates for the single survey blocks do not contain additional variance. Table 5 of Solvang *et al.* (2021) provided the necessary details about which areas had and had not been surveyed in various years over the four survey cycles, in addition to the corresponding abundance and variance estimates. They also noted that their abundance estimates are independent through time, and whilst the additional variance is estimated using data from all years, the uncertainty in the additional variance is not included. The Committee noted that this information would aid the upcoming *IR*, and that the IST sub-committee may wish to re-examine the assumption of zero covariance over time.

The Committee considered the question of what to report in the IWC Table of Accepted Abundance Estimates when additional variance has been estimated. This is primarily important for the future use of the estimates (e.g. for an *IR*), but it might be helpful for that information to be tabled. The Committee agrees to resolve this question next year.

It was noted that for each time a *Medium Area* survey was completed, an updated additional variance estimate was produced, which encompassed the current and all previous surveys. The authors were asked if these updated additional variance estimates were applied to the older surveys. The authors confirmed that whilst additional variance estimates were updated each survey cycle, these were not applied retrospectively. The Committee considered that retrospective updating would be preferred (noting however that there was no need to alter *Small Management Area* estimates), but, at the very least, the IWC Table of Accepted Abundance Estimates should be annotated to indicate which survey cycle data were used to estimate additional variance for the estimates for the various periods. It was noted that a full retrospective update was unlikely to be feasible, given the complexity and long history of past analyses.

The Committee agrees that the 2014-2019 summer abundance estimate for common minke whales for *Medium Area* E + *Small Management Area* CM of 149,722 (CV=0.15), the estimate for the CM *Small Management Area* of 37,020 (CV=0.261) for the year 2016, and the estimate for the E *Medium Area* of 104,692 (CV=0.17) covering the years 2014-19, should be endorsed as Category 1A and included in the IWC Table of Accepted Abundance Estimates. The separate *Small Management Area* estimates (tables 2 and 5 of Solvang *et al.*, 2021) are also endorsed as Category 1A. The abundance estimate for *Medium Area* E and the total abundance estimate from *Medium Area* E + *Small Management Area* CM should be annotated to reflect that the CVs account for additional variance, which was estimated with survey data from all five survey cycles, beginning in 1995.

11.1.3 North Atlantic humpback whales

Leonard and Øien (2020; 2020b) report on shipboard line-transect surveys of the northeast Atlantic targeting common minke whales, but with abundance estimates presented for other species as well. ASI was requested to review only the humpback whale estimates.

The Committee agrees that humpback whale abundance estimates from Leonard and Øien (2020a) of 9,749 (CV=0.34, 95% CI: 4,947-19,210) for the 2002-07 period, and 12,411 (CV=0.30, 95% CI: 6,847-22,497) for the 2008-13 period, should be endorsed as Category 1A. The Committee also agreed that the humpback whale abundance estimate from Leonard and Øien (2020b) of 10,708 (CV=0.38, 95% CI: 4,906-23,370) for 2014-18 should be endorsed as Category 1A. The three time periods were analysed separately (i.e. no pooling of data) and thus can be considered independent.

Wenzel *et al.* (2020) uses photographic sighting histories of humpback whales in the Cape Verde Islands to estimate population size, survival and recruitment using a Jolly-Seber mark-recapture model. The Committee agrees that while stock identification questions still need to be resolved and there was potential for bias in the estimates due to issues with detectability and spatial and temporal heterogeneity in sampling effort that cannot be accounted for by the Jolly-Seber model, this estimate represents a valuable improvement over previously available information. Further noting the suspected small size of this stock, the Committee agrees that the estimate of 272 (CV=0.037, 95% CI=253-292) should be endorsed as Category 1B.

Lawson and Gosselin (2018) describes a multi-species aerial survey of the Canadian waters of the Atlantic in Aug-Sept 2016. Abundance estimates were generated for two regions: (1) Newfoundland and Labrador; and (2) Gulf of St Lawrence, Scotian Shelf and Bay of Fundy.

The ASG had asked for clarification on whether an availability correction had been applied to both regions. The authors confirmed that the availability component had been inadvertently omitted for one region and provided an updated estimate. The Committee thanked the authors and noted that both estimates were now fully corrected and that questions raised by the ASG about the extent to which the surveyed areas corresponded to stock definitions were a matter for consideration by NH; therefore, the Committee amended the ASG recommendation.

The Committee agrees that the humpback whale abundance estimate of 10,471 (CV=0.51) for Aug.-Sep. 2016 for the Newfoundland and Labrador region, and the abundance estimate of 1,854 (CV=0.40) for the Gulf of St Lawrence, Scotian Shelf and Bay of Fundy region, should be endorsed as Category 1A. It also agreed that the entries in the Table of Accepted Abundance Estimates should include a note stating that the abundance estimates only apply to the survey regions and not the entire eastern Canadian feeding stock.

11.1.4 North Atlantic right whales

Pace *et al.* (2017) used a state-space mark-recapture model with Jolly-Seber assumptions about birth and immigration to estimate the abundance and trends of North Atlantic right whales. Pace (2021) extended the data time series to 2019 and used a newer version of the model to test the hypothesis that expected survival changed following shifts in distribution patterns beginning in 2011 (the 'regime model'). North Atlantic right whales' abundance increased from 1990 to 2011 and then declined through 2019.

The Committee reviewed the 'regime model' and noted that the retrospective analysis in Pace (2021) supported the conclusions about the regime shift, in the sense that the breakpoint in the data was adequately informed by independent information. The Committee also noted that the statistically significant drop in adult survival documented in Pace (2021) relates to total survival rates, which include both natural factors and impacts of anthropogenic effects. There is already clear evidence that ship strikes and entanglement are affecting the survival of North Atlantic right whales, but such a large change in adult survival rate should be brought to the attention of NH and HIM as it raises serious concern about the viability of the population. Finally, the Committee also commended the authors for including the code for the analysis, which facilitates review.

The Committee preferred the 'regime model' analysis of Pace (2021), which also included more recent years of data, so it amended the advice from the ASG. The Committee agrees that the medians of the posterior distributions and the 95% credibility intervals from Pace (2021) should be endorsed as Category 1A and included in the IWC Table of Accepted Abundance Estimates. These estimates are: 263 (95% CI 260-269) in 1990, 308 (307-311) in 2000, 476 (472-478) in 2010 and 368 (356-378) in 2019. The Committee noted that its abundance estimate category definitions did not require all endorsed small population estimates to be categorised as 1B, and agreed that the 1A categorisation is appropriate for the estimate provided by Pace (2021).

11.1.5 Eastern North Pacific gray whales

Stewart and Weller (2021a) provides updated results from shore-based surveys of eastern North Pacific gray whales conducted regularly off central California between December and February during the gray whale southward migration, adding to a time series that began in 1967. A 23.7% decline in abundance from 2016 to 2020 coincides with the unusual mortality event that started in 2019.

The Committee noted that the 2019/20 estimate was the newest in a long time series of estimates from surveys using similar field methods and, often, consistent analyses. It noted that endorsement of such estimates might be more efficiently achieved by aggregating several years of such estimates for periodic review. This is discussed in Item 11.3.5.

The Committee noted that covariance information is available for the first part of the time series of abundance estimates (Laake *et al.*, 2012) but not for recent years nor for the covariance between the Laake *et al.* (2012) and the Durban *et al.* (2015; Durban *et al.* (2017) series. The Committee requests that Katara inquire with the authors as to whether the missing covariance information was available to add to the IWC Table of Agreed Abundance Estimates

Concurring with the ASG, the Committee agrees that the 2019/20 abundance estimate of 20,580 (95% CI 18,700-22,870) should be endorsed as Category 1A.

Attention: S
*The Committee **request**s that Katara contact the authors of Laake et al. (2012) and Durban et al. (2015; Durban et al. (2017) to obtain as much covariance information as is available for the complete time series of abundance estimates for eastern North Pacific gray whales.*

11.1.6 North Pacific sei whales

Hakamada *et al.* (2009) report on abundance estimates for sei whales in the JARPNII offshore survey area (east of the Japanese coast, west of 170°E, north of 35°N, south of the Russian and US EEZs), based on ship-based multi-species sighting surveys. Due to the migration pattern of sei whales in the area suggested by the sighting survey data, abundance was estimated separately for the early and late seasons.

Similarly, Hakamada and Matsuoka (2016a) presented abundance estimates for sei whales in the JARPNII survey area for the years 2008, 2009, and 2011-12. Again, the numbers of whales were estimated separately for the early and late seasons. These estimates represent only a part of the population considered.

These two documents were originally reviewed in the 2020-21 intersessional period, and considered by ASG and ASI at SC68C (Item 11.1.6 of IWC (2022a)). At that time, the Committee concluded that additional information was required before the estimates could be fully evaluated. Information provided by the authors was reassessed during the 2021-22 intersessional period and was deemed to have clarified the methodological questions that had been raised, although some concerns remained.

Discussion by the Committee focused on Hakamada *et al.* (2009) as it was recognised that the two papers have similar methods but differ in some aspects (sample size, detection functions) and that separate evaluations should be made for each. It was also noted that the endorsement category for the estimates might depend on what level of spatial resolution might be required for their intended use (e.g. at the subdivision level or for combined strata).

One concern was that each estimate should be valid if treated separately for each combination of year and area, but when summing estimates for different years and/or areas, additional variance components need to be estimated. In theory, this additional variance can be assessed by using these small areas in a population model but potential biases due to the interaction between the survey design and migration patterns need to be clarified.

A second important concern was that sample sizes by year might be sufficient at broad scales, but they become small when divided by strata, at least in some of the subdivisions. The Committee noted that this uncertainty should be reflected in the coefficients of variation of each estimate and can be dealt with within the population models being used by the IA and IST sub-committees. Small sample size is not necessarily an impediment to endorsing the estimates at a fine level of granularity in the case that a survey yields a reliable estimate of the total abundance that is then statistically partitioned to smaller sub-areas where few or zero sightings were made. However, concerns remained as to whether that case applied here: it was unclear whether the data were analysed at a scale consistent with the survey design. Moreover, clarifications were sought on the methods and raw data, as concerns were raised about inconsistencies between the abundances and years presented in Hakamada *et al.* (2009) and those in the current models used by the IA sub-committee (Item 8.1.1.2). The IA sub-committee has included an investigation of this issue in its workplan.

Notwithstanding these caveats, the ASG had initially proposed to recommend endorsing all of these estimates. However, additional concerns were raised in ASG discussions regarding the appropriateness of combining survey data from multiple years (e.g. 2002/03, 2004/05) when inter-annual variability is unknown but potentially high, particularly within relatively small areas (e.g. SA8 and SA9 had their subdivisions surveyed in different years), and considering that the survey vessels moved in the same or opposite direction as migrating whales in various time periods and regions. The Committee considered that it would be extremely important to resolve such concerns before making any endorsements.

The Committee thanked the authors and the reviewers for their detailed work. However, the possible confounding effects of these issues (combining estimates based on small sample sizes across areas and years with potential biases due to migration) prevented the Committee from endorsing these estimates. Recognising that the IA sub-committee is unlikely to require these endorsed estimates in the near term, the Committee established an intersessional correspondence group to investigate these issues (Table 2 item 11.1.6). Japanese scientists offered to be available for questions from this group. This group will examine each paper separately to better understand how the data were analysed, recommend at which level the estimates should be endorsed (and for which categories), and assess whether and how best to combine estimates across space and time, to endorse and include such estimates in the IWC Table of Accepted Abundance Estimates.

11.1.7 North Pacific blue whales

Bradford *et al.* (2021) report on abundance estimates for 21 species of cetaceans in the U.S. Exclusive Economic Zone of the Hawaiian Islands (Hawaiian EEZ) using ship-based, line-transect surveys conducted in 2002, 2010, and 2017. Only one blue whale sighting was made on effort over 3 years, resulting in abundance estimates of 0, 137 (CV 1.12), and 0 in 2002, 2010, and 2017, respectively.

The ASG initially recommended endorsing all three estimates (as Category 3) and using the weighted average of the three estimates as the best estimate for the overall abundance of blue whales in the Hawaiian EEZ for the summer-autumn period. However, renewed attention from ASI was focused on the fact that the non-zero abundance estimate was based on a single on-effort sighting. The Committee believed that an estimate of total abundance over such a broad area requires more than one sighting to produce a reliable estimate. This situation differs from the case when a survey yields many sightings and a reliable estimate of total abundance, but this estimate is then statistically partitioned to smaller subareas where few or zero sightings were made. Indeed, zero estimates in small sub-areas have been endorsed before for use in RMP *Implementations* (e.g. for North Pacific minke whales). The Committee considered that while the survey methods and analysis of Bradford *et al.* (2021) were excellent, a single sighting was insufficient to provide reliable inference and that averaging the three estimates would introduce additional issues of concern while not resolving the primary underlying problem.

Therefore, the Committee concluded that Bradford *et al.* (2021) show that blue whales are very scarce in this region at this time of year, but agreed that the estimates should be classified as 'Not Suitable'.

Calambokidis and Barlow (2020) provide updated abundance estimates for blue and humpback whales on the US West Coast from mark-recapture estimates based on photo-IDs through 2018. ASI had been asked to consider only the blue whale estimates.

The Committee agrees that the abundance estimates for the entire time series should be endorsed as Category 1A, and that estimates of 1,422 (CV 0.093) for 1998, 1,397 (CV 0.075) for 2008, and 1,898 (CV 0.085) for 2018 be added to the IWC Table of Accepted Abundance Estimates. These years were chosen to reduce correlation among tabled estimates.

11.1.8 North Pacific humpback whales

The paper provided for ASI review under this agenda Item was withdrawn by the requesting Convenor intersessionally after notification that the authors intended to conduct a re-analysis.

11.1.9 Southern Hemisphere non-Antarctic blue whales

Williams *et al.* (2011) present a model-based abundance estimate of Chilean blue whales using effort and sightings from a survey along the Chilean coastline undertaken by the SOWER programme in December 1997-January 1998. This project was first considered by SH in 2009 (Item 3.1 of IWC (2010b), at which time only a preliminary estimate was available.

The Committee agrees that the December 1997-January 1998 abundance estimate of 303 (95% CI 176-625) for the survey area should be endorsed as Category 2. It is further agrees that when this estimate is included in the IWC Table of Accepted Abundance Estimates, a note should be added to indicate that the estimate is likely to be substantially negatively biased for this population of blue whales due to the boundaries of the survey area.

Bedrinana-Romano *et al.* (2018) describe a study of blue whale abundance and distribution in Chilean Northern Patagonia, within 25km of the coast. The Committee noted that the survey region was unlikely to cover the summer geographic extent for this stock. Concurring with the ASG, the Committee agrees that the 2009 summer abundance estimate of 356 (95% CRI 191-652) for blue whales in Chilean Northern Patagonia should be endorsed as Category 2.

Galletti Vernazzani *et al.* (2017) reported on photo-ID surveys conducted in the waters off Isla Grande de Chiloé, southern Chile from 2004 to 2012 and Isla Chañaral, northern Chile, in 2012. Preliminary results from Galletti Vernazzani *et al.* (2017) were presented to SH in 2016 (Item 5.3.1 of IWC (2017g). At that time, SH noted that, given that most of the data were collected from the Chiloé feeding ground, the abundance estimate should only apply to this region and not the broader Chilean blue whale population.

In determining the category for this estimate, the Committee noted that the authors summarised their work as follows: 'nine years of data reveal that the Chiloé feeding ground is used by a small number of whales in the mid-hundreds which have high inter-annual fidelity to this region', which would seem to match the definition of a Category 3 estimate, in that it gives only a broad impression of the abundance. Therefore, the Committee agrees that the superpopulation abundance estimates of 762 (95%CI 638-933; left side) and 570 (95%CI 475-705; right side) for the survey area for the period 2004-12 should be endorsed as Category 3.

Cooke and Jackson (2017) present a brief reanalysis of the 2006-11 data described in Galletti Vernazzani *et al.* (2017) intended to account for the possibility of a transient/resident mixture in the population. This analysis was undertaken during the 2016 SC meeting (Item 5.3.2 of IWC (2017g). There were previous applications of this approach to southern right whales and gray whales in the western North Pacific, although IWC (2016c; Item 4) and IWC (2017e; Item 3.2.2) focus on modelling outputs. It was noted then, as now, that there was insufficient detail in the paper to evaluate the modelling fully, although further information on the modelling may be available in the future. The Committee's familiarity with the approach is reassuring, although it falls short of full evaluation and endorsement. Therefore, the Committee concurred with the ASG and agrees that the abundance estimate of 450 (CV=0.17) for the survey area for the period 2006-11 should be endorsed as Category 2, but that it should be given an Evaluation Extent of 4 (estimate was partially considered by the sub-committee and a new method was used). A review of the full details of the modelling is required before this abundance estimate might be used for management advice.

11.1.10 Antarctic blue whales

Matsuoka and Hakamada (2014) describe abundance estimates for Antarctic blue whales south of 60°S for regions across the IWC Management Areas III-E+IV+V+VI-W (i.e. 35°E-145°W) using sighting data collected during 1995/96-2008/09 from Antarctic sighting surveys from the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA) and JARPAII.

The results in Matsuoka and Hakamada (2014) were originally presented as part of the review of the JARPAII Special Permit Research Programme (Item 6.3.1 of IWC (2015c). Various abundance estimates arising from the 1995/96-2004/05 surveys (Matsuoka *et al.*, 2006) were reviewed in 2006, but the blue whale abundance estimates were not mentioned specifically (Item 2.4.2 and 2.5.2 of IWC (2008a). The Committee agrees that the abundance estimate of 300 (CV=0.308) for the 1995/96 summer season, for the combined IWC Management Areas III-E+IV+V+VI-W (i.e. 35°E-145°W, south of 60°S), and an abundance estimate of 1,223 (CV=0.345) for the IWC Management Areas III-E+IV+V+VI-W for the 2008/09 summer season, should be endorsed as Category 1A. The Committee also agrees that the abundance estimates for the individual IWC *Management Areas* and corresponding years (as given in Table 4a of the paper) should be categorised as 1A, but that those numbers are not included in the IWC Table of Accepted Abundance Estimates for the sake of simplicity. However, a footnote to the Table should be added to highlight the endorsement, and category, of those IWC *Management Area* abundance estimates. A further footnote should be added to highlight that the CVs for the combined *Management Area* abundances do not account for additional variance, which is information that would be required to weight time series of non-synoptic combined-area abundance estimates for assessment purposes.

Branch (2007) presented a study of Antarctic blue whale sightings during the three complete circumpolar surveys of IWC's IDCR/SOWER programme. The Committee agrees that the circumpolar (and south of 60°S) abundance estimates of 453 (CV=0.40) for CPI (1978/79-1983/84; mid-year 1981), 559 (CV=0.47) for CPII (1985/86-1990/91; mid-year 1988) and 2,280 (CV=0.36) for CPIII (1991/92-2003/04; mid-year 1998) should be endorsed as Category 1A. These estimates should also be footnoted with comments that: (1) the survey designs and sighting protocols for CPI differed somewhat from those of CPII and CPIII; and (2) the CVs do not account for additional variation. The Committee also agrees that the circumpolar abundance estimates for 'comparable areas' (table 4 of the paper), and IWC *Management Area* estimates (table 5), should be endorsed as Category 1A, but that those numbers should not be included in the IWC Table of Accepted Abundance Estimates for the sake of simplicity. However, a footnote to the Table should be added to indicate the endorsement, and category, of those IWC circumpolar comparable area and *Management Area* abundance estimates, and that the circumpolar 'comparable areas' estimates do not account for additional variance.

11.1.11 Southern Hemisphere right whales

Renault-Braga *et al.* (2021) present a study of southern right whales wintering along the Brazilian coastline using photo-id data from 2004 to 2018. The study was discussed by the Sub-Committee on Conservation Management Plans, CMP, in 2021 (Item 9.1.2 of IWC (2022a), where it was noted that this is the first update of the population trends for southern right whales in the Brazilian breeding ground since 2010.

It was noted in the ASG Report that heterogeneity in capture probability was not accounted for, in part because of the small sample size in the study, and that this study remains a work in progress. The authors of this paper have expressed an interest in collaborating with other Committee scientists to improve their analyses. The Committee suggested that the authors might work with the independent reviewers, noting that addressing the reviewers' comments would be an excellent start. New agreed to facilitate this potential collaboration. The Committee agrees that the abundance estimates, 569 (±38) for females and 2,626 (±737) for adults during winter 2004-18 (2011), should be categorised as Category P. The Committee also noted that before finalised estimates are considered for endorsement in the future, the '±' notation for uncertainty should be clarified by replacing it with a standard error, CV, or confidence interval.

Smith *et al.* (2021) was presented to the Committee in 2021 (Item 8.2.3.2 of IWC (2022a) and reported on aerial surveys for southern right whales along the southwest coast of Australia (Cape Leeuwin to Ceduna) between 1993 and 2020. The Committee noted three primary concerns regarding the analysis in Smith *et al.* (2021): (i) the use of the simple correction factor (IWC, 2013a) to convert cow/calf counts to total abundance (noting that the Committee recommends updated review of this factor and its usage); (ii) the manner of extrapolation to areas not surveyed in 2020 due to covid-19 restrictions, and, most importantly; and (iii) the lack of a measure of uncertainty associated with the resulting total abundance estimate. Therefore, the Committee agrees that the 2020 total abundance estimate should be categorised as Not Suitable. However, the Committee agrees that the time series of relative abundance indices is nonetheless potentially useful for assessment purposes and should be endorsed as Category 3, with a note added to the IWC Table of Accepted Abundance Estimates that this time series represents an index of relative (not total) abundance. Moreover, the Committee noted that a project funded by Australia is currently undertaking research to provide a comprehensive understanding of the population abundance and degree of spatial connectivity of southern right whales in Australian waters. This will provide the first abundance estimate of the total Australian population of southern right whales and investigate the connectedness of whales utilising breeding areas on the eastern, southern and western coasts of Australia. The Committee encouraged those efforts. Finally, the Committee recognised the memory and outstanding contributions of John Bannister to this project, and cetacean science broadly, over many decades.

Attention: SC-SH, SC-ASI
*The Committee **recommends** that the multiplier developed from Argentinian and South African data and adopted at the International Right Whale Workshop held in Buenos Aires, Argentina, in September 2011 to convert southern right whale cow/calf counts to total abundance (IWC, 2013a) be reviewed and potentially updated to reflect any new data and a corresponding measure of uncertainty.*

Brandão *et al.* (2021) had been submitted for ASI review intersessionally. Jackson noted that the authors had subsequently advised her that the intent of Brandão *et al.* (2021) was to investigate how to remove model misspecification, not to provide abundance estimates that would be suitable for Committee use in the context of the categories the Committee applies when endorsing estimates. Therefore, she had withdrawn her request that ASI reviews this paper at this time. New noted that another Convenor had requested a withdrawal intersessionally upon learning of an author's intent to reanalyse their data. Accordingly, the Committee did not discuss this paper further.

The Committee noted, however, that the authors' ongoing modelling work for this project (a component of SORP), using the important long-term dataset for southern right whales off South Africa, represents a potentially valuable contribution that could advance progress in the SH sub-committee and other Committee subgroups, after the resultant abundance estimates are fully reviewed and endorsed by the Committee through its agreed processes for the purposes articulated in the statement of ASI's role (Item 11 above). The Committee encouraged the authors to provide, as soon as practicable, an appropriate paper to the SH sub-committee for consideration for forwarding to ASI for such a review. That would allow this modelling work to contribute to the management and conservation efforts of the Committee as a primary basis for recommendations. The authors subsequently advised that their most recent modelling work on this assessment would enable the provision of such a paper very soon.

11.1.12 Southern Hemisphere humpback whales

Félix *et al.* (2021) describe a new population estimate for eastern South Pacific humpback whales (Breeding Stock G; BSG) based on mark-recapture models and fluke catalogues from 23 research groups. Félix *et al.* (2021) was originally presented to the Committee in 2021 (Items 8.4.1 and 11.1.9 of IWC (2022a), at which point concerns were raised about the assumptions of a closed population, sources of the samples, and that some of the CVs seemed unrealistically small.

The Committee concurred with the comments and concerns discussed in the ASG Report. After discussion, concerns remained regarding the authors' assumptions of a closed population for such a lengthy dataset (i.e. 27 years), as well as the failure to account for variation in sampling effort, and therefore in capture probabilities. These factors have the potential to introduce a strong positive bias, although this could be mitigated in part, because: (i) these analyses were undertaken when adult humpback whale survival rates were extremely high and the population experienced steady growth; and (ii) the bulk of sightings data were collected during the latter half of the survey period. The Committee considered whether these potential factors were better accounted for during population modelling undertaken by the SH sub-committee, or addressed by the authors through a reanalysis applying a more appropriate model. Without resolving this question, the Committee concluded that, on balance, the abundance estimate is expected to be positively biased, by some unknown amount, due to a number of features of the data and the mark-recapture model selected.

The Committee agrees that the 1991-2018 abundance estimate for Eastern South Pacific humpback whales (Breeding Stock G) of 11,784 (SE=266) should be endorsed as Category 3 and that the entry in the IWC Table of Accepted Abundance Estimates should include a note outlining the expectation that this abundance estimate is positively biased to some unknown degree. The Committee encourages the authors to continue their work, noting the significance of the data they have collated, and the value of abundance estimates for this population for future assessments.

The Committee further noted that the scope and complexity of such mark-recapture analyses is something the Committee may need to consider again in the near future for other stocks and species. The Committee agrees that Givens should raise this issue with the Convenors of the NH and SH sub-committees, and seek their advice on the level of priority that might be assigned to developing better guidance for such analyses. The Committee established an intersessional correspondence group to address various matters related to mark-recapture abundance estimates (Table 2 Item 11.2.2). This group might offer help to the paper's authors to improve their work and begin consideration of guidance for complex mark-recapture analyses, thereby developing further expertise within the Committee for similar future work.

11.1.13 Franciscana

Last year, the Committee reviewed several abundance estimates for franciscana and recommended revisions to some analyses (IWC, 2022b; 2022, item 11.1.2). The authors of some of these papers had made revisions intersessionally and will be presenting their new analyses to the Workshop on the Status of the franciscana scheduled for June 2022. After the workshop, the Convenor of the SM and CMP sub-committees will consider requesting ASI review of these revised papers so that the new estimates may be considered for endorsement at the next meeting.

CMP received SC/68D/CMP/17 estimating franciscana abundance and requested that ASI review it intersessionally (Item 9.1.4).

11.1.14 Indo-Pacific finless porpoise near Hong Kong

Jefferson and Moore (2020) presented estimates of the density and abundance of Indo-Pacific finless porpoises in waters to the south and east of Hong Kong, the first abundance estimate since the early 2000s. The presentation of a long time series of estimates in this study prompted the Committee to consider the question of how to summarise such long series (i.e. for the IWC's Table of Agreed Abundance Estimates); see Item 11.3.6. Based on those discussions and considering the high interannual and seasonal variability of the finless porpoise estimates, the Committee calculated inverse-variance weighted averages for three-year periods at the start, middle and end of the series, for the wet and dry seasons separately, using the uncorrected estimates. The ASG Report provides further details.

The Committee endorsed these weighted averages of uncorrected abundance for Indo-Pacific finless porpoise in Hong Kong waters during the wet season: 37 (CV=0.303) in 1996-98, 67 (CV=0.184) in 2007-09, and 77 (CV=0.207) in 2017-19; and during the dry season: 65 (CV=0.223) in 1996-98, 121 (CV=0.144) in 2007-09, and 108 (CV=0.140) in 2017-19. Given that the porpoises in the survey area comprise only a fraction of the larger population in the South China Sea, the Committee agrees to classify these as Category 2 and include them in the IWC Table of Accepted Abundance Estimates. The entire time series of seasonal annual uncorrected estimates would also be archived as discussed in Item 11.3.6.

11.2 Update and review abundance table maintained by the IWC

11.2.1 Additions to the IWC Table of Accepted Abundance Estimates

Abundance estimates recommended for inclusion in the IWC Table of Accepted Abundance Estimates during the meeting are listed in the recommendation below.

Attention: SC, S, C

*The Committee **recognises** that the IWC Table of Accepted Abundance Estimates is an important tool for the work of the Committee and the Commission.*

*The Committee **recommends** that estimates endorsed during the 2022 meeting (SC68D) should be incorporated intersessionally into that table, uploaded to the IWC website, and endorsed by the Commission. Specifically, these estimates are:*

- *Bering-Chukchi-Beaufort Seas bowhead whales in 2019: 17,175 (CV=0.237), Category 1A.*
- *North Atlantic common minke whales in Medium Area E + Small Management Area CM in 2014-2019: 149,722 (CV=0.15); in Small Management Area CM in 2014-2019: 37,020 (CV=0.261); and in Medium Area E in 2014-2019: 104,692 (CV=0.17); all Category 1A.*
- *Humpback whales in the northeast Atlantic in 2002-2007: 9,749 (CV=0.34); in 2008-2013: 12,411 (CV=0.30); in 2014-2018: 10,708 (CV=0.38); all Category 1A.*
- *Humpback whales in Newfoundland and Labrador region in Aug-Sept 2016: 10,471 (CV=0.51); Category 1A.*
- *Humpback whales in Gulf of St. Lawrence, Scotian Shelf, and Bay of Fundy region, in Aug-Sept 2016: 1,854 (CV=0.400); Category 1A.*
- *Humpback whales in the Cape Verde Islands in 2010-2018: 272 (CV=0.037); Category 1B.*
- *Western Atlantic right whales in 1990: 263 (95% CI 260-269); in 2000: 308 (95% CI 307-311); in 2010 476 (95% CI 472-478); in 2019, 368 (95% CI 356-378); all Category 1A.*
- *Eastern North Pacific gray whales in 2019/20: 20,580 (95% CI 18,700-22,870); Category 1A.*
- *Blue whales in the eastern North Pacific in 1998: 1,422 (CV=0.093); in 2008: 1,397 (CV=0.075); in 2018 1,898 (CV=0.085); all Category 1A.*
- *Chilean blue whales off the coast of Chile, in December 1997-January 1998: 303 (95% CI 176-625); Category 2.*
- *Blue whales in Chilean Northern Patagonia, summer 2009: 356 (95% CRI 191-652); Category 2.*
- *Blue whales off Isla Grande de Chiloé, southern Chile, in 2004-2012: 762 (95% CI 638-933) and 570 (95% CI 476-705); Category 3.*
- *Blue whales off Isla Grande de Chiloé, southern Chile, in 2004-2012: 450 (CV=0.17); Category 2 and Evaluation Extent 4.*
- *Antarctic blue whales in combined IWC Management Areas IIIE+IV+V+VIW in summer 1995/96: 300 (CV=0.308); in summer 2008/09: 1,223 (CV=0.345; both Category 1A.*
- *Antarctic blue whales, circumpolar, in 1978/79-1983/84: 453 (CV=0.40); in 1985/86-1990/91: 559 (CV=0.47); in 1991/92-2003/04: 2,280 (CV=0.36); all Category 1A.*
- *Southern right whales along the southwest coast of Australia, time series of relative abundance estimates as cited in Smith et al. (2021, Item 11.1.12); Category 3, noting these are an index of relative (not total) abundance.*
- *Eastern South Pacific humpback whales (Breeding Stock G) in 1991-2018: 11,784 (SE=266); Category 3.*
- *Indo-Pacific finless porpoise in Hong Kong waters in the wet season in 1996-98: 37 (CV=0.303); in 2007-09: 67 (CV=0.184); in 2017-2019: 77 (CV=0.207); all Category 2.*

- *Indo-Pacific finless porpoise in Hong Kong waters in the dry season in 1996-98: 65 (CV=0.223); in 2007-09: 121 (CV=0.114); in 2017-2019: 108 (CV=0.140); all Category 2.*

*The Committee **recommends** that all of these abundance estimates meet the definition of an Evaluation Extent of 1 ('examined in detail by the Committee') except for one estimate noted above, which is Evaluation Extent of 4 ('estimate was partially considered by the sub-committee and a new method was used'). The Committee also **requests** that Katara update the table intersessionally to include these estimates.*

The Committee also discussed which of the estimates endorsed at SC68D should be added to the IWC website. Recognising that there are no fixed criteria, the Committee identified those estimates that represent very large areas or nearly complete populations, and are believed to have no severe biases. An intersessional correspondence group was established to finalise the choices identified by the Committee and to review the estimates already on the website to ensure a consistent approach (Table 2, Item 11.2.1).

11.2.2 Revisions to the IWC Table of Accepted Abundance Estimates

Allison and Katara presented changes made to the IWC Table of Accepted Abundance Estimates since SC68C. All estimates endorsed and categorised during the 2021 meeting (11.1.12 in IWC, 2022a) have been incorporated into the table as recommended last year.

During SC68C, a new category (1B) was added to the list of options for abundance estimates endorsed by the Committee (IWC, 2022a, item 11.1.1). This created the need to recategorise some previously accepted estimates to adhere to the new category definitions. The Committee reviewed a list of candidates for recategorisation. Although category 1B is intended for some small estimates, it is unnecessary for others. Thus, the Committee agrees that estimates previously endorsed as Category 1 (using the prior system) having an Evaluation Extent of 1 should be recategorised as 1A, except for a few cases. The exceptions were several estimates for small populations of gray whales, Maui dolphins, and bowhead whales that the Committee agrees should be recategorised as 1B. The Committee noted that, for Okhotsk Sea bowhead whales, only the 2016 estimate had been placed in the table, although a longer time series was available. The Committee requests Katara to check whether additional estimates could be included.

Attention: SC, S, C

*The Committee **recommends** that the following, previously endorsed estimates should be recategorised as 1B and endorsed by the Commission:*

- *Western Feeding Group gray whales in 1995 and 2015: 74 (CV=0.05) and 200 (CV=0.03).*
- *Maui dolphins in New Zealand (North Island) in 2001 and 2016: 96 (CV=0.20) and 57 (CV=0.10).*
- *Gray whales from the Sakhalin and Kamchatka Feeding Group in 1995 and 2015: 129 (CV=0.08 and 282 (CV=0.05).*
- *Bowhead whales in the Okhotsk Sea in 2016: 218 (CV=0.22).*
- *Bowhead whales in Svalbard in 2015: 343 (CV=0.49).*

*The Committee **requests** that Katara revise the IWC Table of Accepted Abundance Estimates accordingly, retaining the original Evaluation Extent in each case.*

The abundance estimate for BS B2 humpback whales was also considered for category 1B. Concerns were raised about potential policymaker misunderstandings related to the area to which this mark-recapture estimate applied, given that another, larger stock is nearby. This is potentially a more general problem. The Committee agrees that the IWC Table of Accepted Abundance Estimates should be supplemented with some text explaining the differences between abundance estimates based on line transect surveys and those based on mark-recapture models, in terms of how they apply to the area and stock being estimated. ASI established an intersessional correspondence group to propose such text for the next SC meeting (Table 2 Item 11.2.2).

The Committee agreed to defer recategorisation of the BS B2 humpback estimate until the next meeting so such text could also be considered then.

Finally, the Committee noted that the categories and evaluation extent for several humpback whale estimates in the Antarctic were unclear and agreed that the categorisation of these should be reconsidered at the next SC meeting.

Allison and Katara presented minor updates to the IWC Table of Agreed Abundance Estimates that were proposed during the previous intersessional period. Almost all the estimates from the Iceland/Faroes component of the 'NASS2015' surveys were revised following the identification of a slight issue with the stratification used in the analyses, but there was no change to the models used to obtain the estimates (details provided in Annex 1 of NAMMCO (2018)). Therefore, the Committee agreed that these changes to the IWC Table of Accepted Abundance Estimates for the relevant North Atlantic humpback, minke and fin whale estimates should be made.

Attention: SC, S, C
*The Committee **recommends** that the following estimates for areas within the NASS survey (NAMMCO, 2018), which had been previously endorsed by the Committee but have been revised by NAMMCO, should be endorsed by the Commission:*

- *Humpback whales in Iceland/Faroes in 2015: 9,687 (CV=0.37); Category 1A.*
- *Minke whales in CIP, in 2015: 8,497 (CV=0.326); Category 1A.*
- *Fin whales in WI, in 2015: 16,862 (CV=0.22); Category 1A.*
- *Fin whales in EI/F, in 2015: 7,357 (CV=0.53); Category 1A.*
- *Fin whales in EG (Blocks IG_EG + IP, no overlap with East Greenland survey below), in 2015: 12,779 (CV=0.21); Category 1A.*
- *Fin whales in EG, in 2015: 6,440 (CV=0.26); Category 1A.*

*The Committee **requests** that Katara revise the IWC Table of Accepted Abundance Estimates accordingly, retaining the original Evaluation Extent in each case.*

Allison and Katara also presented updates to the agreed North Pacific minke whale estimates. The Steering Group for the North Pacific Minke Whale In-depth Assessment considered these estimates suitable for use in conditioning trials, but the Committee agreed in 2021 (Item 8.1.3) that ASI would conduct an intersessional review. Several estimates have been recalculated by Miyashita and Hakamada to use the exact sizes of the relevant sub-areas and were presented to the Committee. The Steering Group also noted that three additional estimates of abundance previously agreed upon but not used in conditioning the 2013 trials should be added, and one of these included the exact size recalculation. In discussion, the Committee requests Katara and Allison to work with Miyashita and Hakamada to clarify the methodology being applied to these subareas but agrees that these recalculated abundance estimates for North Pacific minke whales should be endorsed in the same Categories that had originally been assigned and that the new, uncategorised estimates should be endorsed as Category 2 with Evaluation Extent 3 ('degree to which the estimate was considered by the sub-committee is unclear but method standard').

Attention: SC, S, C
*The Committee **recommends** that the following estimates, which had been previously endorsed by the Committee but have been revised by Miyashita and Hakamada, should be endorsed by the Commission:*

- *North Pacific minke whales, sub-area 10E, in 2002 (May-June): 1,192 (CV=0.66); Category 1A.*
- *North Pacific minke whales, sub-area 10E, in 2003 (May-June): 591 (CV=0.57); Category 1A.*
- *North Pacific minke whales, sub-area 10E, in 2005 (May-June): 875 (CV=0.44); Category 1A.*
- *North Pacific minke whales, sub-area 9, in 1990 (August): 3,287 (CV=0.819); Category 1A.*
- *North Pacific minke whales, sub-area 9(S), in 2011 (May): 0; Category 1A.*
- *North Pacific minke whales, sub-area 9(N), in 2011 (May): 115 (CV=1.05); Category 1A.*
- *North Pacific minke whales, sub-area 9, in 2011 (May): 115 (CV=1.025); Category 1A.*
- *North Pacific minke whales, sub-area 12SW, in 1990 (August-September): 4,774 (CV=0.51); Category 2.*
- *North Pacific minke whales, sub-area 12NE, in 1990 (August-September): 11,805 (CV=0.38); Category 2.*
- *North Pacific minke whales, sub-area 12NE, in 1992 (August-September): 11,051 (CV=0.705); Category 2.*

*The Committee **requests** that Katara revise the IWC Table of Accepted Abundance Estimates accordingly, retaining the original Evaluation Extent in each case.*

Attention: SC, S, C
*The Committee **recommends** that the following revised or uncategorised estimates in the IWC Table of Accepted Abundance Estimates be recategorised and endorsed by the Commission:*

- *North Pacific minke whales, sub-area 10E, in 2007 (May-June): 672 (CV=0.33); Category 3, Evaluation Extent 1.*
- *North Pacific minke whales, sub-area 6E, in 1992 (July-September): 893 (CV=0.67); Category 2, Evaluation Extent 3.*
- *North Pacific minke whales, sub-area 10E, in 1992 (July-September): 707 (CV=0.57); Category 2, Evaluation Extent 3.*

*The Committee **requests** that Katara revise the IWC Table of Accepted Abundance Estimates accordingly, and that Katara and Allison work with Miyashita and Hakamada to clarify the methodology used for these abundance estimates.*

The Committee thanked Katara and Allison for these updates and requested that such information be provided in advance of each ASI meeting. The Committee encouraged researchers who update abundance estimates endorsed by the Committee to notify the Secretariat so that the IWC Table of Accepted Abundance Estimates can be updated accordingly.

Attention: SC, S
*The Committee **requests** that Katara annually provide the Committee, in advance of each ASI meeting, with a list of suggested revisions to the IWC Table of Accepted Abundance Estimates arising when authors make minor changes to estimates previously endorsed.*

Attention: SC, S, R
*The Committee **encourages** researchers who update abundance estimates endorsed by the Committee to notify the Secretariat so that the IWC Table of Accepted Abundance Estimates can be updated accordingly.*

11.3 Review and refine the abundance review process

11.3.1 Edits to category descriptions, supplemental wording, and examples

Last year, the Committee revised the list of categories it uses for abundance estimates endorsed and included in the IWC Table of Accepted Abundance Estimates. An ICG was established to discuss how best to draw a distinction between categories 2 and 3, and to develop supplementary wording that explains how estimates in categories 1A, 1B, 2 and 3 might be used. The group was also tasked to provide examples of the reasoning for choosing one category over another in various circumstances. Intersessionally, the ICG Convenor also asked it to consider any edits it believed were needed to clarify the wording for all category descriptions.

The Committee received the suggested wording, revised it, and agrees to adopt the following category descriptions:

- Category 1A: An estimate which is acceptable for use in In-depth assessments or for providing management advice using the RMP, AWMP or other modelling or analysis. This (and category 1B) may include estimates with minor or possibly competing small biases (e.g. assuming $g(0)=1$ when it may be slightly less), provided that these biases are recognised.
- Category 1B: An estimate which pertains to a 'very small' population, and is acceptable for providing management advice in that context, which includes situations where no sophisticated modelling or analysis is required.
- Category 2: An estimate which may be acceptable for 'conservative' management (e.g. in the AWMP where the user objective is expressed as an absolute number of catches/strikes with no need to eventually maximise catches/strikes, or in an assessment of whether a given level of bycatch will lead to recovery or further depletion of a population). The estimate may be subject to considerable negative bias for reasons such as limited spatial coverage (compared to the range of the population for the season in question) or lack of correction factor(s) (e.g. related to $g(0)$).
- Category 3: An estimate which is informative, but not acceptable for inclusion in (1A), (1B) or (2). This category includes estimates with an unquantified bias which is likely to be too severe to allow inclusion in Category 2, as well as relatively unbiased estimates that are adequate to provide some general indication of abundance while still not qualifying for (1A) or (1B). Such estimates may be used when fitting population models, but not for use as estimates in actual implementations of IWC management procedures (i.e. the RMP *CLA* or AWMP *SLA*s).
- Category P: A preliminary estimate, not suitable for use at the time of review, but which may provide an acceptable estimate once finalised. It will be omitted from published tables until finalised and assigned a category from (1) to (3).
- Category X1: Category 1A or 1B estimates that have since been superseded by revised estimates for the same area and time period. They will be omitted from published tables.
- Category ND: An estimate which has not yet been discussed by ASI, but which may be discussed in future. These will be omitted from published tables.
- Category NS: An estimate reviewed by the Scientific Committee, but agreed not to be suitable for acceptance due to factors such as: insufficient data (including inadequate coverage achieved of the area planned to be surveyed); insufficient methodological information presented; concerns about survey design; concerns about conduct or interpretation of analyses; lack of an appropriate measure of uncertainty; failure to account for large potential biases; or assumptions that are unreasonable or clearly violated. These will be omitted from published tables.

The Committee did not receive suggested supplementary wording or examples, but looks forward to progress on this from the Abundance Review Process ICG next year (Table 2, Item 11.8).

Attention: SC, SC-ASI
*The Committee **recommends** that the abundance estimate category descriptions finalised at SC68D be used to categorise estimates that are reviewed by the Committee, including those input into the IWC Table of Accepted Abundance Estimates.*

11.3.2 Adding CMP Convenor to the Abundance Steering Group

The Abundance Steering Group (ASG) carries out the intersessional review of abundance estimation papers on behalf of ASI, and occasionally advises ASI on other matters. When established, the ASG was formally comprised of the Chair and

vice-Chair of the SC; the Head of Science, Conservation and Management from the Secretariat; the Head of Modelling and Statistics from the Secretariat; and the Convenors of the following sub-committees and standing working groups: ASI, NH, SH, SM, ASW, IST, IA, EM (IWC, 2020b).

The Committee **agreed** to add the Convenor of the Sub-committee on Conservation Management Plans (CMP) to the ASG membership list.

Attention: SC, SC-ASI
*The Committee **agrees** that the membership of the Abundance Steering Group be expanded to include the Convenor of CMP.*

11.3.3 Deadline for intersessional review of abundance estimates by the Abundance Steering Group

Last year, the Committee noted that there are two pathways for papers to be reviewed by ASI: (i) traditional in-person consideration at the annual meeting by participants at an ASI session after an author presentation; and (ii) intersessional written reviews by independent reviewers, followed by ASG consideration, then final recommendation by ASI. The Committee expressed a preference for the second path, as much as possible, even though it is slower (IWC, 2022a, item 11.1.1). However, the second path is not practical for papers received immediately before the ASG pre-meeting or the Committee meeting. Therefore, the Committee established a deadline that, for papers to receive path (ii) review, the paper must be sent to ASG by the requesting Convenor at least one month before the next Committee meeting (IWC, 2020f). In the 2021-22 intersessional period, the ASG tried to respect the Committee's preference for path (ii) as much as possible. Accordingly, 26 papers were processed through path (ii), and zero through path (i). Consideration of one paper was postponed so that path (ii) could be taken next year, rather than following path (i) now.

In submitting papers to the ASG, three problems were encountered. First, it was difficult to ensure that the deadline was known and abided by. Second, the ASG pre-meeting started about 1 week before the Committee meeting, so the deadline actually gave ASG only 3 weeks to solicit two independent reviews, get an author response, and consolidate everything into a working paper to be reviewed at the ASG pre-meeting, or in advance, as is preferred by some ASG participants. This is extremely burdensome on reviewers and authors participating in the process and discourages them from participating in the process in the future. Reviewers are already hard to recruit, so it is counterproductive to treat them poorly. Third, the Committee may be forced to begin biennial meetings, due to budget considerations. In this case, tying the submission deadline to the start of a Committee meeting gives the unintended implication of a two-year review cycle. Instead, the deadline should be tied to the start of an ASG meeting, which is likely to occur annually, in some manner, even without a concomitant Committee meeting.

Therefore, the Committee agrees that the deadline for submission of an abundance estimate for ASI review will be 6 weeks before the start of the next ASG meeting.

Attention: SC, SC-ASI
*The Committee **agrees** that the Scientific Committee Procedures for Submission, Review, and Validation of Abundance Estimates (IWC, 2020f) should be amended so that the deadline for submission of an abundance estimate for ASI review is 6 weeks prior to the start of the next ASG meeting.*

11.3.4 Process for reviewing papers revised in response to ASI review

Sometimes ASI recommends revisions to the analysis of an abundance estimate it has reviewed, often aiming to help the authors improve their estimate so that it can be endorsed by the Committee in a category that corresponds to Committee intentions for the estimate (e.g. 1A or 2, instead of 3 or P).

For example, this situation occurred with several estimates of franciscana abundance, from various authors, which were first considered at the 2021 Workshop on the Status of the franciscana (IWC, 2022b). Estimates were reviewed, suggestions for improvements were offered, and subsequently reviewed and endorsed by the Committee (IWC, 2022a, item 11.1.2). In a follow-up franciscana workshop planned for June 2022, some revised and improved estimates that take into account those suggestions will be considered. Those estimates will subsequently be forwarded to ASG for intersessional review.

The Committee considered what level of review should be required for estimates that have undergone such revisions. It noted that sometimes, the authors provide a detailed explanation of how the methodological suggestions were addressed, but that the complexity of the revisions and the comprehensiveness and clarity of the authors' response will differ from case to case.

The ASG Convenor expressed his intention that, if such cases are addressed individually, ASG would bias the process in the direction of less review. If a detailed author response was provided and the revisions were not too complex, he would prefer to bring such a paper, including the original reviews and new author response, directly to the ASG pre-meeting without further review. Additional independent reviews of the revised paper would be solicited for the next ASG meeting only if it was necessary, and in such cases, the preference would be to use the same reviewers as previously.

The Committee considered that a blanket policy for revised papers would be ineffective. Therefore, it agreed that such situations should continue to be handled by the Convenor of ASG on a case-by-case basis in the manner he described.

11.3.5 Guidance for Convenors about submitting abundance estimates for ASI review

Convenors remain uncertain about which papers to refer to ASI for review. ASI has reiterated its role (Item 11, above) as a point of reference for Convenors. The Convenor of ASI agreed to engage with other subgroup Convenors intersessionally to help further clarify any confusion. Greater communication among ASI, requesting Convenors, and authors would help ensure that the most relevant papers are provided for review with sufficient guidance for ASI and reviewers to do a good job.

The Committee also noted that much cetacean research involves projects spanning many years, and it drew attention to the importance of the long time series of data generated by such work, including whale (or calf) counts, abundance estimates, and photo-id databases. For some long projects, regular abundance estimates are routinely provided (e.g. annually) as more data are collected, using the same survey and analysis methods as in prior years. In such cases, it may not be necessary for ASI to review each new estimate when it is done. For example, perhaps such estimates could accumulate for three years before receiving a review by ASI. After review, the set of recent prior estimates would all be added to the IWC Table of Accepted Abundance estimates, if they are endorsed. There would be some complexities introduced by this approach. The relevant Convenor might be unsure whether the methodology had changed enough to warrant stopping the aggregation. If methodology did change in the middle of an aggregation period, multiple sets of reviews would be needed. Also, an aggregated set of papers may reduce the workload for ASG at the expense of increasing it for reviewers. There was insufficient time to consider fully whether this approach was advisable, so the Committee recommended that ASI consider the potential aggregated review of routinely updated abundance estimates at the next meeting.

Attention: SC, SC-ASI
*The Committee **recommends** that ASI consider the best manner to review abundance estimates that are routinely updated (e.g. annually) using the same survey and analysis methods with new data.*

A common point raised in the discussion of papers was the difficulty in categorising endorsed estimates when the survey area and stock boundaries did not coincide, especially when the purpose of a survey was to produce results for a specific area - often one relevant for management. The ICG revising category wording (Item 11.3.1) addressed this by providing guidance for Convenors requesting that they consider (and communicate to ASI) the stock and/or area relevant for evaluation of the estimate. The Committee endorses this guidance, which is provided in Item 11 above.

Finally, the Committee noted that many analyses submitted for ASI review, use methods that are not described in detail in the submitted paper, requiring reviewers to access previous papers to make a full evaluation. This situation is quite common, given the long-term nature of many important cetacean research projects. This issue is compounded by the increasing need to recruit new reviewers who might not necessarily be fully aware of the long history of some of these studies and their consideration by the Committee. While additional background papers could be provided to reviewers, this has the potential to add to their burden substantially. To reduce the burden, the senior author of each submission could be asked to provide one other document with detailed methods, if needed. However, not all papers submitted for review involve authors who choose to be engaged in the ASI review process. Therefore, the Committee agrees that it should be the responsibility of the Convenor requesting ASI review of a paper to provide the paper and sufficient other background material to facilitate the review.

11.3.6 Choice of years to add to IWC Table of Accepted Abundance Estimates when the analysis provides a long time series of estimates

The Committee noted that the question of selecting years a long time series of estimates for inclusion into the IWC Table of Accepted Abundance Estimates arose in ASG and ASI discussions on numerous occasions (e.g. eastern North Pacific gray whales, Item 11.1.5). Including only the final abundance estimate might be misleading, and endorsing the entire series would ignore potential correlation. Overall, the current approach has been to select the earliest and most recent estimates as well as one in the middle of the time series, but this can result in estimates more than a decade apart. This can be advantageous, as estimates close in time can be correlated with one another, but this may not always capture important trends. Building on discussions from IWC (2021c, Item 11.1.1) and recognising that the Table contains a link to the full time series to provide more details when needed, the Committee agreed that selecting one estimate roughly every 10 years should be an informal rule of thumb, with exceptions decided on a case-by-case basis.

11.4 Methodological issues

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

The Committee agreed in 2018 (IWC, 2019g) that the 'Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme' (referred to as the RMP Guidelines, IWC, 2012c) need to incorporate spatial modelling approaches to estimate abundance from line transect surveys. Such work has been undertaken by Miller, and, intersessionally, oversight of this project was transferred to IST.

11.4.2 Progress on simulation software to evaluate methods for abundance estimates from surveys

Smith and Palka (2021) provided an update on the modernisation of visual survey simulation programs. The Committee has used simulated data to evaluate novel analysis methods for line transect abundance surveys in the past. These datasets have been archived with the Secretariat, but the original executable code used to create those simulated data was generated using compilers that are now outdated. The Committee provided financial support for a project to document, update and streamline the code so that it is compatible with current compilers. This document describes the updating process, now complete, and provides guidelines and examples showing how to use the programs to create new simulated data scenarios, and how to re-compile the code after further development. The existing simulated datasets, together with others that may be generated with the updated programs, could comprise a library of datasets for use by the Scientific Committee in evaluating future novel analysis methods for line transect data. During the 2021-22 intersessional period, this contract was renewed to facilitate the completion of the project, specifically to continue to make the code user friendly and functioning on modern Windows computers, and to make the code accessible via GitHub. The Committee noted the value of such simulations to advance the work of the SC and looks forward to receiving a report on the completion of this project at the next meeting. The Committee agrees that the best use of this software by the Committee should be discussed next year.

11.4.3 Consider diagnostic methods for mark-recapture models

In 2019, the ASI established an ICG to consider diagnostic methods (e.g. model fit) for mark-recapture models to estimate abundance (IWC, 2020b). Although this group has been renewed annually since then, the Committee has not received information from it but continues to recognise the importance of this topic.

This year, the Committee identified several other issues related to mark-recapture abundance estimation that warrant consideration. Appropriate approaches to deal with the scope and complexity of strongly heterogeneous mark-recapture data (e.g. combining data from dedicated photo-id surveys with citizen-based data from platforms of opportunity) were identified as a concern in Item 11.1.12. Several studies reviewed in Item 11.1 raised the concern that it was difficult to suitably endorse or use estimates from mark-recapture studies conducted over very long time periods (e.g. decades), especially if a closed population model is used.

The Committee agrees that all these issues could be addressed by the same ICG (Table 2 Item 11.4.3). This group might also offer guidance to the authors of Félix *et al.* (2021), should they desire it, as suggested in Item 11.1.12.

11.5 Provide advice to the Commission on the status of stocks

The Committee has been asked to provide information on the status of whale stocks for the Commission and the general public. Recent work on this project is summarised by IWC (2018d; 2020g; 2021c; 2022). Originally planned as a biennial document, a Status of Stocks Website was deemed more practical and useful in recent Committee discussions, and ASI has begun its development.

An intersessional correspondence group was formed last year to progress this work (Items 11.4 and 11.6 of IWC (2022a)). The goal of the proposed Status of Stocks Website is not to replace or contradict existing IWC web pages, nor to replicate either the intent of or the material contained in, other sources of information such as the IUCN Red List. Instead, the Committee wishes to highlight its quantitative assessments, which provide a view of status that is different to those provided elsewhere. Specifically, the Committee intends that the information provided in the Status of Stocks Website should be based on the Committee's In-depth Assessments, *Implementations* and *Implementation Reviews* for the RMP and AWMP, modelling used for the development of AWMP SLAs, and other *Comprehensive Assessments*.

On behalf of the ICG, Givens, Punt and Allison developed a detailed proposal, including examples for three assessed stocks and several unassessed stocks that illustrated other issues that would arise. This proposal was shared with communications and IT specialists from the Secretariat, who presented a proposal for how that content could be interwoven with the IWC website, *http://www.iwc.int*. These two proposals, and a lengthy discussion thereof, are presented in the ASG Report. A summary follows.

The ICG proposal makes no appreciable changes to the mathematical modelling and statistical summary of the assessments that ASI has developed for the Status of Stocks project. Introductory content would be presented as a single page providing an overall summary of the status for all assessed stocks that could be understood at a glance without reference to technical detail. To achieve this, simple indicators of depletion (referred to as 'relative abundance' in the proposed website content) and population change for each stock or species would be displayed using radial colour 'thermometer' graphs. These would indicate, on a continuous scale, the estimated values and uncertainty ranges for relative abundance and change, which supplement the discrete categories and labels discussed last year. The new thermometer graph emphasises the continuum of the estimates and their uncertainty. Within this introductory page, links would provide access to status summary pages for each species that contain introductory level information on their assessment, including a definition of relevant stocks, recent exploitation and abundance, the pooled assessment results and uncertainty ranges derived in the manner developed by IWC (2018d; 2020g; 2021c; 2022), stock trajectory plots, a list of threats, data quality classification, and additional material listed in the ASG Report. Further links on the status summary page would provide access to case-specific

pages with technical details about the assessment methods and results, and a generic page with a technical explanation of: fundamental concepts of population dynamics, stock definition, and other important issues in stock assessment; the Committee's assessment methods; and the statistical calculations used to summarise status on these pages. Some of the more detailed or technical content might be better provided by linked PDFs instead of lengthy web pages.

On behalf of the Secretariat, Wilson explained how the ICG's proposed pages could be integrated with the existing content on status at *http://www.iwc.int*. The ICG's work would be used to build on the existing introductory level information, developing a new sub-section on status comprising an introduction, background information, and stock assessment pages. Noting that this is an evolving project and that the number of assessments available would grow gradually, the Secretariat proposed short- and longer-term approaches to the stock assessment pages. In the short term, the content would be divided into separate pages containing status summaries, status tables and assessment details. In the longer term, they proposed that all the available stock assessment information for each stock would be merged onto a single page, beginning with the simple summary and graphics, and moving through to the more detailed and technical content. The aim of this longer-term approach is to simplify the site, assist user navigation and encourage users toward more technical information. The Secretariat highlighted that status is one of the most frequently sought topics on the website, and the aims of the Status of the Stocks project appear entirely compatible with the Secretariat's aim of updating and improving existing website content. The Secretariat welcomed the opportunity to work with the Committee on this initiative.

While there was considerable discussion, the consensus of the Committee was that, overall, the Status of Stocks Website project was welcome, and has the potential to provide an excellent extension of the existing IWC website, facilitating the communication of some of the IWC's core work, and helping answer one of the most common questions about whales posed to the IWC by the concerned public.

In discussion, it was noted that the Status of Stocks project links to other initiatives within the Committee and the Commission, such as the Extinction Initiative, related efforts within the Conservation Committee, and the development of CMPs and task teams. It was further noted that ASI is not particularly well placed to develop small cetacean assessments, providing an opportunity for experts in the SM sub-committee to contribute to the Status of Stocks project, particularly considering that an existing group with the SM sub-committee coordinates with Integrated Conservation Planning for Cetaceans (ICPC) group within IUCN. It was suggested that this SM group might help demarcate assessment roles and integrate expertise in assessments. Finally, it was noted that the Committee has well-established procedures for developing stock assessments, and any circumvention of that process by ASI would require further consideration.

In response, Givens concurred that such other groups and procedures were critical for the success of this project, which is focused on presenting Committee work, not conducting new assessments. The Status of Stocks Website project currently includes no plans to conduct stock assessments outside normal Committee processes. The goal is to summarise completed Committee work for the website, the Commission, and the public, using the types of Committee outputs cited above. The ASG Report contemplates the inclusion of model-based assessments published in the scientific literature but external to the IWC, but processes to incorporate such content - especially for Committee review of these - would need to be considered before pursuing such an approach. Thus, in the near term, the included stocks are likely to comprise large whales, many of which are, or have been, the focus of RMP or AWMP considerations or In-depth assessments. Table 14 of IWC (2021c) lists those stocks considered to be ready for this project.

11.5.1 Coordinating with the IUCN Red List

There was much discussion comparing the IWC Scientific Committee and IUCN Red List assessments. The ASG Report identified the need for clear text on the Status of Stocks Website to explain the differences, and the complementary nature of, the two types of assessment and why the IWC presents both. The Committee agrees that drafting the proposed website text for this purpose should be tasked to an intersessional correspondence group in collaboration with the IUCN/IWC coordination group established under Item 4.12. The ASG had formed a small group to begin considering issues relevant to such text.

The small group noted that the two approaches have somewhat different objectives: the IWC seeks to provide advice on status at the population level based upon rigorous model-based assessments; and the IUCN Red List approach is primarily species based (although sometimes smaller units are used) and has categories that are designed to apply to all organisms. The Red List approach seeks to avoid, where possible, classification as 'Data Deficient', in part by allowing a greater degree of expert opinion and a coarser level of assessment[24]. The primary intention of the IUCN Red List is to provide an indicator of the status of the world's biodiversity and its changes over time, raising alarms where needed or suspected. Inevitable differences in the data quality and analytical approaches used for the wide variety of species broadly cancel out to give an important, albeit coarse, overview. In some ways, the IUCN approach can be seen as identifying where there are concerns and a more detailed population-level assessment is needed.

[24]see: *https://www.iucnredlist.org/about/uses* for more information.

The Committee has stressed for many years the importance of assessing populations, rather than species, from a conservation and management perspective. Whilst valuable, the broad Red List approach can lead to certain peculiarities such as the following.

- Fin whales as a species are classified as 'Vulnerable' by the IUCN based on what they describe as necessarily crude modelling. According to the IUCN website Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) species are 'considered to be threatened with global extinction'. However, detailed work under the RMP (and AWMP) for the North Atlantic fin whale has shown the population is capable of sustained removals and thus is in no danger of extinction. It is therefore somewhat incongruous to suggest that the species as a whole is in danger of extinction if the population in the North Atlantic is not.
- The broad IUCN criteria include the concept of comparing present abundance to that three generations ago. Whilst the logic for unexploited species or populations is clear, this can lead to a situation for long-lived animals, such as baleen whales, that were heavily depleted (e.g. by whaling in the Antarctic up to the 1970s) where an improved classification may occur not due to improved data showing an increase, but rather simply to the fact that the depletion from severe whaling is no longer applicable because three generations have passed. Conversely, a species that is increasing substantially following conservation actions in response to a threat that had reduced them may be classified as Vulnerable if 'three generations ago' includes the period when the species was essentially unexploited. The focus on abundance three generations ago intends to recognise that, for most taxa, it is impossible to estimate (or perhaps even conceptualise) the 'unexploited level' and thus the approach provides a measure of consistency amongst listings in line with IUCN objectives. It should be noted that this is an active field of research (e.g., Rodrigues *et al.*, 2019).

The small group emphasised that the points they raised were not to criticise the IUCN system but rather to recognise that given the different objectives and resources available, the IWC population-based approach is more refined, rigorous and able to focus on cetaceans only. As such, the IWC approach should thus be the primary source of information on the IWC website on status, in cases where an IWC assessment has been completed. Whilst the detailed justifications for the IUCN Red List classifications frequently refer to the work of the IWC Scientific Committee, these details are rarely referenced by the general public (or even scientists).

Taylor noted that the IUCN Red List approach required assessments to be undertaken at the species level before population/sub-population-level assessments can be attempted, even though conservation does not happen on a global scale. Taylor also reported that the IUCN is moving into a prioritisation process during which it will choose which subpopulations are subject to assessment. In particular, the IUCN prioritisation process consisted of deciding whether a potential subpopulation: (1) was a demographically independent unit; (2) was of evolutionary significance to the species; (3) had been determined to be in a category of threat based on a preliminary assessment; and (4) would benefit from a conservation perspective from receiving an IUCN assessment (see SC/68D/O/01 for more details). Taylor further noted that most of the proposed species being considered for the initial phase of the IWC's Status of Stocks project would be viewed by IUCN as being of 'Least Concern' and therefore would not be considered as priorities. However, western North Pacific gray whales have been considered a species of concern at the subpopulation level by the IUCN, and an assessment of those whales might be an example of where the IUCN and IWC could coordinate efforts.

Taylor further noted that efforts of IWC and the IUCN should be coordinated and complementary, so that as many whale populations are assessed as possible, as efficiently as possible. She noted that the IUCN Cetacean Specialist Group does many assessments and that this enormous task is helped by having a large body of contributing experts. Taylor further stressed that it is unrealistic to expect assessments of every population of cetacean in the world, particularly if the IWC and IUCN are duplicating assessment work. For example, the IUCN process might be better placed to consider many small cetacean populations, whilst the IWC focussed on large whales.

11.5.2 Language for the website

The proposal, developed intersessionally, and the subsequent discussions by ASG and ASI, noted that it would be essential to develop clear text, at the introductory level, explaining a variety of concepts important for assessment modelling such as carrying capacity (or other reference levels); depletion; the notion of populations, stocks, substocks or other units to be conserved; the principle of scientific uncertainty; and other matters. An intersessional correspondence group was formed to begin drafting needed text (Table 2 Item 11.1.5). This ICG would also draft text explaining the relationship between IWC and IUCN Red List assessments, in collaboration with the IUCN/IWC coordination group established in Item 4.12.

In discussion, it was noted that although the word 'stock' had been used thus far during the project, primarily because 'Status of Stocks' is in the name of ASI. However, the Committee might prefer another term, such a 'population', especially if the animals have never been, or are now not, subject to takes. Furthermore, the term 'stock' is rarely applied to other marine mammals. However, it was also noted that much of the assessment work undertaken by the IWC was for a 'stock' as opposed to a population. It would also be important to consider the desirability of having consistency in terminology for

units like 'populations' or 'subpopulations' between the IWC and the IUCN. The Committee noted that stock definition was a concept that has developed over time, and the concepts and terminology used by the IWC are a combination of historical notions (e.g. as introduced in the Schedule of the ICRW) and developing concepts in science and wildlife management. This context about the language used by the IWC would likely need to be explained in the website materials at an appropriate level.

Lang noted that a small group in the SDDNA working group has worked on such questions of terminology, and she offered to help with this aspect of the project. ASI appreciated that offer and noted that the completed assessments used for this project had been based on stock definition determinations by the SDDNA working group when available. Therefore, in collaboration with Wilson, it would be helpful for members of that group to review the proposed wording for the species-level status summary pages describing population structure to ensure that such information was correct and consistent across *http://www.iwc.int*.

The ASG Report reflects disagreement as to the extent to which the language summarising status should adopt a 'bland' scientific tone or advocacy language. It was noted that some members of the Committee might wish to see advocacy language, particularly when stocks/populations are facing dire outcomes; others were concerned, however, that use of such language might decrease respect for the authoritative nature of the science-based results provided. The appropriate tone for the website would be considered by the ICG.

11.5.3 Status and depletion

Witting presented his thoughts on the proposal to include a depletion ratio on the IWC Status of Stocks website. Depletion is intended to describe the abundance relative to the equilibrium abundance in the absence of harvest, typically referred to as the pre-exploitation abundance or carrying capacity. However, carrying capacity may change over time, so the depletion ratios relative to the pre-exploitation abundance and carrying capacity differ; and presenting both may be confusing. The underlying problem is that the typical density regulated assessment models used by the IWC SC often cannot describe the delayed recovery of large whales following the commercial exploitation in past centuries (Witting, 2003; 2013). This may be because natural populations regulate their abundance not only by density regulation but also by density frequency-dependent selection (where density changes natural selection by a change in the distribution of consumed resources). Selection regulated models often reconcile the long-term dynamics of whale populations. These models have no changes in equilibrium abundance, and thus have a stable reference point for the depletion ratio over time, removing the need for an ad hoc explanation of a change in carrying capacity. Witting suggested that the Committee did not develop a Stock Status framework based on the hypothesis of density regulated growth.

In discussion, it was also noted that while the limitations of the current density regulated assessment models have been acknowledged, there has been little appetite to revisit those assessments. In some cases, the assessment framework was developed as much as two decades ago, and data accumulated in the years since then lead to poorer model performance now. Such problems arise most often for stocks with long catch histories, that have been depleted to a large extent, for which there may be inaccuracies in catch histories, and which may have experienced changes in carrying capacity, e.g. due to climate change. However, the recognition of such imperfections in the assessment models should in no way be taken to suggest that the Committee has concerns about the overall reliability of the RMP, AWMP, or the Committee's assessment conclusions.

The main impediment to pursuing Witting's recommendation is that the Status of Stocks project is not planning to undertake further assessment work or to re-do analyses, so any change in the type of dynamics model used for assessment would best be initiated by Committee subgroups undertaking new assessments or updating completed ones. It was suggested that care is needed when considering the implications of not using density-regulated models, which include both technical issues and questions about how to communicate conclusions to the public.

The Committee concluded that what might be needed is careful website text explaining: (a) that there are many ways of looking at population dynamics, and whilst the Committee uses one way to model it, there are other valuable ways to approach the problem; and (b) sometimes the IWC's population models do not fully capture population dynamics, and imperfect model fit is a very common problem in many scientific contexts without being a reason for undue scepticism about the model results. Such wording would be considered by the appropriate ICG (Item 11.8). In the future, the Committee may wish to consider using different dynamics models for its assessments, but that is a matter for future discussions in the appropriate Committee subgroups.

11.5.4 Statistics and terminology

It was noted that the approach of summarising status by citing population depletion and trend, and the method for calculating the associated summary statistics, had been previously decided (2018d; 2020g; 2021c; 2022). However, the names for these statistics ('Relative Abundance' and '30-Year-Change') were new suggestions in the ICG proposal. In discussion, 'Relative Abundance' was viewed favourably. 'Recent Change' was proposed as an alternative to '30-Year-Change' in case different species or populations required different time spans.

A time-span of 30 years for Recent Change was originally proposed during SC68C, but it was suggested that a shorter time span of 10-20 years, or even something more specific, such as generational time for a species, might be more appropriate. Summarising over 30 years might hide informative dynamics occurring on shorter time scales, such as the very recent decline in North Atlantic right whales. Moreover, the proposed 30-year time frame is very different to that of the IUCN, which uses species-specific generational time scales. It was further noted that the choice of that time frame could bring about very different conclusions in assessments. An idea of using a human generation time (~25 years) as a time span was offered, with a particular reference to its relatability. It was noted that three decades is a reasonable period of time over which to detect and summarise recovery, but that population declines can occur and need to be identified, much more quickly. A final suggestion offered was that the Commission and the public may be interested in even shorter time scales, such as during the past decade, and species-specific decisions may be required.

The Committee also noted that care should be taken to check that the model-estimated trend is evident in the data themselves. It was further noted that trends over different time scales might be offered to cater to a variety of interests. In response, reference was made to the proposed trajectory plot to be included on the status summary page, which would provide a clear visual indication of trends on different time scales. The Committee concluded that a 20-year period would be a reasonable general standard, but that in some cases an alternative choice might be used if it was more appropriate.

Givens noted that the Recent Change statistic was defined as cumulative change, not an annual rate. Therefore, if different time spans were used to calculate Recent Change for different species, the thermometers would be incomparable, which would defeat the purpose of having a single page to summarise the status of many species at a glance. He, therefore, recommended that the definition of Recent Change be revised to be an annual rate of change, instead of the cumulative change, so that the thermometers would remain comparable across cases. The Committee agrees with this suggestion, but also noted that the importance of small Recent Change rates, and small differences between them, might not be clear to non-specialists, so some associated text might be helpful.

In regards to the category thresholds and single-word labels for thermometers (e.g. the lowest Relative Abundance values being labelled 'critical'), concern has previously been raised about whether such labels should carry a value weighting. This is particularly challenging because there are differing views, for example, on how severe depletion would have to be before it is considered 'bad' for the population. This topic is also important in the context of working collaboratively with IUCN. It was noted that there were already implicit value judgments inherent in targets set by the RMP and to a lesser extent the AWMP SLAs. This issue will be considered by the appropriate ICG (Item 11.8).

Concern was raised about basing the proposed category labels on the value of the point estimate, without consideration of the corresponding uncertainty. In response, it was noted that the proposed thermometers do show uncertainty, but it is not straightforward to capture that in a single-word category label. It was also noted that uncertainty had already been accounted for in the two assessment summaries since they are pooled over several scenarios.

Attention was also drawn to the need to consider both Relative Abundance and Recent Change together because they can be misleading individually. The Committee agrees that an integrative statement about status and recovery should be included on the status summary page for each species.

11.5.5 Future work

In the ASG Report, Givens expressed concern about the degree to which progress on this project was currently contingent on very heavy contributions from the ASI Convenors, Punt, and Allison. Without a broader and deeper commitment of effort from Committee members, the project was, in his view, unlikely to be completed. Accordingly, he had advertised the project broadly at this meeting, and he thanked members of the Committee who do not usually attend ASG/ASI sessions, but who contributed to the Status of Stocks discussion this year, noting their contributions had been extremely helpful.

Givens noted that during the 2021/22 intersessional period two ICGs were working on very similar terms of reference and that this had been a source of confusion. The Committee agrees to reorganise work by establishing three ICGs (Item 11.8). The Status of Stocks Model-based Assessment Group (Table 2 Item 11.1.5) would focus on the technical aspects of assessment modelling and summary of results. The Status of Stocks Group on Language, Terminology, and Content Development (Table 2 Item 11.1.5) would focus on drafting careful, accessible wording about stock assessment topics and conclusions for each species. This group would also address the remaining questions about labels and terminology. Finally, the Status of Stocks Steering Group (Item 11.8) would oversee the project, focusing on priorities, consistency, and accessibility. In discussion, it was noted that for consistency and continuity, it would be important to have several people belong to all of the groups, with a suggestion that this includes the Convenors of ASI. Givens agreed to serve in this role but highlighted his need to step back from most content creation work and assume more of an oversight role. Wilson, New, Staniland, and Punt also agreed to help ensure consistency by joining more than one group.

Givens expressed his hope that some content for the IWC website might be approved by the Committee by the end of the next meeting. It was noted that the upcoming Commission meeting might provide an opportunity to better inform the Commission about progress with this project and to receive feedback. The potential connection to the Communications Initiative was also raised: the Status of Stocks project would be a strong candidate for ASI to convey to the Commission,

showing that the Committee is working to fulfil the Commission's desire for more, and clearer, information about stock status that can be communicated effectively to the general public.

Attention: C, SC, SC-ASI
*The Committee **recognises** that the provision of information on the status of stocks to the Commission and the general public is a priority. The Committee **agrees** that the Status of Stocks Website project developed in recent years will be an effective approach to address this priority, and **recommends** that this work continues under the guidance of ASI and its intersessional correspondence groups.*

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

Hammond *et al.* (2021) was presented to the Committee by Punt. This paper was motivated by the need to estimate the abundance of marine mammal populations to inform conservation assessments, especially relating to fishery bycatch. It provides background on abundance estimation and reviews the various methods available for pinnipeds, cetaceans and sirenians and complements Wade *et al.* (2021) and Moore (2021) that respectively outline best practices for assessing and managing bycatch of marine mammals and evaluating bycatch mortality. The paper should assist countries who are preparing to conduct bycatch assessments in response to implementing regulations of the US Marine Mammal Protection Act (MMPA) that require that the fisheries that lead to fish and fish products that are imported into the US have a regulatory program that is comparable in effectiveness to that in place for US commercial fisheries. Hammond *et al.* (2021) outline general principles related to abundance estimation, including definitions for abundance and population. It then summarises the most common methods used to estimate abundance for marine mammals. For cetaceans, these are the collection and analysis of visual data from ships and planes, data from passive acoustics (ships and static/drifting hydrophones), individual recognition data, and land-based counts. For each method the paper reviews it summarises common challenges in implementation, based on strengths and weaknesses concerning a range of logistical and practical issues and the assumptions made, violation of which can lead to bias. The paper concludes with a discussion of some practical issues, given the various challenges that arise during implementation.

The Committee commended the authors of Hammond *et al.* (2021) for this important and useful contribution that will provide much needed, high-level guidance to a number of countries faced with the new MMPA regulations.

11.7 Progress on previous recommendations

The Committee recognises that cancellation of the 2020, 2021, and 2022 in-person meetings severely impacted its work. The technical nature of the review of abundance estimates and providing information on the status of stocks is such that annual in-person meetings are essential in combination with intersessional work. Also, many recommendations relevant to ASI are ongoing, with work in progress toward their completion. Nevertheless, progress was made for some recommendations from previous meetings.

The IWC Table of Accepted Abundance Estimates was updated during the intersessional period and estimates requested by various of the Committee's sub-groups were reviewed intersessionally, during the ASG meeting and the present meeting (Item 11.1 above). More than fifty reviews were received. The Committee reiterates that the review of abundance estimates and the update of the IWC Table represent important recurring tasks for the work of the Committee, and many review requests for the next intersessional period have already been received.

Progress was also made on the provision of advice to the Commission on the status of stocks (Item 11.5) and a workplan and several ICGs have been developed (Item 11.8). Amendments to the description of categories for abundance estimates were agreed upon (Item 11.3.1), and an ICG will complete supplementary wording and examples intersessionally (Item 11.8).

In 2019, the Committee agreed that work required to: (a) address issues related to the estimation of $g(0)$; and (b) develop robust estimates of abundance for North Pacific minke whales, be referred to an intersessional correspondence group under ASI (IWC, 2020g). This year, the Committee transferred this ICG to the IA sub-committee and looks forward to reviewing progress next year.

In 2020, the Committee recommended consideration of incorporating two or more independent abundance estimates for the same year in a management procedure calculation (IWC, 2021c, item 11.1.2). This question was motivated by the case of Bering-Chukchi-Beaufort Seas bowhead whales, where the Committee has endorsed two completely independent estimates of abundance for 2019 (SC/68D/ASI/01 and Givens *et al.*, 2021). One comes from a spring ice-based visual survey near Utqiaġvik. The other comes from a summer aerial survey across the Beaufort Sea. Both are endorsed as category 1A. It is not obvious that either estimate is clearly superior to the other. The Committee agrees that this is primarily a matter for the IST sub-committee. However, ASI believed that if estimates are independent, they should all be incorporated into the calculation for management. Specifically, in such cases, ASI supported the strategy of incorporating both estimates into AWMP/RMP calculations, either directly, or by using an inverse-variance weighted average of the individual estimates to produce a single number if the management procedure requires that. The Committee endorses this view and referred the matter to the IST sub-committee.

Table 19

Workplan for the review of abundance estimates and provision of advice to the Commission on status of stocks for the period 2022-2024.

Item	Topic	Intersessional	Next meeting	Intersessional	Subsequent meeting	Agenda Item
1	Review of Abundance Estimates	ASG to coordinate the review of the abundance estimates as requested by SC sub-group Convenors	Review abundance estimates following the ASG/ASI process	ASG to coordinate the review of the abundance estimates as requested by SC sub-group Convenors	Review abundance estimates following the ASG/ASI process	11.1
2	Update the IWC Table of Accepted Abundance Estimates	Update the table with estimates accepted at SC68D and receive any intersessional revisions to past entries for consideration by the next meeting (Katara)	Review progress and endorse intersessional revisions	Update the table with estimates accepted at the next meeting and receive any intersessional revisions to past entries for consideration by the meeting in 2024 (Katara)	Review progress and endorse intersessional revisions	11.2
3	Abundance Review Process	ICG will develop supplemental wording and examples explaining the choice of categories for endorsed abundance estimates	Review progress and endorse new wording			11.3
4	Franciscana Abundance Review	ICG will continue coordination of the review of estimates of franciscana abundance to complete the review of the status of the species by the next SC meeting.	Review ICG report and complete the review of franciscana abundance estimates			11.1.13
5	Develop simulation software to evaluate methods for abundance estimates.	Finish development of software to make the code user friendly and functioning on modern Windows computers, and to make the code accessible via GitHub (Palka and Smith)	Review progress			11.4.2
6	Consider matters related to mark-recapture models for abundance estimation	ASI establish an ICG, and ICG to begin work	Review progress	ICG continue work	Review progress	11.4.3
7	Provide Commission with advice on status of stocks	Develop content for the Status of Stocks Website	Review progress and endorse content for any stocks completed	Develop content for the Status of Stocks Website	Review progress and endorse content for any stocks completed	11.5
8	Host a three-day pre-meeting for the Abundance Steering Group	Make preliminary recommendations to ASI on papers reviewed by ASG inter-sessionally, and develop content for the Status of Stocks Website in collaboration with ICGs	Host pre-meeting	Make preliminary recommendations to ASI on papers reviewed by ASG intersessionally, and develop content for the Status of Stocks Website in collaboration with ICGs	Host pre-meeting	11.1 and 11.5

In 2019, the Committee recommended the development of RMP guidelines for model-based abundance estimates (IWC, 2020b, item 12.2.3). Intersessionally, responsibility for this task was transferred from ASI to the IST sub-committee.

11.8 Biennial workplan

The Committee agrees to the workplan provided in Table 19. Intersessional email groups for 2022-23 are provided in Annex M. Two intersessional email groups from 2021-22 (IWC, 2022a, item 11.6) continue their work but have been transferred to other Committee subgroups as noted in Item 11.7.

12. BYCATCH AND ENTANGLEMENTS

12.1 IWC's Bycatch Mitigation Initiative

Lent provided an overview of progress on the IWC's Bycatch Mitigation Initiative (BMI), which is summarised in SC/68D/HIM/09. Marguerite Tarzia, who had fulfilled the role of Bycatch Coordinator from January 2018 onward, left the role in January 2022, and the IWC Secretariat is currently in the process of recruiting a replacement. In the meantime, IWC Secretariat staff and the BMI Expert Panel on Bycatch are maintaining momentum on a number of core elements of the BMI.

The Bycatch Mitigation Initiative's (BMI) new four-year workplan (2020-24) was endorsed by the Conservation Committee in October 2020 and is now being implemented. In 2021-22 the focus has been on the following ongoing activities:

- The IWC Secretariat has been contracted by the FAO to develop a series of factsheets to summarise and illustrate the most important elements of the FAO Technical Guidelines to prevent and reduce bycatch of marine mammals in capture fisheries (FAO, 2021)[25]. These factsheets are intended to improve awareness and uptake of the guidelines among a wide range of stakeholders responsible for fisheries management. The factsheets will be developed in collaboration with the BMI Expert Panel and should be completed by September 2022.
- The IWC Secretariat will be a formal partner in the Global Environment Facility, the Common Oceans Areas Beyond National Jurisdiction project, which is due to begin in June 2022. The project will provide funding to the Secretariat over four years to undertake a gap analysis, a spatial bycatch risk assessment and address other information gaps related to cetacean bycatch in tuna fisheries. It also aims to address the mitigation of cetacean bycatch by working collaboratively with Regional Fisheries Management Organisations (RFMOs), national governments, experts and the fishing industry to raise awareness of practical solutions.
- The Terms of Reference for the Expert Panel were updated, reviewed and agreed by the SWG in September 2021, including a procedure for rolling over membership for existing panel members willing to serve another four-year term. The panel membership is currently being reviewed to fill expertise and geographical gaps.
- The IWC Secretariat is actively engaged in external fundraising, which will be essential for implementation of plans for capacity building and pilot projects. The Bycatch Coordinator will work with the Chair of the Bycatch SWG and the Chair of the VCF fund to consider applications to the VCF funding.
- The IWC BMI continues to progress planning for pilot projects. Seven different countries/locations have been prioritised for pilot project development: Peru, Republic of Congo, Kenya, Pakistan, India, Thailand, Malaysian and Indonesian Borneo. Each pilot project is particularly focused on small scale fisheries using gillnets, and proven, practical and novel approaches to monitoring, mitigating and managing bycatch. The focus during 2022 is to continue developing project concepts, applying for external funding, and beginning some activities with existing 'seed funding'.

The Committee expressed its thanks and appreciation for Tarzia's work on the BMI over the past four years. Of particular note was the support on proposal development for participants seeking funding for bycatch work (e.g. pilot projects, capacity building), as well as the truly interdisciplinary approach to monitoring and mitigating bycatch.

Participants expressed some concern that the envisaged programme of work is extremely comprehensive and far-reaching, and will require a team, rather than a single individual to coordinate and implement. The Committee agreed that fundraising for this programme of work to combat the most significant threat to cetacean populations should be prioritised, especially at a time when the Secretariat is affected by budget cuts. It therefore encouraged those who work in government bodies with a mandate to manage fisheries, cetaceans and bycatch to collaborate across ministries and/or agencies and mobilise and consolidate the necessary resources and expertise required to address this issue.

Participants also welcomed the planned factsheets, and hoped that they will become another product, like the IWC Whale Watching Handbook, that can bear the IWC logo and demonstrate the IWC's meaningful engagement in conservation initiatives.

12.2 Collaboration on bycatch mitigation with IGOs

12.2.1 IOTC and other RFMOs

Following the Committee endorsement of a strategy to engage RFMOs during SC68B (see SC/68B/HIM/05 and SC/68B/HIM/06), the IWC Secretariat has been actively pursuing collaboration with two of the tuna RFMOs prioritised in the strategy, the IOTC and the Pacific Community (SPC), which hosts the Bycatch Management Information System. Collaboration between the IWC and the IOTC is expected to be formalised through a Letter of Intent to be discussed at the IOTC Commission meeting in 2022.

12.2.2 CCAMLR

SC/68D/HIM/04 provided details of three entanglements of humpback whales (*Megaptera novaeangliae*) in the Antarctic krill trawl fishery. The accidental captures took place in CCAMLR management areas 48.1 and 48.2 between 27/01/2021 and 17/06/2021. They were documented by a CCAMLR Scientific Observer, appointed by the UK under the CCAMLR Scheme of International Scientific Observation. The vessel in question was a Norwegian registered factory trawler, fitted with trawl nets that use a suction system to continuously trawl for multiple days (e.g. 5-10), with the krill catch being continuously pumped to the ship through a hose connected to the cod end of the trawl. The nets are fitted with excluder devices that were designed to keep pinnipeds from entering the nets. In two of the three instances, humpback whales had somehow entered the net despite these seal excluders, and were dead and bloated by the time they were discovered, documented, and freed from the nets. These are the first reports of whale bycatch in this fishery.

SC-CAMLR seeks to better understand the reasons for these bycatch events and to mitigate them in the future. CCAMLR therefore requested the Committee to provide scientific feedback on these incidents and to nominate scientists to attend the SC-CAMLR working group 'Incidental Mortality Associated with Fishing' (IMAF) in October 2022 in Hobart.

[25] *https://www.fao.org/documents/card/en/c/cb2887en/.*

During discussion, several IWC SC participants, including veterinary pathologists, fishing gear specialists, and entanglement response specialists, expressed the opinion that it was highly unlikely that the whales entered the trawls after death. Reasons include: (1) whale carcasses float very soon after the time of death, and the trawls are towed mid-water (median depth 30-100m); (2) the probability of three whale carcasses becoming trapped in trawls in the same season seems unfeasibly small – and would require a very high density of carcasses in the area, which was not reported or observed by the vessel in question; (3) by contrast, whales were seen following trawls, and thus appear to be interested in engaging with the deployed gear, increasing the likelihood that animals tried to enter the trawls in search of prey. In addition, the reported lengths of the entangled whales (7-10m) are consistent with the lengths of dependent, or newly independent calves of the year (Clapham *et al.*, 1999). Juvenile humpback whales have been shown in other studies to demonstrate higher levels of 'curiosity' and to be more likely to interact with fishing gear than mature adults.

An intersessional group was formed to further consider a number of issues with the terms of reference to provide further advice on the following.

(1) Understanding likely causes of trawl – whale interactions.
   (a) What factors likely contributed to the incidents (spatial, temporal, operational, behavioural factors of both whales and vessels)?
   (b) How should future incidents be investigated and what information should be recorded (e.g. documenting incidents and specimens, biological sampling, crew and/or observer roles)?
   (c) Routine data collection to put bycatch incidents into context (e.g. whale sightings, net monitoring devices).
(2) Considerations for developing effective mitigation, including:
   (a) vessel actions such as avoidance of whales;
   (b) technologies such as exclusion devices; and
   (c) management measures such as move-on rules.

The group will also nominate participants to attend the CCAMLR IMAF meeting on behalf of the Committee. Members include: Parker, Favero and Walker (CCAMLR), Biuw, Hines, Söffker, Heinemann, Stimmelmayr, Landry, S. Reeves, Mattila, Meyer, Johnson and Leaper (HIM Convenor).

12.3 Review of new methods and estimates of bycatch and entanglement rates, risks, and mortality

Wade *et al.* (2021) was developed by the Ocean Modeling Forum's Marine Mammal Bycatch Working Group to address gaps in the available resources available for managers and fisheries scientists wishing to ensure that their fisheries comply with the United States Marine Mammal Protection Act Import Provision regulation (NOAA, 2016). This paper provides a road map, including decision trees and diagrams that clearly present each phase of marine mammal bycatch assessment and management, ranging from planning, to data collection, to risk assessment, and selection of appropriate management actions.

Moore (2021) provided more In-depth guidance on methods to estimate bycatch mortality, introducing concepts such as bycatch per unit of effort, bycatch mortality rates, and total fishing effort with descriptions of methods to calculate or estimate these parameters. This paper is intended to be accessible to managers and fisheries scientists without previous cetacean research experience. It includes flowcharts and an analysis of the strengths and weakness of different bycatch monitoring methods, ranging from observer schemes to self-reporting (including interviews with fishers), and electronic monitoring.

Course (2021) is intended to provide managers within the ASCOBANS area with information regarding methods to monitor fisheries and fisheries bycatch. The report includes descriptions of different monitoring techniques, including VMS, AIS, Fishing Activity Sensors, E-logs, CCTV, remote electronic monitoring (REM), and self-reporting. Several case studies are described that examine how these different methods have been implemented in various European fisheries. Following a comparison of these case studies, and analysis of costs vs. benefits, the author concludes that given the current state of REM technology, a combination of REM with on-board observers can provide an ideal combination for the most accurate and cost-effective fisheries monitoring.

In discussion, participants noted that the proportion of the fleet to be monitored by on-board observers where lower-cost REM is used (or mandated) in order to 'ground truth' REM observations will be dependent on the fishery and the cetacean species that interact with it. While onboard observers may detect 'drop outs' of cetacean bycatch that fall out of a net before it is hauled into the view of an REM camera, REM video, which may include multiple cameras, can be reviewed by multiple observers and may be more reliable at detecting bycatch incidents than human observers in some instances.

Attention: S, R, ASCOBANS
The Committee welcomed the resources shared by the Ocean Modeling Forum's Marine Mammal Bycatch Working Group and ASCOBANS, and applauded their value in providing managers with accessible, but scientifically rigorous tools for bycatch monitoring, and management. The Committee ***recommends*** *that these resources be used by the IWC BMI in future capacity building work, and that where possible the IWC, the Ocean Modeling Forum, and ASCOBANS seek opportunities for synergy and/or collaboration in fundraising for and implementation of capacity building activities.*

12.4 Reporting of bycatch and entanglements (both small and large cetaceans) including National Progress Reports

A summary of the entries into the Progress Reports database for the past year with respect to bycatch and ship strikes is available as Annexes H and I.

SC/68D/SM/16 presented recently collected data on bycatch of Australian snubfin dolphins (*Orcaella heinsonii*) in the Kikori Delta of Papua New Guinea. Dolphins are caught in large mesh (5-7 inch) gillnets that are increasingly targeting fish for a newly emerging market in swim bladders. Fisheries interviews and reports from community dolphin monitors indicate that 3-4 snubfin dolphins per month are bycaught in a small population. Fishers in the area use dolphins to help locate fish, and intentionally set nets in close proximity to them, but are very keen to reduce entanglements. Fishers have themselves suggested reducing soak times so that they would be more likely to detect entangled dolphins before they die, and would almost certainly be open to training and/or resources on safe and humane handling and release techniques (e.g. Hamer and Minton, 2020). The authors would also welcome guidance and support from the IWC SC and the IWC BMI on ways to engage local fishing communities, as local land use rights will necessitate a 'bottom-up' approach, rather than a top-down approach.

It was suggested that the authors consider collaborating with the Consortium for the Conservation of the Atlantic Humpback Dolphin (CCAHD)[26], an organisation that is also trying to work with range-country NGOs and other stakeholders to raise awareness of and reduce bycatch in small-scale artisanal fisheries.

12.5 Review mitigation measures for preventing bycatch and entanglement

(Pace *et al.*, 2021) describes methods to examine the proportion of deaths of North Atlantic right whales that were detected as carcasses vs the estimated true levels of mortality in the population. This follows similar work to estimate cryptic mortality in other areas (e.g. Williams *et al.*, 2011). Based on a population model it was estimated that observed carcasses accounted for only 36% of all estimated North Atlantic right whale deaths during 1990-2017. Entanglement accounted for 87% of serious injuries of whales that were observed but never seen again and assumed to have died, but was identified as the cause of death in only 49% of examined carcasses. This suggests a higher proportion of cryptic mortality due to entanglements compared to other sources.

The Committee welcomed this information and noted that this type of analysis was already being used in some US Stock Assessments. It was also noted that the North Atlantic right whale is particularly well studied with a large effort to detect and recover carcasses. Cryptic mortality in other cetacean populations may be much higher. It was recognised that the approach could help inform estimates of total mortality from bycatch or ships strikes elsewhere.

SC/68D/HIM/07 describes work in the US to develop 'ropeless' gear technology, which is becoming known as 'on-demand' gear technology. This technology reduces entanglement risk for not only North Atlantic right whales, but other species as well, and allows fishermen to avoid time/area closures for gear with static buoy lines by using alternative modes of deploying and retrieving trap/pot gear. To retrieve the gear without a traditional buoy line, fishers either use manual grapples, or a remote release mechanism that lifts gear from the ocean bottom to the surface for recovery using a pop-up buoy, inflatable lift bag, or a buoyant spool. Eliminating buoys requires alternative methods to locate fishing gear, and Long noted this geolocation aspect is probably the biggest hurdle to implementing ropeless in the US lobster/crab fisheries. The US is testing various geolocation approaches with developers and software experts. To facilitate trials, NOAA has curated a 'Gear Library', funded by the US government, several NGOs, and other collaborations, that allows users to borrow a system and provide feedback on gear operability and suggestions for improvement. Overall, 10 models of ropeless systems have been tested or are being developed for use in the northeast US.

The Committee welcomed this update on the progress being made in the USA with regard to this technology and members were pleased to hear that the 'ropeless roadmap' mentioned in the report should be available by the end of May 2022. In addition, the Committee applauded the development of the 'gear library'.

Attention: S, CG
It was noted that the IWC BMI had submitted a proposal to host a similar library of bycatch mitigation equipment, especially for use in developing countries, but the proposal was not funded. The sub-committee ***recommends*** *that the IWC continue to seek support for this initiative, as it would be useful to many countries.*

In discussion of grappling as a low-cost alternative to on demand systems, and whether this might encourage more floating loops of groundline, Long noted that sinking ground line is currently mandatory in some east coast fisheries and fishers in those areas still seem to be grappling successfully. In the USA it is not currently clear whether fishers will be subsidised to make the switch to on demand technology if it is mandated. It is most likely that the costs would be shared by fishers but supported by government subsidies.

Segre *et al.* (2022) focused on the inshore Bryde's whale population in South Africa, classified as Vulnerable on the national Red List. Recent changes in static gear fisheries resulted in a high rate of Bryde's whale entanglements. Between

[26] *https://www.sousateuszii.org/*

2014 and December 2021, 17 Bryde's whales were entangled in octopus and rock lobster gear, with at least 10 resulting fatalities, deemed to be an unsustainable level of mortality for the population. All entanglements occurred near the seafloor and likely while whales were feeding. Bio-logging tags were deployed on 12 inshore Bryde's whales revealing high-speed seafloor chases providing a likely explanation of how Bryde's whales encounter both the looped floating groundlines (connecting traps) and the vertical lines to surface buoys. In 2019, after three whales died, a temporary moratorium was placed on the octopus fishery, followed by a ruling that octopus gear must now include sinking groundlines, redesigned vertical lines, and acoustic or time release mechanisms. Grappling can be used to recover gear. Additionally, the fishery will be temporarily halted if there are two additional nonfatal entanglements of humpback or right whales, or a single entanglement of a Bryde's whale. The fishery will be permanently halted following a fatality from any of the three species.

Meyer noted that since November 2019, there have been no Bryde's whale entanglements in octopus fishing gear. It remains to be seen whether the regulations will be effective in reducing whale entanglement, and whether the government will allow the large-scale expansion of the octopus fishery.

The sub-committee thanked Meyer and co-authors and commended South Africa for its prompt identification of the problem, collection and analysis of data, and subsequent rapid initiation of what appear to be successful mitigation measures. While recognising that the interaction of cetaceans with ground lines between pots/traps will vary depending on species, fishery, and prey, some species including Bryde's and minke whales have been more frequently reported entangled in ground lines than vertical lines. The Committee agrees that switching to sinking ground lines appears to be a very useful tool in reducing large whale entanglement in appropriate circumstances.

Lee presented a summary of SC/68D/HIM/11. The Korean National Institute of Fishery Science (NIFS) set a five-year plan (beginning in 2022) to develop bycatch mitigation methods for five main fishing gears known to cause bycatch. These include stow nets, pots, gill nets, trawl and set nets. Except for the stow net, for which mitigation modifications are already being trialled (see below), each gear improvement process starts with a literature review, followed by the design of gear modifications and development of equipment during the first two years. The following three years are then dedicated to laboratory and field tests with at sea monitoring.

A project to modify stow nets to reduce bycatch of narrow-ridged finless porpoises in Korean waters of the Yellow sea was started in 2017 (SC/68D/HIM/12). In 2021, field tests were implemented comprising three groups: (1) control (gear without an escape hatch); (2) test groups with escape hatches; and (3) varying mesh sizes on the panels to guide porpoises out of the net. In total, 18 vessels participated in the monitoring for a combined total of 1,076 days. Three porpoises were bycaught from three different control group vessels and no bycatch occurred in either test group. A camera and sound recording system was installed to monitor whether the escape hatch was used by the porpoises. This showed large jelly fish species passing through the hatch, but no porpoises. However, acoustic recordings did indicate the presence of porpoises around the test net. In 2022, a further 11 vessels have joined the monitoring programme.

The Committee welcomed this information and commended Korea for these initiatives.

Guidino *et al.* (2022) describes the testing of pingers to determine their effectiveness in reducing bycatch of small cetaceans in a small-scale gillnet fishery targeting sharks, but also catching tuna, dolphinfish, and rays in northern Peru. Over a 16-month period, 60 trips were monitored, with 30 bycatch events involving pilot whales, common dolphins, and other unidentified delphinids. Bycatch of small cetaceans in experimental nets was reduced by 83% when compared to control nets. Pingers had no effect on the catch per unit of effort (CPUE) of fishes or rays. However, shark CPUE was 33% lower in experimental sets. The use of pingers had no effect on whale entanglement rates. With 16 observed entanglement events, humpback whales were the species that most commonly interacted with the fishery, and these incidents raise safety and economic concerns for the fishermen involved, who are interested in participating in bycatch mitigation efforts.

In response to a question about the cost and affordability of current pingers for artisanal fishers along the coast of Peru, Campbell noted that there would likely need to be subsides, or a significant cost reduction through mass production, or in-country manufacturing.

Attention: S, R, CG (Peru)
Given the fishers' expressed motivation to reduce whale interactions, the Committee ***recommends*** *further collaboration with the IWC BMI and the Expert Advisory Panel on Entanglement Response to design and trial effective mitigation measures, and further promote training on safe disentanglement practices.*

Read (2021) reviews bycatch mitigation measures (acoustic deterrent devices, porpoise alerting devices, reflective nets, acrylic echo enhancers, lights and various technical modifications and changes to fishing practices) that have been trialled in the ASCOBANS region. The report also reviews the options for alternative fishing methods (e.g. seine nets, jigging machines, longlines, fish pots and fish traps) to replace static nets. The costs of technical mitigation equipment and for changing to alternative gears were examined.

The Committee welcomes this review and noted that it should be added to the resources listed in 12.3 for use by the BMI when supporting individuals and countries seeking to understand and mitigate marine mammal bycatch.

SC/68D/HIM/02 also included an update on entanglements in the Scottish creel (pot/trap) fishery that the Committee had discussed in 2020 (SC/68B/HIM/02). Entanglements of minke and humpback whales were mainly reported in the floating ground lines between pots.

Attention: CG (United Kingdom), I, R
Given the apparent success of the South African initiative to switch to sinking ground lines in the octopus fishery, and following its previous recommendation that the work of the Scottish Entanglement Alliance should continue, the Committee ***recommends*** *trials using sinking ground line in Scottish creel fisheries.*

Macaulay *et al.* (2022) describes a passive acoustic monitoring (PAM) system for tracking the fine-scale three-dimensional movements of echolocating cetaceans around actively fishing nets by localising their acoustic clicks. The system can be deployed during normal fishing operations by a trained researcher or experienced fisheries observer. Tracks of harbour porpoise showed a variety of behaviours, including multiple instances of animals actively foraging in close proximity to the fishing net. The authors concluded that a relatively inexpensive passive acoustic monitoring system, which is practical to deploy from active fishing vessels, is capable of providing highly detailed data on harbour porpoise behaviour around nets.

The Committee thanked Macaulay for presenting this work and noted the importance of behavioural studies to understanding bycatch risk. The methods described have potential to inform a better understanding whether modifications to gillnets in an attempt to make them more visible to cetaceans, such as lights or acoustic reflectors, are likely to be effective. This could help potentially overcome some of the challenges of mitigation trials in obtaining sufficient sample sizes.

The IWC entanglement initiative coordinator noted that he and the Entanglement Expert Panel were convened to address responding to entangled large whales. However, requests for advice on releasing free-swimming, entangled, small cetaceans are almost as frequent as those for large whales. In most cases these requests have been forwarded to Dr Randall Wells, who has several decades of experience responding to free-swimming, entangled small cetaceans. The Committee agrees that a small group (Minton, Trujillo, Simmonds, Marmontel, Rennell, Aranha, Baird, Porter, Wells and Mattila (Convenor)) should work with Dr. Wells intersessionally to develop best practice protocols for releasing free-swimming, entangled small cetaceans that would complement the guidance for releasing bycaught small cetaceans developed by WWF and CMS, and endorsed by the Scientific Committee (Hamer and Minton, 2020).

This group should take into consideration:

(1) variation in species response to both entanglement and human intervention;
(2) cultural and/or governmental perspectives and regulations;
(3) proper care for positive biological and welfare outcomes, through consultation with knowledgeable veterinarians;
(4) data collection for understanding and improving both short term and long-term success; and
(5) consideration of plausible actions for moribund entangled individuals.

The Committee looks forward to reviewing the protocols at next year's meeting.

12.6 Review studies examining the implications of effort reductions on cetacean bycatch, fisheries economics and yields

Myers and Moore (2020) examined the inshore and offshore trap fishery for American lobster (*Homarus americanus*) in Northeastern U.S. and Canadian waters. The U.S. lobster fishery in Maine expends approximately 7.5 times as much effort as the equivalent Canadian fishery which has much higher lobster catches per trap than their counterparts in Maine. From 2007 to 2013 the number of traps deployed in Maine decreased but landings per trap increased with a doubling in total lobster landings. In the state of Massachusetts record high landings have been achieved since trap/pot seasonal closures have been implemented to protect right whales, especially within the Statistical Reporting Areas most affected by the closures. The authors conclude that a negative economic impact should not be assumed with effort reduction. In fact, reducing effort may serve to increase fishing profits while supporting the protection of endangered North Atlantic right whales and the long-term sustainability of the lobster fishery.

The Committee thanked Myers for presenting this work, noted that effort reduction was often the most effective way to reduce bycatch, and emphasised the importance of inter-disciplinary and multi-disciplinary research in finding solutions to reduce bycatch risks. In discussion it was noted that in some areas, pot limitation schemes have been proposed by the fishers themselves, but this is often a contentious issue, and many fishers oppose regulation and effort restrictions. In some fisheries there is clear evidence that longer nets or more gear are not efficient, but it has often not been possible to convince fishers of this. There are many reasons why individual fishers may deploy more gear than is optimal from an economic perspective. This includes setting gear to maintain access to fishing grounds and the lack of perceived benefit for fishers who reduce effort unilaterally. Myers noted that the fisheries data used in Myers and Moore (2020) were publicly available and the Committee encouraged similar economic studies in other areas for fisheries where there is a high bycatch concern.

12.7 Review of topics related to Hectors and Māui dolphins in New Zealand

In 2019, the Committee recommended a detailed independent review of a 'Spatial risk assessment of threats to Hector's and Māui dolphins' (Roberts *et al.*, 2019) with respect to this document's use for informing management measures to address anthropogenic threats to Hector's and Māui dolphins off New Zealand. Five specific topics were identified in 2021 for the risk assessment review based on discussions within the Committee. Each of these would form the subject of short review papers by independent experts with the appropriate background which will be reviewed at a dedicated workshop. Funding issues limited intersessional progress, but Lundquist announced that New Zealand intends to provide funding to complete the agreed review process.

The Committee welcomes this news, and thanked Lundquist and the Government of New Zealand. The Steering Committee established in 2021 to guide this process, chaired by Staniland was re-established to approach independent experts and organise the workshop. The terms of reference for the review and criteria for independent experts will remain the same as agreed in 2021 (IWC, 2021c, item 12.8.1). However, Lundquist noted that the additional fishing effort data (IWC, 2021c, table 11, item 5.4) would not be available and so it would not be possible to address task 5.4.

Attention: SC-HIM, SM; CG-New Zealand

Between 2021 and 2021, the Committee has made a number of recommendations related to management measures to protect populations of Hector's and Māui dolphins (Annex P).

*In 2021 the Committee **recommends** a process for the review of the information and analysis presented in (Roberts et al., 2019), including a list of topics for solicited review papers (see IWC, 2021c, table 11), The Committee also recommended a pre-meeting to:*

(1) *evaluate the design and structure of the multi-threat risk assessment model;*
(2) *evaluate the overall sensitivity to model choices, data selection, uncertainties or potential biases identified in the review papers; and*
(3) *make recommendations to reduce key uncertainties and improve the utility of the model to inform management decisions.*

*The Committee **reiterates** its recommendation for the process of review, **agrees** that this shall now proceed in 2022-23 and **requests** that a report on its results be presented at the next meeting of the Scientific Committee.*

12.8 Consider definition of R_{max} for small cetaceans for use by the Scientific Committee (joint with IST)

In the context of reviewing the spatial risk assessment of threats to Hector's and Māui dolphins in New Zealand waters (Roberts *et al.*, 2019), in 2020 (IWC, 2021c) the Committee formed an Intersessional Correspondence Group to provide a working definition for the population model parameter R_{max} that would help with developing and evaluating population models for small cetaceans.

The tasks of the Intersessional Correspondence Group (chaired ably by Wilberg) were clarified in 2021 (IWC, 2022a) as:

(1) develop a definition for the population parameter R_{max}, and conduct a review of approaches for estimating R_{max} with their data requirements, strengths, and weaknesses; and
(2) conduct a review of the estimation and use of R_{max} in the risk assessment for Hector's and Māui dolphins.

The primary focus of the intersessional work was on the definition of $R_{max.}$ The text below is largely based upon the report of the Intersessional Correspondence Group but incorporates discussion made at the 2022 virtual meeting of the Scientific Committee. The Committee noted that consideration of the specific issues surrounding Hector's and Māui dolphins would be dealt with by an independent review being sponsored by the Government of New Zealand as first discussed in 2019 (see Item 12.7).

R_{max} is an important parameter in many population models, including those for small cetaceans. This parameter is key to understanding diverse problems including risk to populations of anthropogenic stressors, success of invasive species and responses of populations under harvest. In the context of risk assessments for small cetaceans, the time needed for recovery of endangered species is intimately linked to the intrinsic rate of population increase (Fagan *et al.*, 2010). R_{max} is often used in calculations which attempt to estimate sustainable levels of human-caused mortality. The symbol R_{max} and its variants sometimes have fundamentally different meanings in sub-disciplines of ecology, stemming in part from inconsistent terminology for quantifying aspects of population growth rate. That complication, coupled with a variety of different approaches for estimating different measures of population growth rate from empirical data, have confounded consistency in the way R_{max} has been used in the literature (see (Fagan *et al.*, 2010) for examples and discussion).

After discussion, the Committee adopted the following definition developed by the Working Group:

> *R_{max} is a theoretical concept represented by a population model parameter that describes the per capita population growth rate at low population size (specifically, at a population level where neither depensatory nor compensatory density dependence is occurring). R_{max} describes the upper limit for the per capita population growth rate in deterministic models, and the average maximum per capita growth rate in stochastic models.*

In adopting this working definition, the Committee noted that there are several caveats surrounding the estimation and use of R_{max}, some of which are listed below.

(1) Only in a severely depleted population will competition for resources be at a minimum, and the rate of population growth at a maximum (assuming monotonic density dependence). Therefore, direct observations of populations that are growing at R_{max} are rare.
(2) With all approaches for estimating R_{max}, there needs to be consideration of uncertainty. The extent of uncertainty will differ depending on characteristics of the data and the method of estimation. How the estimated uncertainty in R_{max} is used will depend on the specific purpose of the modelling effort.
(3) Methods for estimating R_{max} have different levels of accuracy and robustness. Care must be taken in simply using estimates or methods from the literature.
(4) Values for juvenile (and neonatal) mortality are frequently highly uncertain; these can have a substantial influence on R_{max}.
(5) Because a population will only grow at a rate of R_{max} at low population size, there is a potential for Allee effects (depensation) to complicate inference.
(6) R_{max} is influenced by the species and its habitat. Because of this interaction, the effect of the environment on R_{max} is an important consideration.
(7) Sources of human caused mortality including cryptic mortality should be considered when estimating R_{max} because failure to take human caused mortality into account will lead to biased estimates of R_{max}.

The Committee noted that the Intersessional Correspondence Group has begun compiling a list of potential methods for estimating/setting R_{max}:

(1) use of empirical estimates of observed rates of per capita population increases when the population is sufficiently low to be considered unaffected by density dependence;
(2) simulation-based approaches using individual-based models;
(3) calculation based on the Lotka equation/Leslie matrix model-based approaches;
(4) estimation using a population model fitted to data that include estimates of abundance and removals; and
(5) application of allometric/life history relationships that have been developed using meta-analyses. To date, this approach has been used to provide values for R_{max} for species/stocks where direct estimates from the methods listed above are not available, i.e. this approach can be used to provide a value of R_{max} in data limited situations.

Attention: SC
The Committee thanked the Intersessional Correspondence Group for its work and ***agrees:***

(1) *to adopt the following definition of R_{max}*

R_{max} is a theoretical concept represented by a population model parameter that describes the per capita population growth rate at low population size (specifically, at a population level where neither depensatory nor compensatory density dependence is occurring). R_{max} describes the upper limit for the per capita population growth rate in deterministic models, and the average maximum per capita growth rate in stochastic models

(2) *that the Intersessional Correspondence Group should continue its work on potential methods for estimating/setting R_{max} and to provide data requirements, strengths, and weaknesses of each approach with the goal of providing a review for the next SC meeting.*

12.9 Progress on previous recommendations

SC/68D/HIM/02 provided an update on bycatch issues in Europe including the European Commission's infringement proceedings for cetacean bycatch monitoring and mitigation failings, and other regulatory and policy measures within the EU which aim to improve bycatch measures. Updates were provided for the Baltic, Bay of Biscay, Mediterranean, Black Sea and UK waters. Population level impacts resulting from bycatch have been identified in each of these regions.

The Committee thanked Dolman for presenting the review. In discussion, it was noted that a number of European countries had not established adequate bycatch measures and had been subject to infringement proceedings by the European Commission. However, it was unclear why such proceedings had just been taken against the Netherlands in 2022.

SC/68D/HIM/01 describes progress on the proposal for Coordinated Development and Implementation of Best Practice in Bycatch Reduction in the North Atlantic Region (CIBBRiNA) which has been submitted to the European Union LIFE programme. The project aims to contribute to several treaty and EU objectives in minimising, and where possible eliminating, incidental bycatch of endangered, threatened and protected species of marine mammals, birds, turtles and elasmobranchs. One of the most important objectives is to achieve successful cross-sectoral cooperation between fishers, regulatory authorities, researchers and other key stakeholders, both within and between countries. It had been hoped that a decision on funding would have been made by the time of the end of the meeting, in which case the Committee could

have provided advice on implementation options dependent on the amount of funding awarded. However, no decision of funding had been taken. The Committee reiterated its support for the proposal noting that it would address several aspects of recommendations made in 2020 (SC20113).

12.9.1 Harbour porpoise bycatch in Europe (joint with SM)

The Committee has repeatedly stated its serious concern for the survival of the Critically Endangered Baltic Proper harbour porpoise subpopulation. This subpopulation is genetically and morphologically discrete and numbers only a few hundred individuals. The Committee has also noted that climate change is now likely to be exacerbating this situation (SC/68D/REP/01).

SC/68D/HIM/05 evaluates the response of relevant EU member states to the ICES advice regarding measures to minimise bycatch of the Baltic Proper subpopulation of harbour porpoise. In February 2022, a Delegated Act under the EU Technical Measures Framework came into effect, closing static net fisheries in some Natura 2000 areas and other areas deemed as important for the Baltic Proper harbour porpoise.

The Committee welcomed this Act as an important first step toward protecting harbour porpoises, but noted that it falls short of the complete ban on static nets or the alternative measure to mandate pingers on all static gear in Baltic harbour porpoise habitat, that was recommended by ICES. The Baltic Sea Regional Fisheries Body (BALTFISH) has proposed dynamic closures in response to reports of porpoise presence as an alternative to gear bans and pingers. However, the Committee considered that this approach is unlikely to reduce bycatch for a number of reasons: (i) there is a lack of evidence of similar approaches being effective in other areas; (ii) there are practical and logistical barriers to effectively detecting this inconspicuous species; and (iii) it seems unlikely that it will be possible to effectively communicate detections to fisheries in the area and establish logical geographical and temporal boundaries within which fishing activities would be curtailed in relation to detected porpoises.

The Committee also discussed the apparent impasse with regards to the deployment of pingers in the region due to concerns that pingers could interfere with military operations. Letters were sent by the IWC Secretariat to the relevant contacts in Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Sweden, Poland, Russia, and the EU Commissioner. However, the IWC has thus far been unable to obtain a satisfactory technical explanation of what aspects of pinger operation are considered a security risk, and whether design modifications would adequately address any security risks. It was noted that seal scarers currently used in coastal aquaculture operations emit much louder, higher frequency sounds, but do not appear to be considered a problem for the military. Given current military developments in the region, it may not be realistic to expect to advance this issue in the immediate future, and the Committee sees a clear need for alternative measures for bycatch mitigation in the entire population range.

Attention: CG (Baltic Sea range states), R, European Commission, S

In light of the new information and discussions, the Committee:

(1) ***reiterates*** *its previous recommendation (SC2097) that, as a matter of urgency, all Baltic Sea range states should act immediately to implement long-term bycatch mitigation measures for the Baltic Proper harbour porpoise until subpopulation recovery is achieved. In lieu of large-scale implementation of pingers in static net fisheries in the Baltic Proper, further closures of fisheries with high bycatch risk, primarily static net fisheries, should be urgently implemented;*

(2) ***encourages*** *countries whose military forces cannot accept large-scale use of pingers to fully investigate the potential effect of pingers on military underwater acoustic activities as well as possible technical adaptations to pingers to minimise such effects. The Committee is ready to offer technical advice as required and has established an intersessional group to facilitate this; and*

(3) *requests the IWC Executive Secretary to maintain the ongoing dialogue with the range states and the EU Commission by writing to inform them of the Committee's ongoing concerns and recommendations.*

The Committee also ***reiterates*** *the following from its recommendations made in 2021:*

(4) ***encourages*** *further research into stranded and/or bycaught porpoises to investigate all factors negatively impacting the subpopulation, including chemical and noise pollution and prey depletion;*

(5) ***encourages*** *again the Baltic Sea range states to propose the Baltic Sea harbour porpoise subpopulation for listing on CMS Appendix 1 at the earliest opportunity and calls on CMS Parties to support this process; and*

(6) ***encourage****s all stakeholders to work expeditiously to increase public awareness of harbour porpoises and the challenges to their conservation*.

SC/68D/HIM/10 summarised a consolidation of different sources of information used to generate estimates of harbour porpoise bycatch in the waters of Portugal and Spain. Information sources included data from strandings and observer programmes collected between 1998 and 2019. Estimates of annual bycatch mortality rates ranged from 8.0-16.6% of an abundance estimate of roughly 2,900 individuals for the entire Iberian Peninsula.

SC/68D/HIM/14 provided further insight into bycatch mortality data compiled by stranding networks in Portugal and Galicia (Spain). The cause of death was evaluated in 364 out of 756 porpoises stranded between 2000 and 2020. Overall, in Portugal and Galicia, individuals stranded due to confirmed bycatch represented 47% of all analysed porpoises. Although detection of strandings has improved over time with the strengthening of reporting networks, the data indicate an increase in strandings, and an increase in bycatch-related mortality over time, with consistent stranding 'hotspots' in the north of Portugal, and the west coast of Galicia. The authors estimate that an annual average of 125 individuals was removed from Portuguese waters between 2011 and 2015. This number exceeds an estimate of PBR based on abundance estimates for that time period.

SC/68D/HIM/17 presents data from aerial surveys replicated annually over a 5-year period in the Portuguese coast. The overall porpoise abundance estimated between 2011 and 2015 (2254 individuals, CV=22% corrected for $g(0)$=0.364 from SCANS III) are low. The highest annual porpoise abundance were estimated in 2012 (2,995 individuals) and 2013 (3,207 individuals). Abundance and density estimates in 2014 were approximately half the values obtained in the previous year, and corresponded to a higher number of strandings detected in that year. Habitat suitability maps for the harbour porpoise in the study area (including the extent area in Galicia, Spain) emphasise the importance of coastal areas between Nazareì (central coast, Portugal) and the western coast of Galicia (Spain).

The Subcommittee **welcomed** these reports, and the efforts to collect bycatch data from strandings and observer schemes. It was noted that the 2011-15 abundance estimates upon which bycatch mortality rates and PBR are calculated, are based on a small number of sightings. Efforts to obtain new abundance estimates should be a high priority.

In response to concerns about this population, ASCOBANS has commissioned a study to investigate morphological and demographic parameters in the Iberian harbour porpoise, and to compare the Iberian population to porpoises in the North Sea and the Bay of Biscay. Knowledge of life-history traits can provide important inferences on population status. Life history data from stranded cetaceans can be used to estimate overall mortality and fishery mortality rates as well as provide baseline information required to monitor the status of a population. The results of the ASCOBANS study are expected to be ready by end of June 2023.

Spain's Ministry for Ecological Transition and Demographic Challenge has acted on previous IWC recommendations by conducting annual abundance surveys in habitat considered 'critical areas' for the species in spring and autumn, as well as assessments at 180 fish landing sites, complemented by 215 interviews with fishers to determine the nature of fisheries interactions with porpoises. The Ministry will also test different mitigation measures, including acoustic devices and gear modification. They also plan to conduct a mark-recapture study on bycaught carcasses that will be tagged so that they can be recognised if and when they strand onshore. Future work will be conducted in collaboration with Portuguese counterparts, with an aim toward creating a transboundary Natura 2000 MPA for harbour porpoises.

Sequeira informed the Committee that the Portuguese stranding network was reinforced in 2020 and the entire coastline is now covered by regional stranding networks. The collection of data on strandings (including biological sampling, necropsies and evaluation of bycatch) follows standardised protocols. She also reported that official contacts were already made between the Portuguese and Spanish authorities in order to start developing an action plan for the harbour porpoise. This action plan will address the bycatch problem and mitigation measures will be evaluated and implemented as a matter of urgency in the near future.

Attention: CG (Spain and Portugal), R

The Committee has previously noted that the level of bycatch of Iberian harbour porpoise is considered unsustainable and will consequently cause a population-level decline. The estimates of bycatch and abundance considered this year further reinforce this conclusion. The Committee also notes that the provisional threshold value for anthropogenic removals for this population put forward by the OSPAR Marine Mammal Expert Group is zero (ICES, 2021).

*The Committee therefore **recommends** immediate actions to effectively reduce, and where possible eliminate, bycatch of harbour porpoise throughout Iberian Peninsula waters. This will require close collaboration with the fisheries involved and may require a range of approaches, including: alternative technologies, protected areas with management plans to address bycatch (possibly including the establishment of zones with special regulations for gears posing a risk of bycatch), specific conservation plans for the species with associated mitigation measures, preventing illegal fishing, pingers, and/or other mitigation measures. Such measures are urgently needed for fisheries using gillnets and trammel nets but also for beach seines along the Portuguese coast which are used in some areas of high porpoise density.*

Vrooman *et al.* (2022) presented an assessment of a proposed initiative to begin satellite tagging harbour porpoises off the coast of the Netherlands. The report includes a review of best practice guidelines, different tags that can be used including their strengths and weaknesses in relation to the research questions being posed, and a consideration of the individual welfare of tagged porpoises. The authors advised a cautious start to tagging studies, focusing initially only on rehabilitated and released animals, then using the experience from these efforts to inform a possible wider programme with wild porpoises.

The Committee welcomed this review, including its attention to individual welfare concerns related to tagging. The Committee encouraged the team wherever possible to collect data on capture myopathy during the handling of animals during tagging operations. Questions were also raised about the criteria that would be applied during the first phase of the project to determine whether tagging should proceed with wild animals. These are still being defined and are likely to take into consideration welfare concerns as well as the utility of the data that are expected to be obtained.

12.9.2 Common dolphin bycatch in the Bay of Biscay

SC/68D/HIM/08 presented an analysis of common dolphin strandings and carcass detection in the Bay of Biscay in 2021. Common dolphin strandings between January and March 2021 appeared to be lower than during these same peak months in previous years. Drift modelling demonstrated that during this period, the area from which carcasses would have a stranding probability from 50-100% was about 35% of the area of the Bay of Biscay in January, 25% during the first half of February, 20% during the second half of February, and only 10% at the end of March. To account for the low stranding probability in March, the authors estimate the density of carcasses observed during aerial line-transect surveys using Distance sampling methodology. By combining this carcass density estimate with stranding estimates from January and February, the estimate of overall mortality of small delphinids in the Bay of Biscay in the winter of 2021 was approximately 6,800 individuals.

Rouby *et al.* (2022a) examined the population-level effects of fisheries bycatch on common dolphin in the Bay of Biscay through analysis of carcasses stranded between 1997 and 2019. Population viability was modelled based on age-at death derived from growth layer lines on cross-sectioned teeth (with a sample size of 642 individuals including both males and females) and sexual maturity derived from histology of dolphin gonads (with a sample size of 240 individuals - both male and females). Results indicate that survival has decreased over time, and that animals are reaching sexual maturity at an earlier age now than in 2002. These effects are both attributed to the pressure exerted on the population by high levels of bycatch mortality.

Rouby *et al.* (2022b) describes the application of regularised multilevel regression with post-stratification, to estimate total bycatch from non-representative samples of data reported by fisheries observers on mid-water pair trawlers in 10 ICES fisheries divisions between 2004 and 2020. A fine-scale analysis of bycatch risk, haul duration, and the number of hauls per days at sea, revealed that pair trawlers with long haul durations presented the highest bycatch risk, with risk increasing substantially in trawls longer than 3 hours.

In discussion, it was hypothesised that longer trawl duration is likely to be associated with the seabass and hake fisheries, which other studies have also linked to higher bycatch risk (Peltier *et al.*, 2021). However, it was noted that further research into the relative bycatch risks associated with fisheries targeting different species would be valuable.

The Committee noted that the bycatch levels of common dolphins in the Bay of Biscay did not decrease in the winter 2020-21 compared to previous years, suggesting that the limited mitigation measures currently in place (pingers on pelagic trawls), had no measurable effect in reducing the total bycatch of common dolphins. Additionally, the Committee noted that the estimates of vital rates (fecundity and survival) for the common dolphin population present in the Bay of Biscay indicated negative population growth (insufficient to ensure long term survival) that decreased over the period 2000-20.

Attention: CG, European Commission

The bycatch levels of common dolphins in the Bay of Biscay remain a concern. Therefore, the Committee reiterates and reinforces its previous concerns. The Committee ***recommend****s urgent action by the European Commission and relevant member states to implement the ICES (2020) advice that there should be a combination of temporal closures of all fishing métiers of concern and application of pingers on pair trawlers to mitigate bycatch outside of the period of closure. The research programs that are either on-going (CetAMBICion and DELMOGES), or awaiting final decision (CIBRRiNA), are extremely welcome as they would help refine long term management options, but should not be a reason to postpone immediate implementation of the management actions proposed by ICES.*

12.10 Biennial workplan

See Table 20.

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)

Following recommendations from the Committee at SC68B and also from the Conservation Committee, a dedicated Data Manager has been employed at the Secretariat since April 2021 to oversee further development of the ship strike database and acquisition of new data.

SC/68D/HIM/06 provided an update on progress on the ship strikes database. In addition to identifying areas of improvement for the different stages of data acquisition, entry, archiving and querying, the database manager has been receiving, assessing, and curating new reports. Currently there are a total of 1,154 cases in the database and 58 additional

Table 20

Workplan for bycatch and entanglements.

Topic	Intersessional	Next meeting	Intersessional	Subsequent meeting
Bycatch Mitigation Initiative		Review progress on the Bycatch Mitigation Initiative; aspects relevant to the Committee and requests for advice		Continue to review and provide input on pilot projects as required.
Rates and risks		Review new estimates of bycatch and entanglement rates, risks and mortality		Continue to review
Mitigation		Review new information on mitigation measures for preventing bycatch and entanglement		Continue to review
Bycatch and entanglement in critically endangered populations		Review new information on		Continue to review
Collaboration on bycatch mitigation	Continue to support Secretariat on collaboration with FAO, IOTC and others*	Continue to review	Continue collaboration with FAO, IOTC and others	Continue to review
Collaboration with CCAMLR on bycatch in Southern Ocean krill fishery	Intersessional group to provide advice and nominate SC representative for CCAMLR IMAF meeting (October 2022)	Review progress from intersessional group and any new information from CCAMLR	Continue collaboration on bycatch issues as required	Review progress
Collaboration with Baltic range states and European Commission on technical issues associated with acoustic interference of military activities by pingers	Intersessional group to provide advice as required.	Review any intersessional developments		
Reviews of topics related to spatial risk assessment for Hector's and Māui dolphins in New Zealand.	Steering Committee request review papers on each topic from independent experts. Hold pre-meeting review.	Complete review process		
Continue developing a list of potential methods for estimating/setting R_{max} and an evaluation of the data requirements, strengths, and weaknesses of each approach	Intersessional group under Wilberg	Review report from intersessional group		
Develop best practice protocols for releasing free-swimming, entangled small cetaceans	Intersessional group under Mattila	Review proposals from intersessional group		

*The Secretariat is also working on a number of initiatives related to collaboration (see Item 12.1).

new reports to assign to cases since April 2020. Of those new reports, approximately 45% are ready to be finalised, 10% lack enough data to move forward, and 35% need additional follow-up. The Secretariat has held discussions with relevant ship strike record data holders in the US and Australia to progress the agreed intention to share records that would significantly expand the records included in the database. Over the past year, there have been four requests for data, three of which were successfully fulfilled, and one of which involved an area for which no records were available. The Secretariat also worked with SC members from the Mediterranean to assist with data requests related to the proposal to designate a Particularly Sensitive Sea Area (PSSA) in the North-Western Mediterranean Sea (see Item 13.2). All National Progress Reports are examined for possible records but in most cases further follow up is needed to obtain more complete information. A number of proposed actions related to the improvement of reporting of ship strike incidents to the database are also included in the updated Draft Strategic Plan to Mitigate the Impacts of Ship Strikes on Cetacean Populations (SC/68D/HIM/03).

In discussion, it was noted that regional searches of publicly available sources (e.g. online archives of newspapers, trade journals, and other media) had resulted in a number of additional records that had not been previously identified (e.g. Peel *et al.*, 2018). Fortuna noted that her searches for the Mediterranean had also helped verify some records and provided additional information particularly from databases of vessel details. Accessing some of these sources in different languages might require a number of researchers with different language backgrounds and knowledge of primary data sources in different countries. The Secretariat can help facilitate sharing experiences of media searches to support these activities.

Attention: SC, R,G, CG
*The Committee **welcomes** this report of progress and commended the Secretariat for their work to maintain and improve the database. As an important tool for understanding the nature, scope and scale of ship strikes globally the Committee **recommends** that:*

(1) *the resources be made available to ensure that work to improve and expand the database continues;*
(2) *anyone with information on a ship strike continues to use the portal to submit a report; and*
(3) *The Secretariat and members of the Committee continue efforts to raise awareness among all relevant parties of the value of reporting ship strikes to the database.*

The Committee also agrees to maintain its Ship Strike Data Review Group.

13.2 Mitigation of ship strikes in high risk areas

Panigada summarised SC/68D/HIM/15 and SC/68D/HIM/16, which provided background information and updates on a preliminary proposal to designate a Particularly Sensitive Sea Area (PSSA) in the northwest Mediterranean Sea through the IMO (IMO, 2021). The objective of the proposal is to minimise the risk of ship strikes with cetaceans. A draft proposal, following the IMO guidelines, is currently under discussion and negotiation between France, Italy, Monaco and Spain and it is expected to be ready for stakeholders' meetings in May-June 2022. The final goal is to submit a PSSA proposal in time for consideration at IMO MEPC 79 in December 2022. The proposal will specify the boundaries of the PSSA and several tentative associated measures that are currently under discussion.

The conclusion of SC/68D/HIM/15 was that fin whale distribution is widespread and varies inter and intra-annually. This means it is not possible to establish permanent routing measures to reduce risks to fin whales. Sperm whales are more closely associated with permanent bathymetric features and there may be options to reduce risk through routing commercial traffic transiting parallel to depth contours further offshore away from steep slopes, but this may increase risk to fin whales and so it is not considered a viable option. For these reasons, the measures currently under consideration for the proposal focus predominantly on speed reductions in the presence of whales. Voluntary, as opposed to mandatory measures are considered more likely to be accepted in a short timeframe. In discussion, it was noted that AIS data could be used to monitor levels of cooperation with the voluntary measures that are put in place.

Panigada noted the challenges of applying speed reductions to the whole area that is proposed as a PSSA. One option being considered is that the measures will rely on an accurate system for alerting vessels to the presence of whales, and a practical working definition of the geographical and temporal boundaries to which speed restrictions would apply when whales are detected. These measures could draw on the experience from measures taken in North Atlantic Right Whale habitat off the northeast coast of the United States.

Attention: CG, I, SC
*The Committee **welcomes** the initiative from France, Italy, Monaco and Spain to implement ship strike mitigation measures within a proposed Particularly Sensitive Sea Area (PSSA) and **recommends** that action needs to be taken to reduce ship strike risks to the Mediterranean populations of fin and sperm whales. The Committee also recognises that, in line with its previous recommendations, since routing options do not seem to be possible in the area, the most effective way to reduce risk is through speed reductions. The Committee has established an intersessional group that is ready to help with technical advice related to assessing the expected risk reduction that might be achieved by the measures that are proposed. The Committee **recommends** that any measures that are implemented are fully monitored and evaluated in terms of the risk reduction that is expected to be achieved, including through the use of AIS data to assess levels of industry cooperation, and that measures can be adapted based on this.*

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

SC/68D/HIM/03 provides an update to the IWC Draft Strategic Plan to Mitigate the Impacts of Ship Strikes on Cetacean Populations, covering the period from 2022-32. The plan outlines seven updated objectives for the mitigation of ship strikes, as well as an update to the list of identified high risk areas along with the current status of research and mitigation efforts for each of these.

In discussion, it was suggested that the Strategy should also emphasise the importance of continuing efforts to identify new potential high risk areas, and offering technical support to stakeholders seeking to conduct the research or analyses required to identify areas of high risk in currently data poor areas.

The Committee noted its previous endorsement of the proposed structure for supporting IWC work on ship strikes outlined in SC/68B/HIM/13 (SC20120). It welcomed and endorsed the revised Strategic Plan (SC/68D/HIM/03) and agreed to maintain its Ship Routing Group to provide technical support to stakeholders seeking advice on assessing routing and other measures that may affect ship strike risks.

Attention: CG, SC, R
*The Committee **recommends** continued work to undertake the necessary research and analysis required to identify potential new high-risk areas.*

13.3 Cooperation with IMO Secretariat and relevant IMO committees

The IWC Secretariat and members of the Committee have continued to engage with the IMO Secretariat and attended IMO meetings (see SC/68D/O/03). Discussions have included how to progress efforts to reduce risks to blue whales off the coast of Sri Lanka (see Item 13.5.3). The IWC expects to take part in the IMO MEPC 79 meeting scheduled for December 2022 when the proposal for a PSSA in the NW Mediterranean may be discussed.

13.4 Review progress for obtaining Automated Information System (AIS) data

The IWC Secretariat reported that discussions to establish an MoU with Marine Traffic to facilitate data sharing have not progressed, but it is hoped that Marine Traffic will continue to be willing to respond to individual requests for data for work relevant to the Committee.

13.5 Progress on previous recommendations

SC/68D/HIM/13 summarises the WWF 'Protecting Blue Corridors' report, which uses satellite telemetry data collected over 30 years by over 50 research groups to map whale migration routes as well as feeding and breeding areas, and highlight potential overlap with human activities including shipping. Together with reports previously reviewed by the SC (Minton *et al.*, 2021; OceanMind *et al.*, 2020), this new report provides an outreach and communication tool for industry and government stakeholders responsible for managing shipping activities that helps identify areas of potential high risk of ship strikes.

The authors encouraged more engagement with the ongoing negotiations of the United Nations on a new treaty for the high seas (Areas Beyond National Jurisdiction). This is something the Secretariat is actively working on as a formal partner in the GEF, the Common Oceans ABNJ project (see Item 12.1).

In 2020, the Committee made recommendations regarding previously identified high-risk areas for ship strikes around the Canary Islands, Hellenic Trench and southern Sri Lanka (IWC Recommendations SC20116, SC20117, SC20118, SC20119). No new information was available from the Canary Islands, but Leaper provided updates for Hellenic Trench and southern Sri Lanka.

The Committee has been discussing the risk to the eastern sub-population of sperm whales in the Mediterranean from ship strikes in the Hellenic Trench for a number of years. In 2015 the Committee recommended that interested parties (including Greece, ACCOBAMS and the shipping industry) move forward with Greece in order to develop a proposal for routing measures. In 2021 the Greek authorities issued NAVTEX messages and updates of the pilot books to make mariners aware of the risk of ship strikes in the specific areas considered by the Committee. The Committee noted in 2021 that this was a welcome step forwards in terms of mariner awareness that provides a basis for potential adoption of voluntary measures by the industry.

In January 2022, the Mediterranean Shipping Company (MSC) announced that they would direct their vessels to avoid the areas that have been identified by the Committee. This company accounts for around 25% of the container fleet passing through the area west of the Peloponnese, although container ships are a relatively small proportion of the overall traffic compared to Ro-Ro vessels. The cruise division of MSC has also announced their vessels will avoid the area except for port calls where they will follow a route that crosses the shelf break as close as possible to perpendicular.

The Secretariat had written to the Government in Sri Lanka to follow up on previous correspondence regarding the ship strike risk to the Northern Indian Ocean blue whale population off the southern coast of Sri Lanka, but has not yet received a response. However, shipping industry organisations have been active in trying to follow up on SC recommendations. The World Shipping Council has been coordinating efforts within the shipping industry and has written to the Government of Sri Lanka with sign-on from industry bodies representing 90% of the shipping tonnage passing south of Sri Lanka. The industry organisations have requested an alternative routing scheme in line with the recommendations from the Committee to improve maritime safety and reduce the ship strike risk to blue whales.

The SC commended these industry-led initiatives to reduce ship strike risks to whales, which were directly inspired and supported by work of the Committee and IWC SSWG.

Attention: S, SC, ACCOBAMS
*The Committee **encourages** other companies to implement similar measures to those of MSC in the Hellenic Trench. It **encourages** the Secretariat, ACCOBAMS and members of the Committee to highlight these actions as evidence of the impact that the work of the Committee can have on the design and implementation of practical conservation measures.*

13.6 Biennial workplan

See Table 21.

Table 21

Workplan for ship strikes.

Topic	Intersessional	Next Meeting	Intersessional	Subsequent Meeting
Rates and risks	Continue ongoing work on database	Review new methods and estimates of rates of ship strikes, risk of ship strikes and mortality including progress on ship strike database		Continue to review
Mitigation		Review new information related to mitigation methods		Continue to review
Reducing risks to fin and sperm whale populations in the Mediterranean	Provide advice on NW Mediterranean PSSA proposal, either to the proponents, should that be requested, or as part of the process of evaluation by IMO. (Ship routing group/Expert Panel)			
Continued cooperation with IMO	Secretariat to maintain dialogue with IMO Secretariat. Attend relevant IMO meetings. Provide advice as required on any routeing proposals (Ship routing group/Expert Panel)	Review cooperation		Continue to review
Follow up on previous contacts offering IWC assistance regarding high risk areas	Secretariat to maintain contact with relevant authorities in identified high- risk areas	Review progress on identified high risk areas in IWC Ship Strike Strategic Plan		Continue to review

14. ENVIRONMENTAL CONCERNS (E)

14.1 Chemical pollution

14.1.1 Review intersessional work on Pollution 2025 (Report on Workshop on Cumulative Effects)

Holm presented the results of the intersessional workshop on cumulative effects and multiple stressors, conducted by the Pollution 2025 ICG online, in Nov 2021 (SC/68D/REP/02). The Workshop aimed to discuss new results and evaluate new methods and approaches for assessing the effects of stressors on cetaceans, both at the individual and at the population level. Additional aims were the identification of appropriate study designs and modelling approaches. Different types of conceptual frameworks that currently exist for integrating data of different sources and types and two conceptual frameworks were presented, as well as new methods, e.g. markers of toxicological pathways, 'omics' methods, biologging, telemetry, drones, epigenetic approaches. Several case studies from various species and geographic areas, each unique in its combination of occurring stressors were presented, e.g. the humpback whale sentinel program, the studies on the Deepwater Horizon Oil spill, the characterisation of multiple external stressors of landed Bering-Chukchi-Beaufort (BCB) bowhead whales, the progress of the Spanish project 'Transfers of Anthropogenic and Natural Stressors Involving Trophic Interactions of Ocean Nekton' (TRANSITION), the results of studies on harbour porpoises in the Baltic Sea, and an initial review on the magnitude and impacts of Per- and Polyfluoroalkyl Substance (PFAS) in stranded odontocetes in New Zealand waters. Models to assess, predict and manage population consequences of exposure to multiple effects, and a dynamic energy budget model were explored. In conclusion, the workshop encouraged the SC and wider Research Community to continue the investigation and improve the understanding, of the cumulative impacts of human activity-induced stressors on marine ecosystems. The workshop emphasised the value of an interface between science and policy to consider multiple sources of morbidity and mortality when developing conservation and management plans and address the geopolitical importance.

The Workshop recognised the importance of long-term monitoring studies, and made a series of detailed recommendations, including that vulnerable populations be monitored before stressors occur, including monitoring sub-lethal parameters, that opportunistic samples collected from vulnerable populations be archived, that uncertainty be incorporated into model frameworks, and that new 'omics' approaches be explored as a means of screening for biomarkers. The Workshop recommended the establishment of an international database and sample archive and requested that the Secretariat communicate with the Stockholm and Minamata Conventions regarding the inclusion of blubber as a core medium for long-term chemical monitoring.

A number of recommendations covered the threats to cetaceans from oil spills, including the need to identify areas of high risk and increase efforts on spill prevention, consider the impacts of oil response activities on the health of cetaceans, and identify means of cleaning oil spills without exacerbating conditions for cetaceans and other marine species. The Workshop drew the attention of the Commissioners to the report and strongly encouraged governments to implement preventative policies. The case study on Arctic monitoring highlighted the need to continue international engagement on debris tracing and prevention, and importance of the precautionary areas in the Bering Sea and Arctic waters.

The Workshop encouraged collaboration across the scientific community to identify shared methodologies for assessing the combined effects of multiple stressors and cumulative impacts from human activities and emphasised the importance of communication and cooperation across stakeholders to inform conservation and management plans.

The Committee welcomes the extensive report and thanked the workshop participants for their efforts. In discussion, it was noted that there are currently several different frameworks for integrating data from different sources and the Committee questioned who will decide which framework or combination of frameworks will be chosen as the standard procedure. Holm replied that several frameworks are developed by research groups in different countries and different populations and applied, which will allow comparison of different frameworks. The feasibility of a framework depends also on the available database. A flowchart approach was suggested as one means of indicating which approach should be used depending on type of data. These flowcharts are already supplied in some of the frameworks e.g. PCOD, PCOM. A comparison of the different approaches and how and when to apply them would need to be pulled together in a paper.

Attention: SC, CC, CG, C
*The Committee **welcomes** the report of the IWC Pollution 2025 Workshop (SC/68D/REP/02) and **endorses** its recommendations. It recognises the importance of understanding cumulative impacts of human-induced stressors on marine ecosystems.*

14.1.2 New information on pollution

SC/68D/E/01 reported on metal concentrations of three dolphin species incidentally caught in nets off South Africa. A comparative approach was used to examine a total of 36 trace elements from 76 muscle tissue samples using inductively coupled plasma mass spectrometry. The three species incidentally caught off the KwaZulu-Natal coastline included the Indian Ocean humpback dolphin (*Sousa plumbea, n*=36), Indo-Pacific bottlenose dolphin (*Tursiops aduncus; n*=32) and the Common dolphin (*Delphinus delphis*, *n*=8). Na, Sb, Sr, and Zn concentrations were significantly higher in *S. plumbea* compared to *T. aduncus*. There were significant differences for Cd, Fe, Se, U and V between all three species; in all cases, *S. plumbea* had the lowest concentrations, and *D. delphis* the highest. Of concern were the concentrations of mercury in all three species, which were generally higher than concentrations reported for similar species elsewhere. *S. plumbea* females were the only group that showed a decrease in mercury with length and mass, suggesting offloading of mercury to calves. These results present the only recent study on metals in cetaceans from South Africa and, together with very high organic pollutant concentrations documented for dolphins from the same location, show that there is a likely threat needing long-term monitoring.

Aznar-Alemany *et al.* (2019) presented information on halogenated and organophosphorus flame retardants in muscle tissue of three dolphin species (*Delphinus delphis*, *Sousa plumbea* and *Tursiops aduncus*) from the southwestern Indian Ocean collected between 2012 and 2015. While the level of some flame retardants were as high as in more industrialised areas, other man-made components were rarely detected or at very low concentrations. Data on flame retardants in biota and environmental samples from the southwestern Indian Ocean are scarce and, as a result, comparisons are difficult. However, data from other marine predators in the region, such as penguins, suggest that further studies are needed to determine if these concentrations are the consequence of a high local contamination or widespread throughout the Indian Ocean.

The Committee thanked the authors for their work. In discussion, the Committee considered potential sources of these pollutants and whether they were linked to agricultural or industrial activities. The authors pointed out that mercury levels were particularly high in comparison to other areas. The Committee also noted the linkage to the One Health initiative, particularly in cases of human consumption of stranded animals.

Attention: SC, CG, CC, C
*The Committee notes with concern the high levels of some flame retardants reported for several populations of dolphins in South Africa and the western Indian Ocean and **encourages** the relevant authorities to support systematic monitoring of pollutants and additional research to identify and mitigate the sources of pollutants.*

Van den Heuvel-Greve *et al.* (2021) studied the transfer of organic contaminants in harbour porpoises from the southern North Sea. Using samples from individuals of all maturity classes and both sexes stranded along the southern North Sea (*n*=121), the authors demonstrated generational transfer of PCBs, PBDEs and HCB from adults to foetuses. Lower halogenated and more toxic contaminants appeared to be readily transferred to calves, exposing them to high levels of contaminants early in life. Among animals included in the study, 38.5% had PCB concentrations exceeding a threshold level for assumed negative health effects (9mg/kg lw). This was particularly true for adult males (92.3%), while adult females had relatively low PCB levels (10.5%) due to maternal offloading. Nutritional stress led to higher offloading in the milk, causing a greater potential for toxicity in calves of nutritionally stressed females. No correlation between PCB concentration and parasite infestation was detected, although the probability of a porpoise dying due to infectious disease or debilitation increased with increasing PCB concentrations, which again points to the risk of cumulative effects.

The Committee welcomed this information and noted the importance of including this new information in the Contaminant Mapping Tool. In discussion, it was noted that information on the potential impacts on reproductive function of organochlorine pollutants in males would be valuable. The Committee also noted the difficulties of comparing concentrations of organochlorine pollutants across studies, due to differences in the congeners analysed and the parameters reported.

14.2 Diseases of concern

14.2.1 Review progress in intersessional work on emerging diseases

Stimmelmayr presented an update on intersessional work on cetacean diseases of concern (CDoC), noting that Morbillivirus (CeMV), Herpes virus, *Brucella ceti*, and *Toxoplasma gondii* have been identified as major diseases of concern for cetaceans. Relevant publications on these topics that had been published in the past two years were highlighted to address outstanding knowledge gaps identified during the previous special focus sessions and provide new details on the pathogens, host susceptibility, pathology and epidemiology.

The Committee welcomes this update and the summary of available new information.

14.2.2 Special primer on coronavirus surveillance in aquatic wildlife

In response to the ongoing global COVID-19 pandemic and the increasing evidence for spillbacks into various terrestrial and a few aquatic animal species the Committee convened a focus session on SARS-CoV-2. Presentations by several experts from various disciplines including virology (Dr. Hon, IP), veterinary medicine (Drs. Martha Delaney, Sandro Mazzariol, Keith Hamilton, Teri Rowles) and marine biology (Dr. Sarah Wilkins) on the current state of knowledge regarding SARS-CoV-2 infection in animals were given, with a special focus on marine mammals and ongoing/future regional surveillance efforts for aquatic wildlife.

Coronaviruses are a group of enveloped viruses with a positive-sense single-stranded RNA genome. Most mammalian coronaviruses belong to the genera of alpha or beta-coronaviruses with mainly respiratory or gastrointestinal tropism and disease presentation. SARS-CoV-2 (beta-coronavirus group) has a very broad tissue tropism with diverse clinical presentation. Delta and Gamma coronaviruses cause mainly infections in birds, but pathogenic mammalian gamma coronaviruses are known. Two alpha coronaviruses have been described in harbour seals and two gamma coronaviruses have been described in aquaria-housed cetaceans including a single beluga, presenting with respiratory disease and liver failure, and in several dolphins (clinically normal), respectively. Both gamma coronaviruses were 99% identical to each other, therefore the name cetacean coronavirus was proposed. SARS-CoV-2 has now been reported in 665 individual animals (as of 18 April 2022) including semi-aquatic and aquatic species such as river otters, mink, hippopotamus and manatees. The potential of SARS-CoV-2 to spill back/over into other marine mammals remains unknown. However, several features of the coronavirus family, such as their high mutation rates, propensity for homologous recombination and a flexible genome size allows this group of viruses to quickly evolve and thus to take advantage of new opportunities and host species.

Cross-species transmission from infected humans and thus the establishment of animal reservoirs and associated spillback potential to humans has been an early ONE health concern during the ongoing global SARS-CoV-2 pandemic. Genomic, as well as in silico and controlled challenge studies (experimental infections) have examined potential susceptibility of terrestrial and marine mammals. Based on genetic ACE2 sequence, several species including cetaceans are considered high to medium high and some exceeding human risk (e.g. dolphins). It is noteworthy that many of the species (cetacean and terrestrial) with known or suspected susceptibility risk to SARS-CoV-2 are also considered vulnerable or endangered. From an ONE health perspective as well as a global wildlife conservation perspective much recent effort has been dedicated to characterising the pathology, clinical presentation, potential of viral shedding (respiratory/faecal) and transmission routes, pathology and pathogenesis in natural infections of domestic, laboratory, zoo and wildlife species. Natural infections have occurred in 10 taxa so far with variable clinical and pathological presentation, including asymptomatic, mild to severe morbidities (mostly respiratory) and mortalities (e.g. mink; ferret; exotic felids). Depending on species, SARS-CoV-2 infections can be asymptomatic. To date, surveillance in the US using RT-PCR testing has been limited to gray whale (25), beluga (6) whale; bottlenose dolphins (5), and killer whale (1). No positive results have been detected.

Given the presence of viable SARS-CoV-2 in faeces and urine, which have been demonstrated in many countries, the potential risk for exposure and transmission of SARS-CoV-2 to marine mammals via environmental contamination of coastal marine habitats through sewage, wastewater etc. was identified early on in the pandemic. For example, metagenomics on SARS-CoV-2 genotypes in the United States and some countries in Europe detected in the sewage are identical to clinical genomes from the region. Currently, the assessment of health risks of water contaminated by faeces is limited by a lack of knowledge regarding the persistence of infectious SARS-CoV-2 in fresh and sea water, but preliminary research indicates that the threat of virus transmission from the aquatic environment is likely low. Although the risk to water supplies is considered low (WHO) the virus can reach river streams, estuaries, and marine habitats and seafood like bivalves have been used as a monitoring tool.

Both the presence of viral genome fragments of SARS-CoV-2 in marine bivalves as well as the spontaneous cases of natural infection in free-ranging manatees (Brazil) with unknown exposure scenarios should give pause before marine exposure can be ruled out. From an epidemiological perspective multiple environmental factors (temperature; salinity, pH, UV, organic

loading, marine debris, biofilm matrices; dilution factor, chemicals, water type etc.) will positively and negatively influence virus survival and infectivity and need to be considered together with dynamic virus load input (i.e. regional human case surges) when framing a marine exposure risk scenario. For example, SARS-CoV-2, like other viruses, shows temperature dependence and persists longer in cold environments including water. Accordingly, coastal areas (risk exposure study on Bohai Sea, part of the Yellow Sea) show a higher risk for exposure to SARS-CoV-2 in winter due water-borne transport from outfalls. For the Italian coast, a risk assessment was developed based on the comparison of the presence of Italian wastewater management plans, the coastal exposure to extreme weather events and the presence of susceptible cetacean populations. Study findings showed the potential SARS-CoV-2 exposure for marine mammals inhabiting Italian coastal waters in specific areas. As coastal waters are the ultimate sink for wastewater and given that we are in the third year of this global pandemic, both studies are important in raising awareness about potential regional exposure hot spots as well as emphasising that surveillance for the virus in water remains important from a ONE health perspective. Furthermore, given the potential risk, thorough investigation of stranded marine mammals is recommended in particular in species that feed close to the coastline year-round or during the cold. In the final remarks from a risk assessment perspective, it should be considered that while the virus RNA may be stable in river and sea waters, the presence of RNA alone does not correlate with infectious virus.

The World Health Organization for Animal Health (OIE) has been working with public and wildlife health partners on the human-animal-environment interface for this viral infection. In response multiple guidelines have been developed for professionals working in the animal sector including wildlife. Furthermore, ongoing risk assessments are underway to assess host range, reservoirs, viral evolution, and variant variation, the susceptibility of different species, especially in a natural setting, transmission dynamics (within and between species), and most importantly, the consequences for public and animal health (clinical virus shedding/contamination, viral evolution, mutation, and recombination). SARS-CoV-2 is a showcase for a ONE health approach and knowledge gained will help in preparation for other emerging viruses with pandemic potential.

Regional response and surveillance programs in wildlife and/or domestic species were implemented separately and to differing extents across North America (USA, Canada, Mexico). Ongoing marine mammal coordination on transboundary Unusual Mortality Events (eastern North Pacific gray whales [Mexico, US, Canada], North Atlantic right, humpback, and minke whales in the western Atlantic [Canada and US]) continued through virtual coordination. However, reporting, responses, data collection and analyses may have been impacted by the pandemic. Communication and collaboration regarding the impacts of the pandemic on data collection, analyses, stranding and entanglement responses, and Unusual Mortality Events are being assessed.

In the US, a OneHealth approach through a Center for Disease Control Federal Interagency Coordinating Group was instituted for response to evaluate the health threats across the human-animal-environment interface. Throughout the pandemic, the Wildlife and Zoo subgroup collated and discussed the science and spread awareness on the risks of SARS-CoV-2 transmission between people and animals with emphasis on three primary situations: (1) wild and exotic species in managed care facilities; (2) free-ranging wildlife; and (3) wildlife rehabilitation.

Specific guidelines and biosecurity protocols have been developed for marine mammals stranding responders and rehabilitation facilities by the US Marine Mammal Health and Stranding Response Program (MMHSRP). Briefly, during the first phase of the pandemic, no routine testing of marine mammals was required but samples of nasal, oral, and rectal swabs from animals admitted and released or during necropsy were requested and archived. Samples from phocids (harbour, gray, harp, ringed, spotted, Hawaiian monk, northern elephant seals), otariids (Steller sea lion and California sea lion), and Northern sea otters have been analysed. A small number of cetacean species have been tested including gray whales, belugas, bottlenose dolphins, and killer whale. To date no samples have been positive. Retrospective analysis is ongoing with a special focus on stranded animals during and post COVID-19 surges in the local human population. In addition, prospectively samples from marine mammals are being archived and targeted sampling and analysis is ongoing for animals that are showing clinical signs or are part of case-specific investigations. Although SARS-CoV-2 is the focus of these current surveillance efforts, screening for other coronaviruses and CDOCs are ongoing as well. In addition, the MMHSRP has distributed a survey to better understand the impact of the pandemic on the response networks and data collected for 2020-22.

In a global context surveillance for SARS-CoV-2 and other coronaviruses within Europe and other parts of the world does not scale up to the US effort with only limited testing (Italy; Canary Islands; Netherlands, New Zealand) having been conducted. Given the tasks at hand, greater cooperation among all of the different researchers in this ONE health field is necessary as well as stronger funding support from the various governments for this important work.

Lastly, given the large-scale impact of SARS-CoV-2 on all aspects of the global human workforce (e.g. regional or country-wide lockdowns, quarantines, remote working) it is likely that stranding data collected during this pandemic is biased low. Analysis of US stranding data is ongoing and it is recommended to gather such information from all regional stranding networks. A survey document has been developed by the US Marine Mammal Health and Stranding Response Program and

will be shared with the IWC stranding expert group. The new IWC stranding coordinator working in concert with the SEP will modify the survey to meet the needs of assessment of the impacts on stranding programs globally. The revised survey would then be distributed and reported at the next SC meeting.

Attention: SC
*The Committee **recommends** that the Strandings Expert Panel compile a standardised survey on the impacts from the pandemic on regional stranding programs, that could be circulated by the new IWC stranding coordinator to stranding network members.*

The Committee thanked all of the presenters in this focus session for their In-depth and informative presentations.

14.2.3 Review new information on Diseases of Concern (DoC)

SC/68D/E/11 presented information on toxicology research and monitoring of gray whales off Chukotka Peninsula (Russia) between 2008 and 2021. Samples from muscle, kidney, liver and blubber of gray whales were necropsied after aboriginal whaling and landing by Chukotka Natives in 2008-21, collected by Chukotka scientists. In 2021 concentrations of heavy metals and radioactivity levels did not exceed the Maximum Permissible Level (MPL) in the studied samples of gray whales. Also last year in the Moscow Severtsov Institute the serum-positivity to eight pathogens (*Toxoplasma, Mycoplasma*, *Trichinella*, *Candida*, *Chlamydia*, Morbillivirus, Herpes and Parvovirus) was determined for serum in 33 gray whales, harvested in Chukotka at 2018-21, all of which were serum-negative to Herpes virus. The highest (10%) positivity level was *Toxoplasma*, which was firstly found in gray whales. Also firstly found was *Trichinella* (6%), *Candida* and Morbillivirus (3% each), *Chlamydia* and *Mycoplasma* (2% each). Isolated cases of lethal toxoplasmosis in marine mammals are often associated with animal immunosuppression as a result of morbillivirus infections. *Toxoplasma* infection can also kill marine mammals, affecting their behaviour and increasing the risk of injury and death from predators and marine mammal hunters. Apparently, the consumption of gray whale meat by Natives can pose a certain danger due to infection with trichinella and toxoplasma with insufficient heat treatment of whaling products. In 2021 Moscow State University scientists analysed the isotopic composition of carbon and nitrogen in 46 skin samples of gray whales collected in different parts of Chukotka. There were also seven whales that had a medical odour of varying degrees. Despite a significant variation in $\delta^{15}N$ values, the content of heavy nitrogen was significantly lower in 'stinky' whales than in common ones. Moreover, the sample with the strongest medicinal odour had the lowest $\delta^{15}N$ content of all samples in general at 11.5%. It is assumed that 'stinky' whales fed on objects of a lower trophic level than ordinary ones. However, it is possible that changes in the isotope composition may reflect pathological processes or disturbances in the nitrogen metabolism of whales. Possibly, infection with several pathogens at once (i.e. the gray whale female caught on August 16, 2019 was 'stinky', inedible and was positive to Morbillivirus, Chlamydia and Candida) may reflect nitrogen metabolism of whales or may have doubling or even cumulative disturbance effect for health status of gray whales.

In discussion, it was noted that the results are highly relevant in light of the ongoing gray whale UME, and that samples for conducting serology analyses are rare. The author noted that a publication on the results is expected in the coming year, and that future analyses will examine additional pathogens, stable isotope analyses, and stomach contents.

Attention: SC
*The Committee **commends** Litovka for the In-depth health assessments and increasing knowledge on 'stinky' whales. The Committee **encourages** submission of the publication on 'stinky' whales to the next SC meeting.*

SC/68D/ASW/03 summarised general information on population indices, whale health and hunter observations of Bering-Chukchi-Beaufort (BCB) bowhead whales for 2020 and 2021. As in previous years, a number of unusual findings (abnormal; pathological) were observed in subsistence harvested bowhead whales in 2020 and 2021. Abnormal findings ranged from infectious to non-infectious disease conditions including parasitic infections (*Crassicauda spp; Anisakis spp.*), trauma related to anthropogenic factors and killer whales, various developmental anomalies (e.g. shortened jaw), benign masses (hepatic lipomas; Encapsulated fat necrosis; Stimmelmayr *et al.*, 2017; Stimmelmayr and Sheffield, 2021), and inflammatory conditions of the digestive and urinary system. With the exception of the case of the shortened jaw, the majority of non-infectious disease conditions were unlikely to interfere with proper function of the affected structure(s) or impact the health of the individual animal. Prevalence of kidney worm infection (*Crassicauda spp.*) in landed whales in Utqiaġvik remains high (80-100%) and clinical pathological investigations are ongoing to better understand the health impact on individual whales. In conclusion, from a population perspective, population indices and general health assessment findings reiterate that the BCB bowhead whale population remains robust, that general health of whales remains good, and the harvest is sustainable. Given the increasing complexity of environmental, ecological and anthropogenic stressors being present within the bowhead whale core habitat (Stimmelmayr and Sheffield, 2021), continued monitoring of health and population indices will be important to aid in our general understanding of how the BCB bowhead whale will continue to respond to the ongoing transformation of the Pacific Arctic ecosystem.

The Committee discussed that the bowhead whale may be a very resilient species, but that one could not underestimate the large and rapid changes of the Arctic ecosystem. It appears that bowhead whales maintain a high level of health and condition despite Stimmelmayr's reporting and there is probably no reason for concern now. A recent estimate (SC/68D/ASI/01) indicates a population size of 17,000 animals, but there is a need to continue to monitor the situation.

Felipe-Jiménez *et al.* (2021) presented an update on CDOC infections in Cetaceans from the Canary Islands. Fifty-five beaked whales (BW) (294 samples) stranded in the Canary Islands from 1990 to 2017 were analysed by molecular methods (conventional nested polymerase chain reaction). Results showed that eight beaked whales were infected by herpesviruses (HVs), although only three animals displayed lesions indicative of active viral replication. Phylogenetic analysis suggests that HV-BW sequences are species-specific, although more studies are needed to better address this question. In addition, to our knowledge, this is the first description of HV infection in Gervais' and Sowerby's beaked whales. Three out of eight HV-positive beaked whales displayed histopathological lesions indicative of active viral replication.

The Committee recognised the importance of these observations and thanked the authors for presenting this information.

Fernandez *et al.* (2022) reported on harmful algal blooms (HABs), which have been increasingly recorded over the last decades and much work has linked these events to multiple oceanographic and climate disturbances. HABs can affect ecosystems either as events that affect dissolved oxygen, clog fish gills, or smother corals or through the production of biotoxins which affect living marine resources through food web transfers or aerosols. HAB represent a natural driver of decline and potential extinction of aquatic organisms, from invertebrates to mammals, which may offer little evolutionary adaptation particularly in very high and long-lasting exposures. Despite numerous multispecies mass-mortality events linked to HAB-associated biotoxicosis globally, there are no records in cetaceans off the central eastern Atlantic Ocean. The report highlighted epidemiology, pathologic, microbiologic and toxicologic investigation results attesting to the first documentation of cetacean mass-mortality in European waters associated with brevetoxins. Twelve rough-toothed dolphins (*Steno bredanensis*) were found dead adrift or beached along the southwestern coast of Gran Canaria from April 28th to May 7th, 2008. Although pathologic examinations were limited by moderate to advanced autolysis and decomposition of the carcasses, consistent findings included multisystemic haemorrhage and undigested ingesta within the gastric compartments, mainly salema porgy (*Sarpa salpa*). Toxicologic analysis of gastric contents identified PbTx2 and PbTx3 brevetoxins. Results provided compelling toxicopathologic evidence of fatal brevetoxicosis in a cohort of rough-toothed dolphins. These data add to the limited knowledge on pathology of HAB in cetaceans and provide the first account of brevetoxicosis in European waters. No other mass-mortality or individual fatality of any cetacean species has been linked to brevetoxicosis in the Canary Islands since this event.

In discussion, the Committee noted that there are often mortality events associated with brevetoxin in US waters, and that blooms have increased in duration. Many mortality events in US waters appear to be acute, and respiratory effects have not yet been seen in cetaceans, however they are observed in people and manatees. The Committee noted that Fernandez' work builds on previous IWC efforts and thanked the authors for the presentation.

14.2.4 Other health issues in cetaceans

SC/68D/E/05 presented an update on Injuries, Emaciation and Skin Conditions in Cetaceans of the Strait of Gibraltar (2016-20). The Strait of Gibraltar is a heavily used marine region and an important habitat for seven cetacean species. The previous paper SC/66B/E/13 covered the time period from 2001-15 and documented injuries, malformations, emaciation and dermal diseases in multiple individuals (Selling *et al.,* 2016). The Scientific Committee of the IWC recommended a continued monitoring and a follow-up of individuals to provide information on survivorship and skin lesion progression over time (IWC, 2017b). The authors screened photographs taken during whale watching operations for pathological conditions, such as emaciation, injuries, parasites and dermal diseases. Multiple fin whales were sighted with high numbers of *Pennella balaenoptera*. Dermal diseases included the observation of dark and pale skin patches, spotted lesions, cutaneous nodules and tattoo-like skin lesions. Skin lesions were detected in all species but seemed to affect bottlenose dolphins the most. Newly occurring lesions (annular lesions, target-like lesions) are a reason for concern and might indicate the occurrence of new pathogens. Continued monitoring and quantitative research to determine disease prevalence was recommended, as well as a monitoring of the chemical pollution levels (PCBs, flame retardants, toxic metals; Aznar-Alemany *et al.*, 2019; Jepson *et al.*, 2016; Plön *et al.*, 2022) and blubber concentrations of cetaceans in the Strait of Gibraltar. The report further documented a broad range of anthropogenic traumata. The severity of the injuries ranged from superficial linear marks to severe traumas. The results indicate that the use of illegal driftnets and recreational fisheries are on-going threats. The Spanish legislation established regulations on how close cetaceans may be approached by boat (Ministerio de la Presidencia, 2008). Recreational fishery vessels have been observed to disregard this law. The authors urge for stricter control and enforcement of existing laws and for a collaboration of Moroccan and Spanish authorities to mitigate the observed human impact.

The Committee questioned whether emaciated animals also show higher prevalence of skin disease, which was confirmed by the author. The Committee thanked Hanniger for presenting this information.

14.3 Strandings and Mortality Events

14.3.1 Review progress of steering committee for IWC Strandings Initiative

The work of the Strandings Expert Panel (SEP) from May 2021-April 2022 was summarised. In the last year, the SEP have revised internal policies; met to review the membership, Terms of Reference and the Chair appointment; and responded to recommendations of the Scientific Committee (SC) in 2021. To address the SC recommendations, the SEP appointed a new part-time Strandings Coordinator, Emma Neave-Webb and created regional focal points for Western Africa, Sri Lanka, Eastern Asia, South America and the Central Pacific. The role of the focal points is to enhance and facilitate communication and to help and support engagement with local stakeholders. In the last year, the SEP has continued its provision of emergency support and training, through use of remote tools, successfully engaging with IGOs and stranding networks in Kenya, Sri Lanka, and Cambodia. The SEP successfully supported two emergencies; (1) the implementation of onsite training in Mauritius for an event reported last year; and (2) administration of support in response to a request from Sri Lanka and the incident of the MV Express Pearl. Governmental request for the SEPs official involvement in these incidents is required, and absent requests limit the level of support the SEP can provide. The SEP identified three key aims moving forward; (1) to complete the Steering Group (SG); (2) to engage with the IUCN and other animal health and welfare organisations to find synergies for future strandings response; and (3) for the SEP to convene in-person at next year's SC meeting to define and implement the next steps of the 4-year workplan.

In discussion, the process for the selection/nomination of the SG members was considered. The Secretariat confirmed the formation of the SG must follow established Rules of Procedure (ROP). The SG must be chaired by a national delegate (two-year term), who is elected by the Steering Group and appointed by the Commission (through the SC Report adoption).

The Secretariat informed the Committee that amendments to the SG can take place following an update to the ROP and Terms of Reference, after the SG is formed and approved. The Chair and VC of SC along with the Chairs of E, CC and WKM&WI nominated four SC members for the SG. Once the SC report has been endorsed by the Committee this group will elect a Chair and meet to discuss next steps.

The Committee suggested the SEP produce visible open-source products providing practical advice and expert knowledge. The Chair of the Expert Panel emphasised the complexity of strandings science and the challenges to summarising the diversity of existing tools. The Chair of the Expert Panel highlighted the SEPs current focus is to evaluate the economics of the materials and tools in existence, and to review their suitability for the capacity of different countries to respond to strandings.

In discussion the absence of local representation and expertise for Africa within the SEP was highlighted. The Chair of the Expert Panel strongly supported local representation from Africa and Asia in future reviews of the SEP membership.

Attention SC, S, C

The Committee notes the absence of representation and expertise from Africa within the Strandings Expert Panel (SEP). The Committee and the Chair of the Expert Panel therefore ***strongly recommends*** *identifying and recruiting local representation from Africa and Asia in future reviews of the SEP membership.*

14.3.2 New information on unusual mortality events

SC/68D/E/08 presented information on the unusual mortality event of harbour porpoises in the Netherlands. In August 2021, a remarkably high number (~ 200) of dead harbour porpoises (*Phocoena phocoena*) washed ashore on the Dutch Wadden Sea Islands in a period spanning ten days. They all appeared in similar state of advanced decomposition, indicating that they died around the same time. Information derived from a drift-model indicated a location NW of Frisian Front and E of Cleaver Bank as the most likely origin of the carcasses. There were no unusual anthropogenic activities in that area during August (e.g. no Unexploded Explosive Ordnance detonation or military activities). Necropsies were conducted on 22 carcasses and revealed that animals were in good nutritional condition with mild to moderate parasitic loads and most were reproductively active. Despite their relatively good nutritional state, no or few prey remains were found in the stomachs. This is indicative of an overall fair to good health status, and a subacute cause of death. Ancillary testing showed that harmful algae blooms (HABs), Influenzavirus, Morbillivirus, herpesvirus and SARS-CoV-2 were unlikely the cause of the mass mortality. Cultures of liver samples (n=21) and from organs with macroscopic changes (n=3) revealed the presence of *Erysipelothrix rhusiopathiae* in 76% of harbour porpoises tested. This bacterium has not previously been cultured from harbour porpoises investigated in the Netherlands. There are no reports in literature of cetacean mass mortality as a result of *Erysipelothrix* infection. The investigation is ongoing.

The Committee welcomes this information. In discussion, it was noted that investigations of mass mortality of seabirds in the North Sea are currently ongoing, and that results of that investigation should be considered in interpreting the likely causes of the harbour porpoise unusual mortality event, as well as potential effects of any disposals of dead fish at sea, or potential sources of pathogens via river Thames. Committee members pointed out that links between water quality and prevalence of this bacterium have been demonstrated previously and that further efforts may provide further clues about these links and their effects on harbour porpoise health. The Committee also noted that information on such mortality

events and their likely causes should be considered in light of cumulative impacts on harbour porpoises in the region (and cetaceans in general), despite bycatch in fishing gear being identified as the primary threat to this species and stressed the importance of the OneHealth approach.

SC/68D/E/03 reported on the bowhead whale (*Balaena mysticetus*) Unusual Mortality Event (UME) in the Gulf of Boothia, Canada, between 1 October 2020 and 14 April 2021. Eleven bowhead whales were discovered, near Kugaaruk, Nunavut. Tissue samples from eight whales were collected to investigate potential causes and extent of the mortalities. In addition, demographic, epidemiologic, pathologic, image analysis, adipocyte, lipid, and contaminant analyses were compiled and reviewed. Due to the remote location and lack of access, sonar/seismic testing, ship strikes, and infectious disease could not be investigated. No gross indication of vessel or propeller strike was observed. Analysis of environmental, morphometric, histopathologic, and contaminant data did not reveal a definitive cause of the mortality. Unusual oceanographic processes and contaminant exposure were unlikely factors. The strandings were concurrent with sightings of killer whales in the region and predation marks and damage to the carcasses were observed by local Inuit. A contributing factor may have been an interaction between poor body (nutritional) condition and predisposition to predation. Sea ice coverage was low in autumn 2020, which allowed killer whales greater access to the Canadian Arctic and for longer than usual. Most of the dead whales were juveniles, which may enhance the risk of killer whale predation. The mortality event was likely related to broad changes occurring to the Eastern Canada-West Greenland (ECWG) population's habitat, due to complex and dynamic ecologic changes associated with climate warming. Fisheries and Oceans Canada plan to continue to monitor the population, further research will include analysis of; drone-collected images to assess body condition; reproductive history from baleen plates; satellite imagery to assess harmful algal blooms; population modelling to determine carrying capacity; and modelling of physical factors to associate future whale health within a larger environmental context.

In discussion, the Committee considered whether the animals were near moribund when predation occurred, the authors acknowledged this possibility and confirmed that moving forward further drone footage will be collected to better understand changes in the ECWG population body condition over time. The Committee also discussed the challenges associated with the analysis of environmental data, for example harmful algal blooms, using satellites in the coastal zone (<40km to the coast). The authors recognised these challenges and confirmed that further investigations are planned, and satellite analyses will be supported with analysis of ring seal stomach content before and after the event.

The Committee discussed the typical number of bowhead whale strandings that occur annually in the region, and while the numbers were low relative to the population, the occurrence of strandings in this region is unusual. The authors raised possible concerns of an increasing trend of predation by killer whales in the Canadian Arctic and highlighted the need for continued monitoring.

14.3.3 Other information

SC/68D/E/02 presented a first look at strandings data collected between 2000-20, by various members and collaborators within the Indian Ocean Network for Cetacean Research (IndoCet), covering over 14,815km of coastline belonging to nine countries. The southwestern Indian Ocean (SWIO) is a region of global importance for marine mammal biodiversity, yet our understanding of most of the species and populations found there is still rudimentary. Cetacean stranding patterns and finer scale spatial and spatio-temporal patterns were characterised. Between 2000-2020, there were 398 stranding events, representing 1,259 individual animals, 17 genera, and 27 species, comprising six families: four balaenopterids, one balaenid, one physeterid, two kogiids, six ziphiids and 14 delphinids. Seven mass strandings were recorded: two were composed of three to 20 individuals and five were composed of >20 individuals. Spatial analysis of stranding events indicated local spatio-temporal clusters were present in all countries/territories except for the Comoros; however, the only significant cluster was detected on the southwest coast of Mauritius just west of the village of Souillac. The SWIO region is predominantly composed of relatively poor range countries, yet imminent Blue/Ocean economy developments are prevalent throughout the region. This study highlighted the importance of establishing baselines, upon which any future potential impact from anthropogenic developments in the region can be measured.

The Committee commended the authors for this comprehensive study. In discussion, interest in the analysis of class and gender of the individual strandings were discussed and the authors confirmed that this information was not included in this higher-level review. The data presented was reliant upon the confidence of individual networks across the IndoCet region. In some regions, little or no manpower, limited the data availability and confidence level. The work presented proved useful to highlight regions needing training and the levels of investment required.

SC/68D/E/04 examined humpback whale (*Megaptera novaeangliae*) stranding data from 2002 to 2021 (1,260 strandings: 106 alive; 1,145 dead; nine without information), collated from the Brazilian Aquatic Mammals Stranding Network (REMAB), and beach monitoring projects – PMP. There was a positive exponential trend in the number of strandings over time. Most strandings occurred in August (30.2%) and September (22.1%), but there is an apparent shift in the peak of mortality, becoming earlier. Calves were the most frequent in 15 out of 20 seasons, with juveniles predominating in only five seasons. In 2021 30 strandings were recorded with 187 classified as juveniles (where age could be determined). Strandings occurred predominantly close to the main breeding area in the Abrolhos Bank, but for 2016 and 2021 there was

a significant displacement to higher latitudes. From 146 necropsies conducted from 2015 to 2021, 19.2% of deaths were caused by anthropogenic interactions, such as entanglement in fishing gear and ship strikes. Regarding body condition, 26.9% were cachectic or thin, and 24.2% were in good body condition. The increase in humpback whale strandings along the Brazilian coast over time might be a result of a combination of different factors. Population growth, which seems to be reflected in the amount of strandings, increases the likelihood of interactions with human activities, hence increasing non-natural mortality. Another factor could be the nutritional condition of the individuals, which relates to food availability in higher latitudes. Previous work suggests a relationship between the occurrence of krill in the Islands at 54°-55°S, 36°-38°W and strandings of humpback whales in Brazil (Marcondes *et al.*, 2017). This seems to mainly affect juvenile individuals that were observed with food remains in their gastrointestinal tracts (on average: 40% per year). Further analyses are underway, focusing on the effect of changes in krill biomass and climate variability on humpback whales' mortality and stranding rates.

In discussion, the Committee considered whether two significant contamination events along the Brazilian coast in 2019 were identifiable within contamination levels of lactating juveniles. While not investigated at this time, the authors confirmed that further analyses were planned.

Boys *et al.* (2021) described the available published data on cetacean euthanasia in 2,147 peer-reviewed articles, highlighting knowledge gaps and providing direction to improve stranded cetacean welfare. The current knowledge and implementation of euthanasia methods remain highly variable, with limited data on the practicalities and welfare impacts of procedures. Two examples of countries by methods employed were drawn from IWC reports. In the UK, chemical euthanasia was most common (52%), whilst in NZ only ballistics methods were used. In general time to death/insensibility (TTD) was rarely mentioned, only reported by 0.5% of peer-reviewed articles, whilst TTD from IWC reports was reported for 35% of individuals in the UK and for 98% in NZ. The findings highlight the lack of available information on cetacean euthanasia and suggest increased data collection and the application of appropriate methods to improve cetacean welfare.

Boys *et al.* (2022a) evaluated Standard Operating Procedures (SOPs) for end-of-life decision-making and technically enacting euthanasia of stranded cetaceans across Australasia. The aim was to highlight similarities and differences in management and explore directions to improve stranded cetacean welfare. For this purpose, twenty-nine parameters for the implementation of end-of-life decisions were evaluated. Euthanasia and palliative care were options for end-of-life, with palliative care recommended when euthanasia was not feasible or presented human safety risks. Three euthanasia methods were recommended. Ballistics was recommended in seven SOPs, chemicals in five and explosives in three SOPs. Variability existed in the exact procedures and equipment recommended in all three methods. Additionally, only five SOPs provided criteria for verifying death, while only two recommended time to death (TTD) be recorded; hindering evaluation of the welfare impacts of end-of-life decisions and euthanasia procedures. The findings highlight the need for detailed guidance and consistency in end-of-life decisions and euthanasia techniques, to ensure reliable welfare outcomes. Systematic, standardised data collection at euthanasia events across regions is required to facilitate assessment of welfare impacts and develop evidence-based recommendations. International collaboration is key to developing objective criteria necessary to ensure consistent guidance for end-of-life decisions.

Boys *et al.* (2022b) explores fundamental concepts and key concerns relating to the welfare and survival of stranded cetaceans. Based on the expert criteria one of the main conclusions was that stranded cetacean welfare should be characterised based on interrelated aspects of animals' biological function, behaviour, and mental state and the impacts of human interventions. The characterisation of survival likelihood should reflect aspects of stranded animals' biological functioning and behaviour as well as a 6-month post-re-floating survival marker. Post-release monitoring was the major knowledge gap for survival. Welfare knowledge gaps related to diagnosing internal injuries, interpreting behavioural and physiological parameters, and euthanasia decision making. Twelve concerns were highlighted for both welfare and survival likelihood, including difficulty breathing and organ compression, skin damage and physical traumas, separation from conspecifics, and suffering and stress due to stranding and human intervention. These findings indicate inextricable links between perceptions of welfare state and the likely survival of stranded cetaceans and demonstrate a need to integrate welfare science alongside conservation biology to achieve effective and ethical management at strandings.

Attention: C, SC Environmental Concerns, and WKM&WI
*The Committee **welcomes** this new information on cetacean welfare and **encourages** that these papers should be brought to the attention of the IWC's Whale Killing methods and Welfare Issues group.*

14.4 Climate change

14.4.1 Review report from intersessional workshop on climate change

Simmonds presented the report of the 2021 Climate Change Workshop (SC/68D/REP/01). The workshop met virtually between 30 November and 3 December 2021. Sixty-six participants took part from 21 countries. The workshop took note of the previous work by the SC on climate change and a compilation of recent publications on cetaceans and climate change made by Nunny and Frey. The workshop considered the latest contributions from the IPCC. Global warming of 1.5 or 2°C – the upper limit defined in the Paris Agreement – will be exceeded during the 21st century unless deep reductions in CO_2

and other greenhouse gas emissions occur. However, even then there are many changes due to past and future greenhouse gas emissions that will remain irreversible for centuries or even millennia, especially in the oceans. Examples include the melting of the Greenland and Antarctic Ice Sheets, global sea level rise, ocean warming, deep ocean acidification, and deoxygenation.

The workshop received and discussed a number of presentations including the following.

- Rebuilding baleen whale ecosystems, which noted that whaling in the Southern Ocean provides a case study in which over a million great whales were removed but for many species recovery has been slow and is currently hampered by the potential decline of krill biomass.
- Recent developments related to climate change in the Bering-Chukchi-Beaufort Sea where there is an increasing complexity of environmental, ecological and anthropogenic stressors; new information from a population viability analysis (PVA) for beluga (*Delphinapterus leucas*) that explicitly included climate change (Williams *et al.*, 2021).
- Climate change effects on the four species of marine mammals present in the Baltic Sea, where the Baltic Proper harbour porpoise is critically endangered (Carlén *et al.*, 2021).
- A review of baleen whale ecology in high-latitude marine ecosystems; belugas (*Delphinapterus leucas*) which have been recorded potentially outside of what is regarded as their normal habitat or range.
- The Climate Smart Conservation Cycle; the use of Climate Vulnerability Assessments; Important Marine Mammal Areas (IMMAs).

Additionally, Cavanagh and colleagues from the British Antarctic Survey presented on the impacts of climate change on Southern Ocean ecosystems, looking in particular at synergies between the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and IWC. The workshop noted that due to its truncated virtual nature, not all elements of the planned agenda had been completed. A further in-person workshop was recommended.

The Workshop recognised the gravity of the impacts of climate change and noted the importance of long-term monitoring programmes to detect climate-driven changes in cetacean populations and habitats. The Workshop made a number of recommendations, including that climate change should be considered explicitly in recovery efforts for endangered species, that the IUCN Important Marine Mammal Area (IMMA) assessment process include an evaluation of the effects of climate change on IMMA habitats, and that there be stronger collaboration between the IWC and CCAMLR. The review of multiple case studies generated recommendations for highlighted species, including that the range states for the Baltic harbour porpoise take action to improve the resiliency of the population, and that expert networks, translocation protocols, and hydrological monitoring be established to address climate-related threats to river dolphins.

The Workshop also produced several over-arching recommendations, including prioritising climate change-related research in regions known to be experiencing intense climate change impacts, shifting management focus from sustainability to building resilience in cetacean populations, and including climate change impacts in investigations on cumulative effects of multiple stressors.

The Committee welcomed the extensive report and thanked the workshop group for its work. In discussions it was noted the importance of the issue and that there was a mandate from the Commission for the Committee to work on climate change (IWC, 2010a). The importance of understanding the potential effects of climate change to cetaceans was recognised and the Climate Change Steering Group was encouraged to find ways to continue to integrate climate change within the work of all relevant sub-committees such as accounting for it effects in population assessments and management plans.

Attention: SC,CC, C

*The Committee **welcomes** the report of the virtual IWC Climate Change Workshop (SC/68D/REP/01) and endorses it recommendations. The Committee **encourages** further work, recognising the importance of continuing the integration of new information on climate change impacts to cetacean populations into its work.*

*Whilst a second workshop, intended as an in-person meeting, could not be supported at this time the Committee **encourages** the Climate Change Steering Group to promote integration of climate change aspects within the work of all relevant sub-committees.*

14.4.2 Review new information

SC/68D/E/10 highlights recent publications about the various effects of climate change on cetaceans. Changes of cetacean habitat due to climate change include, *inter alia*, additional freshwater input into key habitats. This can alter salinity, which can have serious health consequences for some species (Fazioli and Mintzer, 2020). Extreme temperature events are also of concern. For example, in 2013, a persistent area of warm water developed off Alaska and, by summer 2014, this water mass stretched all the way south to Mexico. These triggered extended harmful algal blooms (HABs) and several populations of marine predators were adversely affected. In 2019, a second similar substantial area of warm water developed off the

Pacific coasts of North America. Similar marine temperature anomalies have been reported from elsewhere in recent years, notably to the west of New Zealand. A change in the frequency and severity of storms is also of concern, as the available literature indicates that this may lead to changes in behaviour and distribution of cetaceans. Climate change is also predicted to change the occurrence and distribution of HABs (Townhill *et al.*, 2018). Finally, climate change may lead to alteration of human behaviour or distribution of human activities, which in turn may affect cetacean populations (Alter *et al.*, 2010). Examples include the development of marine renewable energy sources and increased marine debris in the Arctic. In order to more fully understand these various potential and actual impacts of climate change and better mitigate against them, the authors propose a second workshop on climate change, where some of the issues outlined above could be further considered alongside mitigation plans.

The Committee welcomed this information and noted the proposal for a second workshop.

Agrelo *et al.* (2021a) presented new information on the effects of ocean warming on the recovery of southern right whales (*Eubalaena australis*). By analysing a five-decade (1971-2017) data series of individual southern right whales photo-identified at Península Valdés, Argentina, the authors found a marked increase in whale mortality rates following El Niño events. The modelling of population responses to changes in the frequency and intensity of El Niño events suggests that such events are likely to impede southern right whale population recovery and may even lead to population declines, with the potential for disruptions of trophic web interactions in the Southern Ocean, further weakening that ecosystem's contribution to the mitigation of climate change.

In discussion the Committee noted two important points. First, the effects of climate change may be putting recovery of baleen whale populations at risk, even in areas where anthropogenic threats were previously considered to be relatively low. Second, this study emphasised the need to take into account how El Niño events may be affecting prey availability for southern hemisphere baleen whales feeding in Antarctica, and the important linkage to CCAMLR and the management of the krill fishery.

Attention: SC, CC
*The Committee **recognises** that climate change will affect the recovery for many cetacean species and **recommends** that future studies of population dynamics and recovery for cetaceans consider the effects of climate change on survival and fecundity.*

14.5 Underwater noise

The Secretariat presented paper SC/68D/E/09 on the collaboration with the International Maritime Organization (IMO) on reducing underwater noise from shipping. The IWC Scientific Committee has been discussing the impacts of noise on cetaceans for two decades and has been sharing the findings from this research with the IMO, the international organisation responsible for guidance or regulations to address underwater noise from ships. The IWC has observer status at IMO and contributed to the development of non-mandatory technical guidelines in 2014 for reducing underwater noise. Due to a low uptake in these measures, the IMO has started a process of revising the guidelines and identifying the next steps required to reduce underwater noise from shipping. The IWC will contribute to this work by providing input on available information on known impacts of shipping noise and relating this to the distribution of cetaceans and proposed measures to reduce underwater radiated noise. The IMO Correspondence Group will provide a report in early 2023 to the SDC 9 (the IMO Ship Design and Construction sub-committee). The Committee welcomes this information and noted the importance of continued progress towards collaboration with the IMO.

Cholewiak reported on the seismic survey activity detected along the US eastern seaboard in the western North Atlantic, utilising acoustic data from 11 passive acoustic recorders deployed during 2016-17. Airguns were detected at some sites for up to 69% of the study period. Results showed that at some periods, signals were detectable across all offshore US waters. Localisation analyses suggest the source of some of the surveys likely originated from South America. This long-distance propagation indicates that the area in which marine mammals could be exposed to noise generated by seismic surveys includes an entire ocean basin.

The Committee thanked Cholewiak for presenting this information and expresses concern over these findings. In discussion, the Committee noted the potential value in using AIS data to better understand the temporal and spatial scale of these seismic surveys. The Committee looks forward to receiving additional information on this study at its next meeting.

Reyes presented a proposed questionnaire to compile information on ongoing and planned marine seismic surveys in national and international waters, in order to get a better overview of the timing and locations of these activities and identify sensitive areas where potential impacts from impulsive noise on cetaceans may occur. This initiative is part of the workplan of the IWC Anthropogenic Underwater Noise Working Group of the Conservation Committee, which identified seismic exploration as one of its priority issues to be addressed in the short term and follows IWC Resolution 2018-4 on anthropogenic underwater noise.

The Committee welcomed the information presented and thanked the working group for their efforts.

Attention: SC, CC, C
Recalling Resolution 2018-04, and recognising the threats posed to cetaceans by underwater noise, the Committee:

(1) ***encourages*** *further collaboration between the IWC and the IMO with regards to addressing ship noise; and*
(2) ***reiterates*** *the need for intersessional collaboration between the Scientific Committee and the Conservation Committee on underwater noise, particularly with respect to addressing seismic survey impacts.*

14.6 Marine debris

Fossi *et al.* (2020) discussed the relevance of cetaceans as ocean health indicators of marine litter impacts and the development of new methodologies for evaluating such impacts. An approach based on the detection of new plastic tracers in tissues and the identification (through 'omics techniques) of the potential ecotoxicological effects caused by plastic debris ingestion in indicator species is a promising new diagnostic methodology. Coordinated efforts on the studies of debris ingestion and entanglement in cetaceans are of key importance to better understand the impacts of both macro- and micro-debris. In this context, the authors re-emphasise the recommendations from the IWC workshop concerning standardised approaches to necropsies and recording and measuring plastics and other debris (IWC, 2021b). Recently, the idea of cetaceans as indicators of ocean health has attracted the attention of the scientific community (IWC, 2021b). Some cetaceans, in particular sperm whales (*Physeter macrocephalus*) and fin whales (*Balaenoptera physalus*) have the potential to provide important information about marine litter impact at a global scale and may help in steer further research.

In discussion, the Committee noted that even the deep sea is not immune to the impacts of marine debris, and that the Mediterranean Sea appears to be a hotspot for marine litter. The Committee agrees that there is now ample evidence of the impacts of marine debris on cetaceans, and that action on the part of international bodies is required to address this issue.

Eisfeld-Pierantonio *et al.* (2022) suggest that about 68% of cetacean species are affected by interacting with marine debris, with an increase in the number of species reported to have interacted with it over the past decades. This includes 31 species impacted by entanglement and 57 species reported to have ingested plastic, with macroplastics being the main issue for all. The contribution of the ongoing COVID-19 pandemic to marine plastic pollution appears to be substantial, with potentially serious consequences for marine life including cetaceans, though so far, no cetacean species have been recorded as affected by COVID-19 related litter. However, the pandemic offers an opportunity to investigate the direct links between industry, human behaviour and the effects of marine debris on cetaceans. This may help inform management, prevention efforts, describe knowledge gaps and guide advancements in research efforts. The review highlighted the lack of assessments of population-level effects related to marine debris and suggested that these could be rather immediate for small, threatened populations already under pressure from other anthropogenic activities. Finally, the review suggested that marine debris is not only a pollution, economic and social issue, but also a welfare concern for the species and populations involved.

The Committee thanked the authors for presenting this information and expressed serious concern over the findings reported in this paper.

Stockin *et al.* (2021) provide a first assessment of microplastics (MPs) in stomach contents of 15 common dolphins (*Delphinus delphis*) from both single and mass stranding events along the New Zealand coast between 2019 and 2020. MPs were observed in all examined individuals, with an average of 7.8 pieces per stomach. No correlation between total number of MPs and biological parameters (total body length, age, sexual maturity, axillary girth, or blubber thickness) was observed, with similar levels of MPs observed between each of the mass stranding events.

The Committee welcomes this information and noted the increasing number of papers on the topic of microplastics and marine debris. The Committee also discussed the value of necropsies, recognising that in the waters around New Zealand, species such as beaked whales may serve as good indicators for microplastics in the deep ocean.

Attention: SC, CC, CG, C
The Committee ***reiterates*** *its growing concerns about the impacts of marine debris on marine wildlife.*
The Committee:

(1) ***encourages*** *new information on wastes arising from the COVID-19 pandemic that are entering the marine environment, and in particular that findings of these materials during necropsies be reported;*
(2) ***encourages*** *necropsies that examine stomach contents for marine debris materials whenever possible.*

Recalling previous recommendations (SC20136, SC20137), the Committee agrees to continue work on marine debris issue via an intersessional correspondence group (ICG), including considering how marine debris-related information might be best collected and collated in an IWC database. In discussion, the Committee also noted that the UN Environment Assembly had agreed in March to establish an Intergovernmental Negotiating Committee with the mandate to forge an international legally binding agreement to end plastic pollution, and that the IWC could contribute to this effort.

Attention: SC, CC, CG, C
Recognising the importance in addressing the marine debris issue on a global scale, the Committee:

(1) ***requests*** *the Commission to support the development of the international legally binding instrument on plastic pollution, including in the marine environment, at the UN Environment Assembly;*
(2) ***requests*** *that the Secretariat engage in the ad hoc open-ended working group to prepare for the work of the intergovernmental negotiating committee to end plastic pollution convened by the UNEP Executive Director resulting from UNEA 5.2 resolution 5/14; and*
(3) ***recommends*** *the Secretariat consult on ship-based marine debris with the IMO.*

14.7 Habitat alteration as anthropogenic impact on cetaceans

Baldwin *et al.* (2021) provided an overview of 20 species of cetaceans occurring off the Sultanate of Oman, with chapters 3, 4 and 5 detailing known threats to cetaceans off Oman, mitigation options for threat reduction and organisations involved in conservation management of cetaceans, respectively. Identified threats include ship strikes, underwater noise, hydrocarbon exploration and production activities, fisheries activities, whale watching, chemical pollution, coastal development, biotoxins and infectious disease, and climate change. Species and threat-specific mitigation options are provided specifically for ship strikes, underwater noise, fisheries activities and an emerging whale watching industry, including linkage to IMO, CMS and IWC. Details of conservation and management organisations relevant to Oman (IWC, IMO, CMS, IUCN, CITES, FAO, regional fisheries organisations, ASWN and Omani organisations) are also presented, with the aim of educating readers and providing them with tools to help address environmental and conservation concerns, and build synergies between various organisations.

The Committee welcomed this information and noted the relevance to and linkage with the Conservation Management Plan (CMP) for the Arabian Sea humpback whales.

14.8 SOCER

The State of the Cetacean Environment Report, or SOCER, was the result of several resolutions of the Commission, including Resolutions 1997-7 and 1998-5, which directed the Scientific Committee to provide regular updates on environmental matters that affect the cetacean environment. In 2018, a compendium of the previous five years was produced, which is now available on the IWC website. The 2022 SOCER (SC/68D/E/12), with just over 75 entries, focuses on the polar oceans.

The remoteness of polar seas is increasingly affording less protection to cetaceans from a wide range of threats. Climate warming, as exemplified by changes in the Greenland ice sheet, a massive ice shelf collapse in East Antarctica and significant reductions in Antarctic sea ice, is expected to exacerbate such threats. For example, pollutants as diverse as mercury and microplastics that are currently stored in ice will be set free. Underwater noise here is also predicted to increase because: (1) ice-free waters are generally louder and this will be affected by earlier melt and later freeze-up; (2) shipping is predicted to increase during the extended ice-free months; and (3) sound propagation may change with temperature. In light of increased vessel traffic, several papers have recently dealt with oil spills and their potential behaviour in Arctic waters and sea ice. The ship strike risk for baleen whales may also increase as trans-Arctic shipping routes open up, as will the risk from a range of other vessel-related contaminants. The reaction of polar organisms is described as 'naïve' with regard to a wide range of threats. In the Arctic, certain whale prey species such as copepods are expected to shift northwards and shifts in the distribution of endemic Arctic cetacean species have been recorded. The Southern Ocean and Antarctica are highly sensitive to environmental changes, with the greatest anthropogenic threat being climate change, in contrast to global marine ecosystems, where exploitation is considered to represent the greatest risk. There are gaps in our knowledge of major aspects of the ecology of krill, as key whale prey; a potential decline of krill or a shift to a salp-dominated ecosystem is of key concern.

Many of the studies related to climate change in the Arctic and Antarctic will ultimately have global impacts through changing marine ecosystems, ocean chemistry, global circulation patterns and sea levels. The synergy between climate impacts and ocean noise is also highlighted, especially in polar regions. The latest IPCC report paints a grim view of how the world is responding to climate change, with a high likelihood that we will exceed a 1.5°C increase in global temperatures and will soon be at a 'tipping point' for major climatic changes. Other 'global' environmental highlights include the increasing number of studies on microplastics in the marine environment and biota. It was found that there was poor compliance with voluntary speed restrictions to reduce the threat of ship strikes on whales and enforced, legal speed limits may be required. Research has also increased our understanding of how cetaceans react to sonar, and impacts appear to be primarily behavioural – which is a critical issue as many regulations assume physical impacts, which occur at much higher levels of sound exposure than would cause behavioural effects.

The Committee welcomes the new compilation of SOCER and thanked the editors for their continued work in compiling it. The full SOCER report can be found as Annex L.

Table 22

Workplan for Environmental Concerns.

Topic	Intersessional	Next Meeting	Intersessional	Subsequent Meeting
Pollution 2025	Continue collecting information on legacy and emerging contaminants in cetaceans, on cumulative impacts; monitor and research on trace element and heavy metal contamination in Caribbean cetaceans (SC20122, SC2164, SC2165)	Review progress	Continue collecting information on legacy and emerging contaminants in cetaceans, on cumulative impacts	Review progress
Cetacean Diseases of Concern	Continue collecting information on Emerging diseases, adapt ToR (SG-8), SC20125	Review progress	Continue collecting information on Emerging diseases	Review progress
Strandings	Reform steering committee of the SI and appoint a convenor, SI and SEP will finalise the details of the workplan, work on recommendations on satellite imagery, SC20128, SC20128, SC20130, SC20131	Review progress of intersessional work	Progress towards workplan	Review progress
Climate Change	Continue collecting information on impacts of climate change, follow up on workshop, adapt ToR (ICG-9)	Review progress of intersessional work	Continue work to follow up on recommendations	Review progress
Noise	Adapt ToR (ICG-9), SC20133, SC20134, SC201235, SC2183	Review progress of intersessional work	Continue work to follow up on recommendations	Review progress
Marine Debris	Follow up on recommendations (SC19185-19224), adapt ToR (ICG-10); 20137, SC2185	Review progress	Continue work to follow up on recommendations	Review progress
SOCER	Report compilation on the Indian Ocean regions	Review SOCER report	Report compilation on the Mediterranean and Black Sea regions	Review SOCER report
Sub-committee coordination (ICG)	Porter & Convenor will work with SC sub-committee Convenors to develop a strategy to better integrate the SM and E workplan across the SC as appropriate	Review progress	Continue ICG if needed	Review progress
One Health approach (ICG)	Continue to develop recommendations; work across sub-committees, and specifically with the ecosystem functioning group	Review progress of intersessional work	Continue work across sub-committees	Review progress of intersessional work
ICG on beaked whales in conjunction with SM ICG	Develop response protocol, develop recommendations for improved data sharing (SC2181)	Review progress of intersessional work	Continue ICG if needed	Review progress of intersessional work

Attention: SC
*The Committee **agrees** that the State of the Cetacean Environment Report for the next meeting should be compiled for the Indian Ocean.*

14.9 One Health

SC/68D/E/14 provided an update on the advances on Intersessional Correspondence group (ICG) on One Health approach. The 'One Health' concept recognises that animal, human and environmental health are intrinsically intertwined and interdependent. The ICG objectives were to propose specific recommendations on how the One Health approach can be operationalised within the Scientific Committee, and its sub-committees, particularly to inform preventative, mitigation, and management actions. It was noted that One Health could be addressed at least for three major stressors (zoonoses, pollution and climate change) which may overlap in space and time. The ICG proposed to advance on recommendations at two levels: to integrate One Health considerations into existing sub-committee groups of the IWC and to increase collaboration with other international organisations on One Health matters. The ICG noted that several IWC programmes and groups are already applying a One Health approach to their protocols and research, including the IWC Global Entanglement Response Network, the IWC Strandings Initiative, and the sub-committee on Environmental Concerns. The ICG also considered that international collaboration with other organisations, such as the World Animal Health Organisation (OIE), IUCN, FAO, WHO, UNEP, Wildlife Disease Association, CITES, CMS, and others, is an important step to develop a broad and synergistic One Health approach to facilitate a good conservation status of cetaceans and marine ecosystems. The ICG undertook a literature search on One Health and marine wildlife, that could be applied to the work and aims of the IWC. The review identified over 200 published research articles with about 40 studies directly addressing One Health. It remains a work in progress as new papers are identified.

In discussion, the Committee **noted** the importance of this approach, as well as the importance of linking it with other interrelated topics such as ecosystem functioning and the ecosystem health approach, recognising the role that cetaceans play in the health of marine ecosystems.

Attention: SC, SC-E, CC
*The Committee **endorses** the recommendations presented in the One Health approach, recognising that work will continue intersessionally to refine those recommendations.*

*The Committee also **encourages** the development of a case study to apply the One Health approach to a Conservation Management Plan (CMP) or marine protected area, to develop a proof of concept and show how the approach can be operationalised.*

14.10 Biennial workplan

See Table 22.

15. ECOSYSTEM MODELLING

The Ecosystem Modelling Working Group was first convened in 2007 (IWC, 2008b) 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 EM 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.

15.1 Workshop on the Role of Cetaceans in Ecosystem Functioning: Gap Analysis

15.1.1 Review outcomes and recommendations from the Workshop on the Role of Cetaceans in Ecosystem Functioning: Gap Analysis

In response to Resolution 2016-3 (IWC, 2017a) 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 gap analysis 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, 2019b, p.46).

In 2019, the Committee reiterated the need for a workshop to begin the process of responding to Resolution 2016-3 and agreed a plan including potential hypotheses and questions for consideration, and a comparison of the ecosystem function of cetaceans between different ecosystems (IWC, 2021c). However, due to difficulties in holding the workshop as planned originally, the committee held a virtual IWC-CMS workshop on Cetacean Ecosystem Functioning in April 2021 (IWC, 2021a) for better coordination for the future in-person workshop.

Unfortunately, similar circumstances prevented a face-to-face workshop from being held before SC68D, but the Committee agrees that it would be beneficial to hold the second workshop before the next meeting (as a pre-meeting as previously discussed). For this reason, the Committee re-established a workshop steering group with the same terms of reference as previously (see Table 23 provided below). The Committee recognises that estimates of pre-exploitation and current abundance of large whale populations are needed in advance of the second workshop. Re-analyses to estimate population-wide prey consumption and nutrient excretion rates so as to inform on the ecosystem functioning mechanisms under consideration are also needed and the second workshop should be deferred if the necessary information is not available in time.

15.1.2 Any new information on ecosystem functioning

SC/68D/EM/01 presents new information on nutrient concentrations in minke whale faeces and the potential impact on dissolved nutrient pools off Svalbard, Norway. There is increasing interest in assessing the impact of whales on nutrient and carbon cycling in the ocean. By fertilising surface waters with nutrient-rich faeces, whales may stimulate primary production and carbon uptake, but robust assessments of such effects are lacking. Based on the analysis of faeces collected from minke whales (n=31) off Svalbard, Norway, this study quantified the concentration of macro- and micronutrients in whale faeces prior to their release in seawater. Concentrations of the macronutrients nitrogen (N) and phosphorous (P) in minke whale faces were 50.1 ± 10.3 and 70.9 ± 12.1 g kg-1 dry weight, respectively, while the most important micronutrients were zinc (Zn), iron (Fe), manganese (Mn) and copper (Cu). By combining measured faecal nutrient concentrations with estimated prey-consumption and prey-assimilation rates, the study calculated that the current population of approximately 15,000 individuals, in the small management area (SMA) of Svalbard, defecate annually 1,258 ± 259 tonnes (t) N and 1,782 ± 305 t P. The molar ratio of N:P in minke whale faeces was 1.6:1, meaning that N was proportionally limiting, when compared to average elemental ratios of 16:1 in phytoplankton. In the case of no N-limitation in surface waters at that time, the release of elemental P through defecation in surface waters has the potential to stimulate 73,000 t of carbon per year as new or regenerated primary production in the SMA of Svalbard. This amounts to 0.5% of annual new primary production and 0.4

to 4.1% of daily net primary production to this region. This study provides the first assessment of nutrient concentration in whale faeces prior to their dissolution in sea water. Further research, namely on the amount of N released via urine and the proportion of excreted nutrients remaining in the euphotic zone, is needed to better assess the full potential of whale nutrient additions to dissolved nutrient pools in surface waters at regional and global scales.

In discussion, the author advised that research is ongoing in regard to several key questions, including the dissolution rate of nutrients in faeces exposed to seawater, utilisation of excreted nutrients, and nutrient concentrations in urine. Faeces reported in SC/68D/EM/01 were collected from hunted specimens. There is the possibility of obtaining faecal samples from stranded whales. However, it is better to have fresh samples because substances like carbon degrade over time. Additionally, if the whale stranded due to illness, it might not be representative of the whales in the area. The Committee also discussed the need to investigate spatial and temporal variability in nutrient concentrations in faeces from minke whales that would result from different minke whale diets, and also differences in faecal nutrient concentrations across different species of cetaceans. All of the faeces reported in SC/68D/EM/01 were from minke whales that had been feeding on capelin. Tamura advised of his interest in collaborating on future research by collecting faecal samples in the waters off Japan and comparing differences in nutrient concentrations between geographic areas. The Committee noted that there are no existing faecal samples from whales hunted in the past in the Southern Ocean.

The Committee was given a summary of the IWC Conservation Committee Workshop on Socio-Economic Values of the Contribution of Cetaceans to Ecosystem Functioning. The workshop was held virtually on 5th, 6th and 11th of April 2022, and was aimed at reviewing analytical valuation methods and assessing the potential of applying those methods to cetaceans. The workshop received information on the IWC-CMS workshop on cetaceans and ecosystem functioning; the relation of ecosystem functions and services to other traits from marine megafauna and to cetacean carcasses; the possible future impacts of climate change and other threats related ecosystem services; and the United Nations System of Environmental Economic Accounting. The workshop also reviewed market and non-market techniques of economic valuation for ecosystem services, and discussed the need to integrate socio-economic data into marine science policy. The workshop discussed the need to create financial and institutional structures to support the conservation of marine species using the Common Asset Trust and Nature-Based Solutions frameworks. Discussions relating the cetacean traits, identified by the IWC-CMS workshop, to an ecosystem service that could be used from a socio-economic perspective revealed that this is a challenging exercise. A preliminary review of the IWC-CMS table on cetacean traits showed that probably two of the 26 traits identified could be used for direct valuation of ecosystem services because, from a socio-economic perspective, the beneficiaries ultimately need to be humans. Options to include other important traits to enable incorporation of indirect benefits and non-market valuations were discussed. In the short-term, the workshop proposed the development of a pilot project on one species and simplifying the number of functions used. For the medium-term, the workshop proposed modelling potential socio-economic impacts derived from climate change and other threats. Finally, the workshop suggested that the IWC could consider exploring the development of financial and institutional frameworks to create conservation funds for those species that provide socio-economic benefits based on non-market valuation of cetacean ecosystem services.

During discussion, the Committee indicated that the socio-economic values of the contribution of cetaceans to ecosystem functioning need to be assessed for two different time points. The first valuation represents the potential or inherent value of the current system. This initial valuation is the focus of the Committee's present undertaking and will be assessed with a pilot project involving a single focal species. The species to be examined in the pilot project has yet to be determined; species selection will depend on available information. Members of the Committee, particularly the EM Working Group, are encouraged to assist with the pilot project. The second valuation represents the change in the status quo due to any actions taken in accordance with management decisions.

15.2 Review results of ecosystem modelling in the Antarctic Ocean and northeast Atlantic Ocean

Ecosystem modelling is an active area of research of particular interest to the Committee with regard to investigating ecological functions of whales in the ecosystem. The Committee received no papers this year on ecosystem modelling in the Antarctic Ocean or northeast Atlantic Ocean. The Committee noted that some of the discussions in the workshop on the ecosystem functioning of cetaceans overlapped with the ecosystem modelling in these regions (see Item 15.3); therefore, the Committee looks forward to submissions on this topic next year.

15.3 Review progress on estimating pre-exploitation and current abundance of large whale populations

To proceed with the analyses of the 'ecosystem functioning of cetaceans', pre-exploitation and current abundance estimates of large whale populations are needed as these play a fundamental role in understanding ecosystem functioning. At SC68C, the Committee began identifying existing information and potential resources for those estimates in the North Atlantic and Southern Ocean, the main areas of interest to the Committee for investigating ecosystem functioning of cetaceans. The Committee recognised that abundance estimates for several North Atlantic stocks have already been approved by the Committee and used for IST, AWMP or RMP. Both NAMMCO and the IWC have developed tables of accepted abundance

estimates. Therefore, identifying the best abundance estimate for each stock will be a relatively straightforward undertaking for the North Atlantic. In contrast, the Committee has not recently conducted reviews or In-depth assessments for Southern Ocean whale populations. Reviewing existing and identifying the best abundance estimates for the Southern Ocean will be a larger task; notwithstanding that, this region is of primary importance to the Committee's investigations into the ecosystem functioning of cetaceans. The fact that the Secretariat maintains a database of recent abundance estimates for Southern Ocean stocks, including those listed in the IWC Table of Accepted Abundance Estimates, may assist in this regard.

Last year the Committee established an intersessional correspondence group to provide plausible sets of pre-exploitation and current abundance of populations of relevant large whale species in the Southern Ocean and the North Atlantic from the literature, and to conduct additional analyses if needed. Unfortunately, little progress had been made during the intersessional period. However, considering the importance of this information for the Committee's work on the ecosystem functioning of cetaceans, the Committee re-established an intersessional steering group to progress these issues (see Table 23). The steering group's membership includes Kitakado (Convenor) Givens (co-Convenor), Allison, Biuw, Butterworth, Donovan, Elvarsson, Ferguson, Haug, Jackson, Katara, Kelly, Kinzey, Lindstrøm, Moosa, New, Palka, Plaganyi, Punt, Robbins, Sigurdsson, Solvang, Tulloch, Víkingsson, Watters, Witting, and Zerbini. Steering group membership includes expertise on the Committee's statistical and computational needs and priorities, the North Atlantic ecosystem (including representation from NAMMCO), and the Southern Ocean ecosystem (including representation from CCAMLR).

Note that this work is not a complete review of the population estimates (such as is being conducted by the ASI group), but rather the task is to provide a summary of existing population estimates and those based on ongoing work. Furthermore, for assessment models and the estimation of pre-exploitation abundance, the extent and accuracy of the values listed should be commensurate with the accuracy needed for evaluating the contribution of whales to ecosystem functioning in the region in question. The Terms of Reference are as follows:

(1) North Atlantic

- (a) Compile a list of absolute estimates or relative indices of abundance of blue, fin, humpback, right, common minke, and gray whales in all or part of the region north of 60 degrees, including those recorded in the IWC and NAMMCO databases.
- (b) Compile a list of pre-exploitation estimates of abundance for these same species for part or all of the region north of 60 degrees based on modelling studies.
- (c) The extent and accuracy of the values listed should be commensurate with the accuracy needed for evaluating the changed contribution as a result of past harvesting of these whales to ecosystem functioning in this region.

(2) Southern Ocean

- (a) Compile a list of absolute estimates or relative indices of abundance of Antarctic blue, fin, humpback, minke, southern right, sei, and Bryde's whales in all or part of the region south of 60 degrees, including those recorded in the IWC database.
- (b) Compile a list of pre-exploitation estimates of abundance for these same species for part or all of the region south of 60 degrees based on modelling studies.
- (c) The extent and accuracy of the values listed should be commensurate with the accuracy needed for evaluating the changed contribution as a result of past harvesting of these whales to ecosystem functioning in this region.

15.4 Progress on multi-species distribution models (MSDMs)

Duengen *et al.* (2019) presented a model of fin whale distribution on their Nordic and Barents Sea feeding grounds. Understanding cetacean distribution is essential for conservation planning and decision-making, particularly in regions subject to rapid environmental changes. Nevertheless, information on fin whale spatiotemporal distribution is commonly limited, especially from remote areas. Species distribution models (SDMs) are powerful tools, relating species occurrences to environmental variables to predict the species' potential distribution. This study aims at using presence-only SDMs (MaxEnt) to identify suitable habitats for fin whales (*Balaenoptera physalus*) on their Nordic and Barents Seas feeding grounds. The analysis used spatial-block cross-validation to tune MaxEnt parameters and evaluate model performance using spatially independent testing data. The analysis considered spatial sampling bias correction using four methods reflecting the important environmental variables: distance to the shore and sea ice edge, variability of sea surface temperature, variability of sea surface salinity, and depth. Suitable fin whale habitats were predicted along the west coast of Svalbard, between Svalbard and the eastern Norwegian Sea, coastal areas off Iceland and southern East Greenland, and along the Knipovich Ridge to Jan Mayen. The paper concluded that the results support presence-only SDMs as effective tools to predict cetacean habitat suitability, particularly in remote areas like the Arctic Ocean. SDMs constitute a cost-effective method for targeting future surveys and identifying top priority sites for conservation measures.

During discussion, the Committee addressed several analytical and ecological aspects of the fin whale distribution model. The author clarified that all covariates used in a MaxEnt model are re-scaled to lie between 0 and 1; therefore, the model results are not sensitive to the original scale of the covariates. The Committee asked for elaboration on the methods used

Table 23

Tasks, timeline, and responsibilities of the intersessional steering group on estimating pre-exploitation and current abundance of large whale populations.

	Task	Time	Main Responsibility
(1)	Circulate draft separate tables with references for abundance in the North Atlantic Ocean by past surveys and any kind of assessments/ecosystem modelling (including on-going work, but not requiring further ecosystem modelling to estimate pre-exploitation abundances)	By the end of July 2022	North Atlantic team
(2)	Circulate draft separate tables with references for abundance in the Southern Ocean by past surveys and any kind of assessments/ecosystem modelling (including on-going work, but not requiring further ecosystem modelling to estimate pre-exploitation abundances)	By the end of July 2022	Butterworth, Kelly, Moosa, Tulloch
(3)	Comment on tables of abundance estimates	By the end of August 2022	All ISG members
(4)	Zoom meeting to finalise tables of abundance estimates	September 2022	All ISG members
(5)	Complete tables of abundance estimates and send them to the steering group for the workshop on the ecosystem functioning of cetaceans	Late September or early October 2022	Co-Convenors

to determine how much of the variation in the data the model was able to explain. The author explained that the analysis incorporated spatial cross-validation, wherein the data were partitioned into spatial blocks that were alternately used as training and testing datasets. AUC was used to evaluate the model and the resulting AUC values were high; however, the author cautioned that AUC was not designed to evaluate models constructed from presence-only data. The Committee observed that distance to sea ice was considered the most important predictor variable in the model, showing a peak in fin whale habitat suitability that occurred approximately 200km from the mean sea ice edge. The Committee asked what factors might be acting to influence fin whale habitat at that distance from the sea ice. The author replied that fin whales have been recorded only in sea ice-free areas throughout their range, so this association with the sea ice might be related to the ecology of the species. It is also possible that the data were spatially biased, and that a different dataset might produce different results.

El-Gabbas *et al.* (2021a) reported on a dynamic species distribution model used to predict year-round habitat suitability for baleen whales in the Southern Ocean. Species distribution models (SDMs) relate species information to environmental conditions to predict potential species distributions. The majority of SDMs are static, relating species presence information to long-term average environmental conditions. The resulting temporal mismatch between species information and environmental conditions can increase model inference uncertainty. For SDMs to capture the dynamic species-environment relationships and predict near-real-time habitat suitability, species information needs to be spatiotemporally matched with environmental conditions contemporaneous to the species' presence (dynamic SDMs). Implementing dynamic SDMs in the marine realm is highly challenging, particularly due to species and environmental data paucity and spatiotemporal biases. El-Gabbas *et al.* (2021a) implemented presence-only dynamic SDMs for four migratory baleen whale species in the Southern Ocean (SO): Antarctic minke, Antarctic blue, fin, and humpback whales. Sightings were spatiotemporally matched with their respective daily environmental predictors. Background information was sampled daily to describe the dynamic environmental conditions in the highly dynamic SO. The analysis corrected for spatial sampling bias by sampling background information respective to the seasonal research efforts. Independent model evaluation was performed on spatial and temporal cross-validation. The analysis predicted the circumantarctic year-round habitat suitability of each species. Daily predictions were also summarised into bi-weekly and monthly habitat suitability. Important predictors and species suitability responses to environmental changes were identified. The paper concluded that the results support the propitious use of dynamic SDMs to fill species information gaps and improve conservation planning strategies. Near-real-time predictions can be used for dynamic ocean management, e.g. to examine the overlap between habitat suitability and human activities. Nevertheless, the inevitable spatiotemporal biases in sighting data from the Southern Ocean call for the need to improve sampling effort in the Southern Ocean and using alternative data sources (e.g. passive acoustic monitoring) in future SDMs. The paper further discussed challenges of calibrating dynamic SDMs on baleen whale species in the Southern Ocean, with a particular focus on spatiotemporal sampling bias issues and how background information should be sampled in presence-only dynamic SDMs. The paper also highlighted the need to integrate visual and acoustic data in future SDMs on baleen whales for better coverage of the environmental conditions suitable for the species and to avoid constraints of using either data type alone.

Discussion focused on the availability and spatiotemporal resolution of different types of dynamic variables that might influence baleen whale distribution in the Southern Ocean. The Committee noted that physical oceanographic covariates sampled daily and matched to contemporaneous whale sightings provided the dynamical forcing in the model. The spatial and temporal resolution of the environmental predictors vary across datasets, and it was suggested that variables characterised by finer sampling resolutions (in space or time) would likely perform better than coarsely sampled variables.

The author clarified that the analysis considered only physical oceanographic datasets that had a daily resolution; however, the spatial resolution varied across datasets and the 10 x 10 km analytical resolution was a compromise among the datasets. The Committee noted that wind direction, wind speed, and upwelling, both contemporaneous and lagged, have been found to be good predictors of bowhead whale habitat in the Arctic. The author explained that wind and upwelling data are not available across the full extent of the Southern Ocean year-round. The analysis examined whether the variance in sea ice concentration over the preceding 14-day period was associated with baleen whale habitat in the study area. The lagged sea ice variable was not found to be important; however, different temporal lags might produce different results. The sea surface height anomaly is another remotely-sensed physical oceanographic predictor that has shown promise in predicting cetacean habitat in other areas. The analysis incorporated sea surface height (SSH) and current speed data. ADT (absolute dynamic topography) was used to represent SSH, while current speed was estimated from the zonal and meridian components of the absolute geostrophic velocity. The author expressed interest in investigating the use of finite Lyapunov exponent dataset derived from sea surface height anomaly in future investigations.

Furthermore, the Committee acknowledged that the whales are likely choosing their habitat based on the availability of krill, not the physical oceanographic covariates, and asked whether it is likely that the relationship between the physical properties and the krill would remain stationary. The author explained that the Southern Ocean lacks biological data sampled synoptically throughout the region. For example, Krillbase was considered as a potential predictor variable for the model, but the data were not available for the full extent of the study area. Chlorophyll data were also considered, but ultimately were not incorporated into the model because they do not sufficiently cover the study area throughout the year. The spatial coverage of the data was only sufficient from December to March, hindering the use of these data in year-round dynamic models.

The diversity and complexity of analytical methods used for single species distribution models (SDMs) and multispecies distribution models (MSDMs) continues to increase at a rapid rate. To ensure that the Committee can evaluate these types of models and determine whether their results can be used to provide the Committee with management advice, SC68C established an Intersessional Correspondence Group to advance the Committee's work on developing guidelines and possible simulation platforms for SDMs and MSDMs. During the intersessional period, the ICG convenor and co-Convenors conducted small-group virtual meetings to develop a strategy for accomplishing the tasks set forth in the group's terms of reference, and the ICG conducted discussions over email. New scientific literature on SDMs and MSDMs was compiled and added to the previous library developed by the Committee. This work will be continued by an ICG during the upcoming intersessional period.

Attention: SC
The Committee ***recommends*** *continued work under an Intersessional Correspondence Group, with membership of Ferguson (Convenor), Kitakado (co-Convenor), Palacios (co-Convenor), Biuw, Burkhardt, El-Gabbas, Friedlaender, Genov, Herr, McKinlay, Miller, Kelly, New, Palka and Solvang, 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 develop guidelines for multi-species distribution models (MSDMs);*
(3) *to continue to conduct a literature review of SDMs and MSDMs; and*
(4) *to develop possible simulation platforms to evaluate SDMs and MSDMs.*

15.5 Progress with development of individual-based energetic models (IBEMs)

The Committee has developed an individual-based energetic model (IBEM) to be used, *inter alia*, in RMP simulations. The IBEM may be used to incorporate information on prey types, foraging strategies, individual energetics and breeding and feeding cycles into simulations for assessing populations and testing ecological hypotheses to explain population trends. Last year, the Committee agreed that future efforts should be directed towards making the IBEM itself easier and quicker to use, rather than in further refining the emulator for the IBEM.

The chair of the EM Working Group was informed by correspondence that the IBEM developer, de la Mare, has completed the fundamental structures to model multiple species (e.g. humpback and minke whales) in the same environment, including a model with sea ice and krill swarms, but that further time is needed to complete the work. For example, additional programming is needed to allow two species to limit competition through features such as the amount of ice coverage and through behaviours that depend on seasonality, food concentrations, etc. The Committee recognised that the IBEM's estimates of density-dependent cetacean mortality may be potentially useful in parameterising aggregated models (most recently by Moosa and Butterworth, 2017 and Tulloch *et al.*, 2017). Furthermore, the Committee highlighted this synergy between modelling efforts as an example of how cross-fertilisation of ideas and results from different modelling approaches within the Committee may enhance understanding of various aspects of cetacean science. The Committee looks forward to receiving further progress next year.

Table 24

Progress on previous recommendations.

Number	Text	Type	Year	Commission body	Species	Themes	Actions	To be actioned by	Also relevant to	Progress	Last review	Outcome
SC21128	The Committee agrees to continue SDM-related work under a new Intersessional Correspondence Group, with the following members: Kitakado (Convenor), Ferguson (co-Convenor), Palacios (co-Convenor), Biuw, Burkhardt, Friedlaender, Genov, Herr, McKinlay, Miller, Kelly, New and Palka. This group will develop 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.	Workplan action	2021	Scientific Committee, Working Group on Ecosystem Modelling		Ecosystem modelling	(In progress) - continue the work under the Intersessional correspondence group (Annex M) for the tasks (1)-(3) as described in the ToR.	Working Group on Ecosystem Modelling	Research Community	Ongoing	Works are ongoing	Re-established the ICG to continue the work.
SC21129	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.	Workplan action	2021	Scientific Committee, Working Group on Ecosystem Modelling		Ecosystem modelling	(In progress) under SC21128	Working Group on Ecosystem Modelling	Research Community	Ongoing	See above	See above
SC21130	The Committee agrees that future efforts should be directed toward making the IBEM easier to use directly, rather than in further refining the emulator. A possible exception is in the conditioning of RMP trials, where the emulator may be useful for the purpose of making operating model parameters more compatible with the current information.	Recommendation	2021	Scientific Committee, Working Group on Ecosystem Modelling		Ecosystem modelling	(In progress) by a developer		Research Community	Ongoing	Works are ongoing	Continue discussion within EM
SC21131	The Committee agrees to re-establish the intersessional correspondence group with members Friedlaender (Convenor), Biuw, Cooke, de la Mare, Donovan, Kitakado, Palacios and Palka to facilitate this work with new terms of reference: (1) to further develop individual-based energetics models (IBEMs), with emphasis on their application to Southern Hemisphere baleen whale populations and their interaction with krill; (2) find ways to incorporate existing ecological and demographic data; and (3) use the model to infer functional responses for baleen whale feeding on krill.	Workplan action	2021	Scientific Committee, Working Group on Ecosystem Modelling	Baleen Whales	Ecosystem modelling	(In progress)	Working Group on Ecosystem Modelling	Research Community, CCAMLR	Ongoing	Works are ongoing	Continue discussion within EM
SC21132	The Committee reiterates the importance of understanding baleen whale demographics and long-term environmental variability and re-established an intersessional corresponding group led by Cooke (Convenor) with membership of Butterworth, Friedlaender, Kitakado, de la Mare, Palacios and Tulloch to conduct a literature review into the effects of climate change and environmental variability on whales and marine ecosystems.	Workplan action	2021	Scientific Committee, Working Group on Ecosystem Modelling	Baleen Whales	Ecosystem modelling, climate change	(In progress)	Working Group on Ecosystem Modelling	Research Community	Ongoing	Works are ongoing	Continue discussion within EM

Table 25

Summary of the biennial workplan for the Ecosystem Modelling Working Group.

Item	Intersessional	Next meeting	Intersessional	Subsequent meeting
(1) Preparation of estimates of pre-exploitation and current abundance of large whale populations	Intersessional Correspondence Group activity	Review results from the ICG and discuss associated outcomes		
(2) Update of any exercises on krill distribution and abundance	Conduct any data analysis	Review results of analyses		
(3) Ecosystem modelling in the Antarctic and northeast Atlantic Oceans	Continue further analyses	Review results of further analyses	Continue further analyses	Review results of further analyses
(4) Cetacean and ecosystem functioning: a gap analysis workshop	Continue analyses and hold 2nd workshop	Review result of analyses and outcomes of workshop	Continue further analyses/discussion	Prepare for a report to the Commission in 2024
(5) Species distribution models (SDMs) and multi-species distribution models (MSDM)	Intersessional Correspondence Group activity	Review progress of Working Group	Intersessional Correspondence Group activity	Review progress of Working Group
(6) Effect of long-term environmental variability on whale populations	Continue further analyses	Review results of further analyses	Continue further analyses	Review results of further analyses
(7) Further development of individual-based energetic models (IBEMs)	Continue further analyses	Review results of further analyses	Continue further analyses	Review results of further analyses
(8) Modelling of competition among whales and relationship between whales and prey	Continue further analyses	Review results of further analyses	Continue further analyses	Review results of further analyses

15.6 Modelling of competition among whales and relationships between whales and prey

The Committee briefly discussed two related questions regarding krill and whales in the Southern Ocean. The first question was whether the commercial krill fishery might have had or will have effects on food availability for whales in the Southern Ocean. The second question was whether changes in the ecosystem that are not related to the krill fishery have caused krill abundance in the Southern Ocean to decline. The Committee noted that it is generally considered that the fishery for krill has yet to grow to the extent that it might impact natural predators at a regional scale, but there may be local effects from fishing in the neighbourhood of the land-based breeding colonies of some of these predators. It was further acknowledged that these are fundamental issues that CCAMLR addresses. The Committee was informed that CCAMLR has recently undertaken two risk assessments for the krill fishery in the Southern Ocean. It was noted that CCAMLR and the Committee have begun conversations to collaborate on efforts to further progress these investigations, using updated estimates of whale abundance and their krill consumption rates, and also updated estimates of krill biomass or abundance.

Modelling of competition among whales and relationships between whales and prey is a standing agenda Item for the EM Working Group. The Committee received no papers this year on this subject, but it looks forward to receiving information in the future because this is an issue of great interest to the Committee.

15.7 Standing topics

15.7.1 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, 2011c).

The Committee reiterates the importance of understanding the relationships between baleen whale demographics and long-term environmental variability. The Committee acknowledged that other Committee entities (e.g. sub-committees, standing working groups, or intersessional working groups) might have similar interest in these issues, and that it is important to effectively communicate to share information and progress.

15.7.2 Review progress on evaluation of krill distribution and abundance

In the previous meetings, the Committee had been informed that Japan had conducted a dedicated krill survey independent of NEWREP-A in the Indian Sector of the Southern Ocean in 2018/19. The Japanese data are being analysed to estimate the abundance of Antarctic krill in a region of the Antarctic. The abundance estimates would be presented to the SC after the analysis is completed.

Results from the 2019 large-scale krill survey covering CCAMLR management area 48 (Scotia Sea and the Antarctic Peninsula) have recently been published (Krafft *et al.*, 2021). The coverage of this survey was identical to that carried out in 2000, in connection with the SOWER cetacean surveys, and therefore provides a valuable updated estimate of krill standing stock in this key region for krill fisheries.

15.8 Progress on previous recommendations

See Table 24.

15.9 Biennial workplan

See Table 25.

16. SMALL CETACEANS

16.1 Small Cetacean Use as Aquatic Wildmeat

The Committee has prioritised the need to better document the take of small cetaceans for consumptive and non-consumptive purposes. The products from aquatic vertebrates, including small cetaceans, are referred to as 'aquatic wildmeat' and defined as (IWC, 2016a):

> *'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.'*

The detailed documentation of the use of small cetaceans as wildmeat remains a priority and the Committee agreed to maintain the ICG set up for this purpose and to continue collaboration with the Convention on the Conservation of Migratory Species of Wild Animals (CMS) Aquatic Wildmeat Group (AWG).

16.1.1 Progress on identified issues/areas

The Committee collaborates with the CMS AWG to better document the use of small cetaceans as wildmeat and to identify areas of concern. Together, the Committee and the AWG published a review on the use of megafauna (small cetaceans and other species) for aquatic wild meat in the tropics and subtropics as part of their collaborative work programme (Ingram *et al.*, 2022). The review aimed to consolidate literature and knowledge of the exploitation of aquatic non-fish animals for food and other purposes, drawing on diverse literature and resources, including the reports from the series of regional workshops this Committee supported through the Small Cetacean Voluntary Fund, and provide both research and action recommendations. Prideux summarised the review and other intersessional work conducted by the AWG, highlighting that the use of aquatic animals as wildmeat remains widespread, and that in some places has been sustained for millennia, and is an important source of nutrition, income, and cultural identity to local communities. A critical first step is to understand the scope of this exploitation, so that appropriate international policy and conservation management agendas can become more effective. Some regulated hunts do keep records of the number of species taken each year (e.g. IWC, 2019b), but opportunistic take largely remains undocumented and can only be estimated from local community interviews or assessment of skeletal remains that may be kept by some cultures. Throughout the tropics and sub-tropics, all of the reported numbers of takes of small cetaceans, known either through the hunt log books or estimated from community interviews, appears to be unsustainable and, in some areas, economic opportunities to exploit wildlife at higher levels appears to be increasing; the Atlantic humpback dolphin (*Sousa teuszii*), the Burmeister's porpoise (*Phocoena spinipinnis*), short-finned pilot whales (*Globicephala macrorhynchus*), killer whales (*Orcinus orca*) and all riverine dolphins (e.g. *Inia* spp., *Platanista* spp., *Sotalia fluviatilis*). The review concludes with a series of research recommendations, several of which have particular relevance to the work of this Committee and the work of the Conservation Committee.

- Increase quantitative assessments of consumption and trade in aquatic wildmeat to better understand demand and trade pathways.
- Increase research into the ecological sustainability of current harvests, and the population parameters, processes, and science-based management strategies needed to overcome problems, especially in the face of climate change impacts on habitats.
- Where bycatch is a known problem, design and test fishing methods to minimise and ultimately eliminate bycatch mortality.
- Increase research into the use of aquatic wild meat as bait for other commercial fisheries and the possibility of using alternative baits that can be derived sustainably.

In discussion, concern was raised that the use of small cetaceans, as well as sirenians, has been known to increase in times of war or conflict, e.g. Vietnam and Cambodia, and this was noted as an emerging issue in Myanmar, where the use of small delphinids as a source of protein is now being documented.

The Committee commended the authors for this substantive review and noted that this landmark paper will assist researchers and conservation authorities to identify priority areas. The Committee concurred with the review conclusion that the establishment of networks of appropriate experts to foster collaborative efforts to develop regional action plans for reducing unsustainable aquatic wild meat uses was critical. The Committee noted its intention to develop a framework for progress on this issue has been delayed as the issue is complex and requires In-depth discussion. The Committee agrees to make progress on framework development at the next in person meeting of this Committee.

16.1.2 Review of other information

SC/68D/SM/13 reported the results of genetic and toxicological analyses of piracatinga (*Calophysus macropterus*), a scavenger catfish from the Amazon and Orinoco River basins, whose fishery has relied on the intentional killing of river dolphins and caimans for use as bait, mainly in the central Amazon. A previous genetic study revealed that piracatinga were being sold in Brazil as processed fillets labelled with fictitious names to deceive consumers (e.g. Carvalho *et al.*, 2020).

Due to the potentially unsustainable impact on river dolphin populations, and to the threat to human health posed by the consumption of this mercury-rich species, Brazilian authorities issued in 2015 a five-year moratorium on the fishing, storage and trade of piracatinga. This study reports the analyses of fillets labelled as surubim, dourada, piramutaba, mapará and piranambu, purchased in supermarkets, apprehended in fish processing plants, or offered as meals in a public school during the moratorium (2017-18; *n*=133). Nearly half (47%) of the samples were genetically identified as *C. macropterus*, with 89% of fillets from supermarkets belonging to this species. Mislabelling involving this and other species was revealed in 100% of fillets from supermarkets. Total mercury concentration was above the safe limit for predatory fish set by FAO (1.0mg. kg-1), ranging from 0.27 to 1.92mg. kg-1 in 44% of the *C. macropterus* fillets. This study revealed that despite the moratorium, the piracatinga has continued to be fished and commercialised, and consequently the moratorium may not have been effective in reducing the impact of the illegal fishery on dolphin and caiman populations. Additionally, the weekly consumption of even small amounts of piracatinga weekly can be toxic and a health risk for humans.

SC/68D/SM/15 detailed a survey conducted by INPA (National Institute of Amazonian Research) and Sea Shepherd Global in the five segments of three rivers of the Central Amazon, where the high number of interactions between dolphins (the boto *Inia geoffrensis* and the tucuxi *Sotalia fluviatilis*) and fishing activities is considered the main threat to these species. Observations of the overlap of fisheries and dolphins was collected, in addition to information on any observed dolphin carcasses. In the first survey (October 2021), it was noted that areas that had high numbers of fishing nets were strongly correlated with a lower encounter rate of botos, indicating a potential conflict between this species and fishers. Despite the ban on piracatinga fishing and trade, there was evidence that this illegal activity was still taking place. It was noted that although entanglement in fishing gear (e.g. gillnets) was also a significant threat to both Amazon river dolphin species, it was acknowledged that this was more difficult to address in the short term, compared to illegal piracatinga fishing.

Mosquera-Guerra *et al.* (2022) provides a systematic review of literature published since 1980, together with structured surveys of researchers, to identify areas where Amazon river dolphin products are consumed or traded. Unsustainable fishing practices in large parts of the Amazon, Tocantins, and Orinoco basins have been a principal cause of the declines in Amazon River dolphins leading to IUCN listing the species as Endangered. So-called byproducts of bycaught or stranded dolphins are used in a variety of ways – the flesh and blubber as bait for the piracatinga fishery and, more recently, for human consumption. Organs are used for traditional or medicinal purposes. Fifty-seven areas were identified where botos were used as wildmeat (33 in the Amazon, two in the Tocantins, 22 in the Orinoco and two more on the Brazilian Atlantic coast), with recent reports of targeted take for consumption in the upper Orinoco River. Areas where Amazon River dolphin byproducts are trafficked were also identified. This information was integrated with a kernel density analysis of the distribution of boto populations and indicated that the use of boto as wildmeat is geographically widespread. It was stressed that decision-makers should direct policies towards mitigating the socioeconomic and cultural circumstances associated with illegal practices affecting boto populations.

The Committee noted that the current ban on piracatinga fishing in Brazil will end in June of 2022 (Item 9.1.5). The Committee recognised the importance of this ban for the conservation of the boto and strongly supported the renewal of the piracatinga fishing ban.

16.2 Potential CMP Small Cetaceans

16.2.1 Asian River dolphins (Platanista minor)

SC/68D/SM/14 reported preliminary findings on the first successful satellite telemetry tagging of any freshwater dolphin in Asia. Three Indus River dolphins *(Platanista minor*) were fitted with ARGOS satellite tags (Wildlife Computers) in the Indus River, Sindh, Pakistan. The dolphins were rescued from a canal in Dadu (1 male) and a disconnected mainstem side channel (2 females), on 11th and 15th January 2022, respectively. All were released just above the Sukkur barrage in the Indus Dolphin Reserve, a 1,250km^2 protected area between Guddu (28°25’07.74’N, 69°42’46.95’E) and Sukkur barrages (27°40’45.68’N, 68°50’45.55’E). The two adult females have been transmitting locations since 15th Jan 2022, 97 days to the time of writing, while after a few messages, the tag on the young male did not transmit any more data. The preliminary data from satellite tracking has provided some insights into ranging patterns. It has also helped to identify how various riverine features – confluences, side channels and the mainstem – are used. The two dolphins appear to have spent equal percentages of time (42% recorded locations) in the Indus mainstem. One dolphin recorded 41% and 17% and the other, 21% and 36% of locations in confluences and side channels, respectively. The longest distances travelled for each female were 44.8km and 11km, upstream towards Sukkur barrage. These initial results appear promising for a large-scale telemetry study in Pakistan, and also for applications elsewhere in Asia and in South America. Khan anticipates using the data obtained from this initial effort to improve understanding of dolphin movement patterns in relation to water flow variations and of habitat use and preferences more generally within the Indus, a highly managed river system. It is also expected that telemetry work will help monitor post-release survival of rescued dolphins and will support conservation planning for long-distance translocations in the future.

In discussion it was suggested that in future reporting on their work, the authors add details on how the tags were programmed. Also, it was suggested that they consider using GPS tags rather than Argos-only tags as this would improve

reliability of the data. The authors were encouraged to pursue efforts to locate, resight and photograph the tagged individuals so that potential issues related to tag attachment and wound healing are evaluated. In conclusion, the Committee acknowledged the authors for sharing these preliminary results and commended their ground-breaking work with this threatened species of river dolphin. The Committee also requested that future analyses of this tagging study be shared when appropriate.

16.3 Previous recommendations

16.3.1 Finless porpoise (Neophocaena spp.)

The Committee last conducted a comprehensive review of finless porpoise (*Neophocaena* spp.) in 2005. The Committee has continued to review and receive updates on the status of the freshwater population in the Yangtze River, however, marine populations of finless porpoise have not been considered further although several area-specific issues were noted during the last five years. The 2005 review highlighted the need for taxonomic clarification and noted that further work was required to elucidate population structure throughout the genus' range. At that time, some areas of high density were identified but it was unknown whether these populations were isolated or were part of a wide-ranging and contiguous population. High levels of bycatch were documented from some parts of the genus's range. Also, high levels of mortality from multiple causes have been recorded in areas such as Hong Kong SAR (IWC, 2021c). The purpose of this review is to provide an update on the status of marine finless porpoise populations and, where there is new information, fill previously identified knowledge gaps and assess current threats. This is not intended to be a review of all new information, but an update to assist the Committee in identifying previous recommendations that have been addressed and to better understand the conservation status of marine finless porpoise.

16.3.1.1 Taxonomy and Status

At the time of the previous review of the status of marine populations, only one species of finless porpoise was recognised. The genus has since been divided into two species, the Indo-Pacific finless porpoise (*N. phocaenoides*) and the narrow-ridged finless porpoise (*N. asiaeorientalis*), following the recognition of two reproductively isolated populations with distinctive external morphology and differences in cranial osteology (Amano *et al.*, 1992; Jefferson *et al.*, 2002; Jefferson and Wang, 2011; Wang *et al.*, 2008). The narrow-ridged species comprises two subspecies: the East Asian finless porpoise (*N. a. sunameri*) and the freshwater Yangtze finless porpoise (*N. a. asiaeorientalis*). Outside East Asia, external morphology is less well understood, however, new research shows that pigmentation of finless porpoise in Kuwait and the United Arab Emirates (UAE), differs from those elsewhere, with distinctive white colouration of the mouth and ventral area that is present in both adult and young individuals (Fig. 8). This colouration has also been observed in one stranding reported in Shirgaon, Palghar, Maharashtra, India (Nithyanandan and Bohadi, 2021). In the South China Sea, finless porpoises tend to be uniformly gray, though both light and dark-pigmented individuals have been recorded around Hong Kong (Fig. 9). A recent review of molecular data suggests that the genus should be further investigated as existing, but limited, molecular data point to divisions between the Indo-Pacific porpoise of the Indian and Pacific Oceans (Lin *et al.*, 2017).

The conservation status of the two recognised species of finless porpoise was assessed for the IUCN Red List in 2017. It was noted that the narrow-ridged finless porpoise was relatively better studied than the Indo-Pacific species. The narrow-ridged finless porpoise is currently classified on the Red List as 'Endangered' primarily because of significant declines in population size in some areas, due to incidental mortality in fisheries. The Indo-Pacific finless porpoise, which has a much broader range and which is still less studied than the narrow-ridged porpoise, is classified as 'Vulnerable' because declines in population size have been recorded, or are suspected, in several areas. Both species are threatened from the combined impacts of interactions with fisheries, habitat loss and degradation, prey depletion and pollution (Wang and Reeves, 2017).

16.3.1.2 Distribution

Both species are restricted to shallow, tropical and temperate waters, however, it was noted in 2005 that many parts of the species range that were poorly documented. Contributors to this review provided first-hand data in addition to published information, to help fill gaps in our knowledge of the species' ranges.

Arabian/Persian Gulf, Arabian Sea, Bay of Bengal and Andaman Sea

The Indo-Pacific finless porpoise has been recorded in several areas within the Arabian/Persian Gulf, Arabian Sea, Bay of Bengal and Andaman Sea. Information was presented for the United Arab Emirates (UAE), Saudi Arabia, Kuwait, India and Thailand. In the UAE, finless porpoise regularly occur in coastal waters of Dubai and Abu Dhabi. In the northern Emirates, only one sighting has been recorded in Ras Al Khaimah (2013) and a single stranding in Umm al Quwain (2015). To date, no sightings or strandings have been recorded in other northern Emirates either on the Musandam Peninsula or in the Gulf of Oman. Between December 2012 and April 2019, a citizen-science programme recorded 25 finless porpoise sightings in Emirati waters, with the highest occurrence near the cities of Dubai and Abu Dhabi (Natoli *et al.*, 2021). Between May 2019 and April 2022, an additional ten (10) sightings were recorded both close to the mainland and in waters adjacent to offshore islands. Between 2014 and 2021, 5,444km of line transect survey effort was completed in Dubai waters. A total of nine (9) sightings were recorded, three (3) in 2020 and six (6) in 2021, resulting in an encounter rate of 0.001 finless

Fig. 8. Pigmentation patterns of Indo-Pacific Finless Porpoise (*Neophocaena phocaenoides*) in (1) Kuwait, the Arabian/Persian Gulf (© M. Pope, reproduced from Nithyanandan and Bohadi (2021) and (2) Hong Kong waters (© L. Porter, SEAMAR).

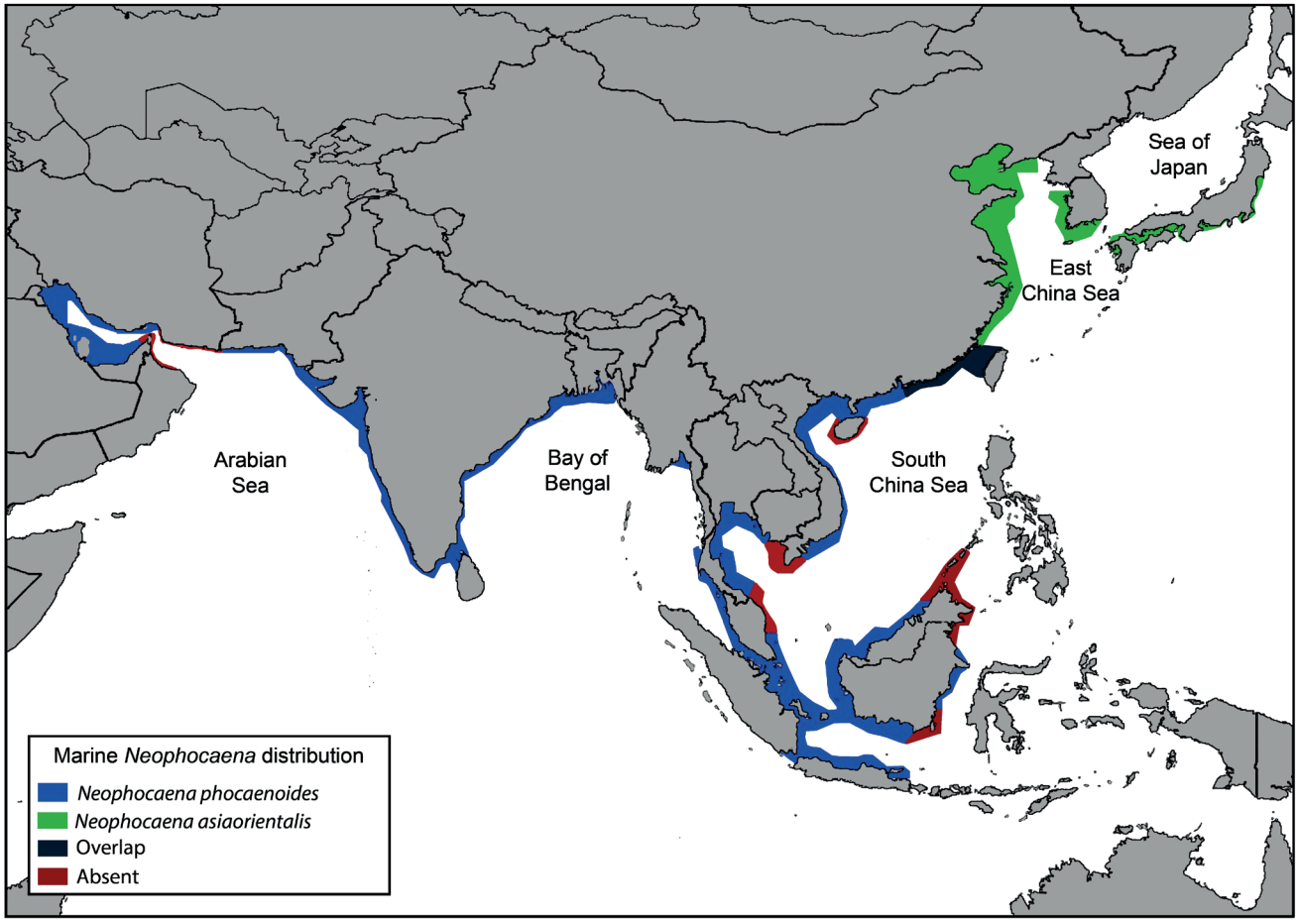


Fig. 9. Distribution of the marine populations of Finless Porpoise, based on sightings and strandings data contributed to the IWC 2022 review.

porpoise per km. Finless porpoise were consistently recorded in the same area each year, between the Palm Jumeirah and the World Island. Additionally, in 2021, two (2) sightings were recorded opportunistically ~15km offshore. In both years, calves were observed and the maximum recorded group size was seven (7) (Natoli, pers. comm.). Since 2010, eight (8) strandings have been recorded, of which three (3) occurred in 2021. Only one (1) stranding was fully necropsied and of the strandings that could be inspected, no signs of entanglement in fishing gear were evident (Natoli *ibid*).

In Saudi Arabia, two line transect surveys were conducted in coastal waters from the Qatar to Kuwait maritime borders, including Bahrain, between 2018 and 2019. No finless porpoise sightings were recorded. Opportunistic records between February 2016 and August 2020 documented only two (2) sightings and one (1) stranding on the northern Saudi Arabian coast between Al-Kalji and Ras Al Khai, suggesting that this region of the Arabian/Persian Gulf is sparsely populated by porpoise (Rabaoui *et al.*, 2021).

A recent review of incidental mortality between January 2010 and May 2020 recorded 27 incidents, confirming finless porpoise occurrence in Kuwait's coastal waters (Nithyanandan and Bohadi, 2021). The strandings included individuals judged to be adults, sub-adults, calves and neonates, leading to speculation that a resident population may occur in the area. Sightings have been recorded near Failaka Island in the north, and Al Khiran in the south (Amr, 2021; Bishop *et al.*, 2013).

In Iran, a compilation of marine mammal records from universities, natural history museums, Department of Environment (DoE) offices, Iranian Fisheries Research Organisation (IFRO) centres and various non-governmental wildlife organisations (NGOs) confirmed 25 records of finless porpoise; 23 were from the Persian Gulf and two from the Gulf of Oman (Braulik *et al.*, 2010). Records appear to be concentrated around Bushehr, near the head of the Arabian/Persian Gulf, and Qeshm Island, near the Strait of Hormuz. It is unclear whether distribution is continuous between these two areas.

In Pakistan, recent reviews of published, unpublished and anecdotal accounts of cetacean sightings, strandings and research initiatives summarised species diversity and distribution as well as threats to local cetaceans. Finless porpoise were recorded year round along the entire coastline, though they occurred more frequently inshore and during the northeast monsoon period (July to September) (Gore *et al.*, 2012; 2017; Ibrahim *et al.*, 2021).

In India, a comprehensive review of marine mammal strandings recorded between 1748 and 2017 showed that finless porpoise strand consistently on both the west (Arabian Sea) and the east (Bay of Bengal) coasts, with slightly more strandings recorded on the west coast since at least the early 20th century (Dudhat *et al.*, 2022). This review combined records of finless porpoise with records of 'dolphins' and therefore must be considered a very coarse indication of stranding patterns.

In Bangladesh, vessel-based line-transect surveys conducted in February 2004 recorded finless porpoise between the Sundarbans Mangrove Forest and the Matamuhuri and Bagkhali Rivers (Smith *et al.*, 2008).

In Myanmar, the presence of finless porpoise was confirmed in the Gulf of Mottama based on opportunistic boat surveys in 2018 (Htay *et al.*, 2019).

In Thailand, the Thailand Strandings Network recorded finless porpoise along both the west (Andaman Sea) and the east (Gulf of Thailand) coasts between 2002 and 2012. The finless porpoise was the second most frequently stranded species on both coasts (Adulyanukosol *et al.*, 2012). The Satun-Langkawi Archipelago, which straddles the Thailand-Malaysia border, has been designated as an Important Marine Mammal Area (IMMA) as finless porpoise occur there in significant numbers[27].

Finless porpoise occur predominantly on the west coast of peninsular Malaysia, in the Straits of Malacca, particularly Penang Island (Rodríguez-Vargas and Yobe, 2018) and Matang, the State of Perak where they are present year-round (Kuit *et al.*, 2021). Opportunistic records and reports from the media and the Department of Fisheries, the Government of Malaysia, indicate that the species occurs throughout all coastal waters of Peninsular Malaysia (Ponnampalam, 2012).

Indo-Malay Archipelago and South China Sea

The Indo-Pacific finless porpoise has been recorded in several areas within the Indo-Malay archipelago and South China Sea and its distribution begins to overlap with that of the narrow-ridged finless porpoise in the vicinity of Hong Kong (22.3°N). Information was presented for China, including Hong Kong and Macau, and for Malaysia, Indonesia and Brunei. An update on information presented to this Committee in 2021 for Taiwan is also included in this update. A comprehensive strandings network operates in the Philippines but no finless porpoise have been recorded in Philippine waters.

In East Malaysia, finless porpoise are observed year-round in the states of Sarawak and Sabah. In Sarawak, sightings appear to be concentrated in Kuching Bay, along the Similajau-Kuala Nyala coastline and around Miri (Minton *et al.*, 2011b; 2013). Since 2006, 29 strandings and incidental takes have been recorded, based on reports from the fishing community and social media (Sarawak Dolphin Project, unpublished data). In Sabah, only two finless porpoise strandings have been recorded, both on Sabah's west (South China Sea) coast (Chen *et al.*, 2017b).

In Brunei, only a handful of opportunistic sightings and eight (8) strandings were recorded between 1990 and 2022. All records came from the southwestern districts of Belait and Tutong. No records exist for northeastern districts of Brunei-Muara and Temburong, including Brunei Bay.

[27] *https://www.marinemammalhabitat.org/portfolio-Item/satun-langkawi-archipelago/.*

In Indonesia, at least 20 strandings have been recorded by Whale Stranding Indonesia[28]. The majority of strandings originated in East Kalimantan, with records also from Bangka-Belitung, Riau, Jakarta, Central Kalimantan and West Kalimantan. On 1 August 2021, a single finless porpoise stranded after being incidentally caught in a gillnet off Sumenep, Madura Island, East Java Province. Genetic analyses confirmed that it was an Indo-Pacific finless porpoise. This stranding has prompted interest in surveying the waters adjacent to Madura Island, to better understand distribution in Indonesian waters and assess threats to the species.

In Vietnam, a summary of marine mammal strandings compiled from social media between 2004 and 2018 recorded 16 finless porpoises, ranging from Quang Ninh province in the north to Tien Giang province in the south (Vu and Ponnampalam, 2018)[29].

In Cambodia, the results of boat-based surveys conducted in 2001 suggest that the waters of Kompong Som Bay were, at least at that time, important habitat for finless porpoise (Beasley and Davidson, 2007).

Finless porpoise are the most commonly stranded cetaceans in Hong Kong, and both species are represented in the stranding record[30]. Hong Kong is the southernmost confirmed location for the narrow-ridged finless porpoise. It is presumed, given that only two narrow-ridged finless porpoise have been identified in the Hong Kong strandings record over the last 25 years, that most sightings and acoustic detections in Hong Kong and adjacent waters are of Indo-Pacific finless porpoise. Finless porpoise are recorded throughout Hong Kong waters, except the northwest, where freshwater influence of the Pearl River is at its strongest. Numbers peak inshore during the northeast monsoon (December to May) although passive acoustic monitoring data from both fixed and towed array transect surveys indicate that they occur in Hong Kong waters year-round (IWC, 2021c; Wong, 2021). Macau SAR is located on the western banks of the Pearl River Estuary and the city of Zhuhai lies just to the north. There are no recorded sightings of finless porpoise from within the western reached of the pearl River Estuary, which is influenced all year round by freshwater flow, however, a handful of strandings have been recovered from these waters (Lin *et al.*, 2019)

In southern China, Indo-Pacific finless porpoise have been recorded in Guangxi, Hainan, Guangdong and Fujian. Strandings and bycatch records sourced from government documents between 2000 and 2006 (Wang *et al.*, 2015) and social media reports between 2008 and 2019 (Liu *et al.*, 2021; 2022) suggest that distribution along the South China Sea coast is likely contiguous, with the exception of the east coast of Hainan.

The East China Sea and the Sea of Japan

In China, narrow-ridged finless porpoise occur in coastal areas of the Bohai Sea, Yellow Sea and the northern Taiwan Strait (Liu *et al.*, 2021). Interview surveys of fishermen along the south coast of the Bohai Sea suggest that the western coast of Laizhou Bay and the area south of the Yellow River Estuary are hotspots for this species (Cheng *et al.*, 2021). Sightings appear to peak in April and September and decrease between November and February. Records sourced from government documents between 2000 and 2006 also suggest that the south coast of the Bohai Sea is a hotspot of finless porpoise strandings and bycatch, with a peak between March and May (Wang *et al.*, 2015). Boat-based line transect surveys in the Bohai Sea and Yellow Sea indicate sighting hotspots in Laizhou Bay, Changdao Island and Laoshan Bay, with peaks in encounter rates between March and November (Cheng *et al.*, 2022).

In Taiwan, both species of finless porpoise occur. Between 2016-20, 62 of the 161 porpoise that stranded were identified to species; 66% were Indo-Pacific finless porpoise and 34% were narrow-ridged finless porpoise. The majority of strandings occurred along the north and west coasts of Taiwan, which have significantly shallower waters than the east coast. Strandings peaked during the onset of the south monsoon (May). Since 2016, there has been a marked increase in the number of finless porpoise strandings that could not be attributed to changes in reporting procedures of the national strandings programme or increased public awareness (IWC, 2021c).

In the Republic of Korea, narrow-ridged finless porpoise are sighted year-round on the west (Zhang *et al.*, 2004) and south coasts (Choi *et al.*, 2010). Distribution appears to be fairly continuous from Busan to Mokpo and north to the border with Democratic People's Republic of Korea. Stranding and bycatch records indicate finless porpoise may also be found along the north coast of Jeju Island, though to date, no sightings have been reported south of the islands of Jeollanam-do.

Finless porpoise are well studied in Japanese waters. On the Pacific coast, they range from the west coast of Kyushu, through the Inland Sea, Ise Bay, and Tokyo Bay, to Sendai Bay, occupying areas with depths of <50m and non-rocky substrates. At least five distinct populations have been identified, including one in the Inland Sea of Japan (Shirakihara *et al.*, 2007).

This review goes some way towards fulfilling the previous recommendation of this Committee to improve understanding of where both species occur and are likely absent, particularly the western extent of the range of the Indo-Pacific finless porpoise. A distribution map is included, based on data contributed to this review, which include confirmed sightings, as well as strandings and bycatch records. In addition to the Philippines, there are seven areas where surveys have been

[28] *http://www.whalestrandingindonesia.com/.*

[29] *https://rpubs.com/Long_Vu_CCES/395186.*

[30] *https://www.opcf.org.hk/en/conservation-research/hong-kong-marine-life-stranding-online-database.*

Table 26

Estimated abundance of finless porpoise (made available since the previous review).

Geographical population	Estimated abundance*	CV	Year	Notes	Source
Narrow-ridged finless porpoise					
Korea (offshore)	58,650 (95% CI=34,961-98,389	26.38	2001	West Coast Offshore Korea (WCOK)	Zhang *et al.* (2004)
Korea (inshore)	1,571 (95% CI=881-2,800)	29.15	2003	West Coast Inshore Korea (WCIK)	Zhang *et al.* (2004)
Inland Sea of Japan	7,572	17.3%	2000	-	Shirakihara *et al.* (2007)
Indo-Pacific finless porpoise					
Hong Kong (summer monsoon)	101.7	0.77	2019	Reviewed ASI (2022)	Jefferson and Moore (2020)
Hong Kong (winter monsoon)	112.6	0.26	2019	Reviewed ASI (2022)	Jefferson and Moore (2020)
Kuching Bay, Malaysia	135 (95% CI=74-246)	0.31	2007-10	-	Minton *et al.* (2013)
Matang, Perak, Malaysia	600 (95% CI=354-1,016)	27%	2013-16	-	Kuit *et al.* (2021)
Bangladesh (inshore)	1,282	54.8%	2004	Nearshore waters	Smith *et al.* (2008)

*Reviewed by the ASI Working Group.

conducted and/or strandings programmes operate and no finless porpoise have been recorded, as follows: the Gulf of Oman (both Iran and Oman coasts), the outer reaches of the Gulf of Thailand (the south coasts of Cambodia and Vietnam), the north end of Borneo (from west coast Sabah, Malaysia to North Kalimantan, Indonesia), south east Borneo (South Kalimantan, Indonesia) and eastern Hainan Island, China (Fig. 9).

16.3.1.3 Population Structure

Evidence for genetic structure (population differentiation and distinctiveness) has been examined for both Indo-Pacific and narrow-ridged finless porpoise inhabiting the Bohai Sea, Yellow Sea, East China Sea, Taiwan Strait and northern region of the South China Sea in Guangdong Province (Jia *et al.*, 2014; Lin *et al.*, 2014; 2017). Different genetic markers have been used in these studies, including mitochondrial DNA control region, microsatellites, and genomic single nucleotide polymorphisms (SNPs). Genetic differentiation was generally observed between the putative populations examined. For instance, significant genetic differentiation between the three recognised species/sub-species (originally diagnosed using morphological characters and geography) would be expected. By increasing the sampling effort, genetic structure was eventually detected across the species/subspecies range, including differentiation between populations in the Bohai/northern Yellow Sea and southern Yellow Sea, Taiwan Strait and Pearl River Delta region, and the Yangtze River. The most recent theories posit the divergence between the narrow-ridged and Indo-Pacific finless porpoise as being a result of lower sea levels during the last glacial maximum, which interrupted gene flow through Taiwan Strait. Following this logic, glacial isolation might also be expected in the eastern Malay Peninsula, Sri Lanka and Malacca Strait as these areas were isolated during the periods of lowest sea level, but any such predictions remain to be tested with increased sampling and research effort in those regions.

A recent review proposed that the genetic divergence between the two forms of finless porpoise is substantially lower than the range of species-level divergences observed for most cetacean congeners, however, our current understanding may be based on inadequate sampling (Hao, pers. comm.). For instance, most of our current knowledge about the genetic structure of the genus is restricted to east Asian coastal and Japanese waters, and is particularly limited for the Indo-Pacific finless porpoise from Southeast Asian waters and the Indian Ocean, with only one individual from the Persian Gulf and two from the west coast of Indian. A preliminary study suggests that the divergence (ϕst based on control region sequences) between Indo-Pacific finless porpoise in the Indian Ocean and Pacific region was >0.75, much greater than the inter-species divergence documented in Taiwan Strait and the average species-level divergence for cetaceans.

16.3.1.4 Abundance

Since the last SC review, several abundance estimates for additional areas have been published, however, the degrees of connectivity between populations or hotspots remain poorly understood. Available estimates are provided here, however, not all of these have been evaluated by the ASI Working Group as the Committee does not, at this time, intend to use the estimates as a basis for management recommendations. In some countries, surveys have covered a substantial portion of a population's range, e.g. the Sea of Japan, whereas in other locations abundance estimates refer to only a portion of what is believed to be a larger population, e.g. Hong Kong (Table 26).

16.3.1.5 Ecology

Stomach content analysis has been used in Korea and Japan to identify prey species of narrow-ridged finless porpoise; in Korean waters, 13 species of crustaceans, eight fish species and three cephalopod species were identified (Park *et al.*,

2005) and in Japanese waters, more than 31 fish species, seven cephalopod species and three crustacean species were identified (Shirakihara *et al.*, 2007). In the Bohai, Yellow and East China Seas, 21 prey species were identified (16 fish, two cephalopods, two crustacean and one bivalve mollusc species') using morphological and DNA-based approaches. All studies indicate that the narrow-ridged finless porpoise is a generalist with regards to prey choice (Chen *et al.*, 2017a; Lu *et al.*, 2016). The prey species of Indo-Pacific finless porpoise is less well studied; in Hong Kong, stomach content analysis identified 25 fish species, three of cephalopod genera and one crustacean species (Barros and Clarke, 2002) and in India, prey items principally consisted of fish species from two genera (*Clupeidae* and *Loliginidae*) (Krishnan *et al.*, 2008).

Significant knowledge gaps remain in what is known of prey species for specific populations and, concomitantly, by-catch risk, in many areas. In recent years, however, the use of passive acoustic monitoring (PAM) techniques has provided new insights to the distribution and behaviour of some populations of finless porpoise, particularly in relation to soniferous fish prey species. In Laizhou Bay, China, a static PAM station was deployed to investigate the potential relationship between porpoise and their prey. Porpoise were acoustically detected year-round, however, detection rates differed between spring (April-May) and autumn (September-October) in concert with fish choruses. During spring, fish choruses occurred throughout the afternoon, and porpoise vocalised more frequently during this season. In autumn, when fish choruses were absent, porpoise detection rates decreased and diurnal patterns were not detected. In the Yellow River Estuary, both towed and static PAM was used to gain information on the spatial distribution of porpoise and soniferous fishes. In spring, a higher density of acoustic detections was recorded in the northern part of the estuary and central Laizhou Bay compared to the southern part of the estuary and western Laizhou Bay. Only two types of fish calls were identified in the northern Yellow River estuary and central Laizhou Bay, with a particularly high density of fish choruses recorded in central Laizhou Bay (Cheng *et al.*, 2022).

In Hong Kong waters, both towed and static PAM was used to obtain information on the diurnal occurrence of porpoise. Porpoise vocalisation density was higher at night and distribution was more widespread throughout the habitat, compared to daytime periods. General Additive Modelling indicated that porpoise night-time occurrence was related to lunar phase, tidal height, temperature, water depth and seabed slope, although it was noted that more effort was required to sample the area effectively (SMRU Hong Kong 2018[31]). During both visual and acoustic surveys, no observations were made of mixed schools of finless porpoise and Hong Kong's other resident cetacean, the Indo-Pacific humpback dolphin. In Sanniang Bay, Guangxi Province, China, where finless porpoise and Indo-Pacific humpback dolphins both reside, one incident has been recorded of a single finless porpoise calf with a large group of dolphins of multiple age classes (Pan Wenshi, pers. comm.)

In the United Arab Emirates (UAE), ecological niche modelling analysis showed that the finless porpoise has a broader area of suitable habitat in the Gulf than the other two most often sighted species: the Indo-Pacific bottlenose dolphin and the Indian Ocean humpback dolphin. The strong correlation to different environmental variables compared to the other two species suggests that this relates to different prey preference (Natoli *et al.*, 2021). There are no records of finless porpoise mixing with other cetacean species, despite the small size of the total habitat area.

At this time, interactions between finless porpoise and predators, e.g. sharks and killer whales, remain poorly understood, with little evidence of predation apparent in the large strandings database compiled in recent years, noting these data are dominated by the well-developed strandings networks in the East and South China Sea area.

16.3.1.6 Threats

Both species of finless porpoise are threatened by take, both directed and incidental, pollution (chemical contaminants as well as noise), habitat loss and degradation, ship strike and altered prey availability. Vast gaps remain, however, in understanding the extent of these threats on specific populations or areas. Some isolated studies provide indications that throughout their range, both species of finless porpoise are impacted by multiple threats and are in decline. For example, in the Bohai Sea, more than half of the fishermen interviewed during a survey of local ecological knowledge, reported an overall decline in population and attributed this to increasing pollution, declining prey resources and ongoing fishery bycatch, although it was noted that direct take for consumption rarely occurred (Cheng *et al.*, 2021). In the Yellow River Estuary specifically, and likely elsewhere, underwater noise that masks fish choruses could interrupt finless porpoise feeding success, in addition to the negative impacts of intensive fishing of these prey species on both resource availability and the rate of entanglement in fishing gear (Cheng *et al.*, 2022). In Taiwan, an analysis of strandings between 2019-20, indicated that of the known causes of death, bycatch accounted the highest proportion or mortality, followed by ship strike and disease (IWC, 2021c). In Kuwait, where cause of death was determined, ship strike accounted for the highest proportion, followed by bycatch of recovered finless porpoise strandings (Nithyanandan and Bohadi, 2021) and in Iran, the high number of bycaught individuals recorded suggests that incidental mortality in fishing gear is unsustainable (Braulik *et al.*, 2010). There is little information on the level of directed take, however, it seems unlikely that this is a significant threat, compared to bycatch. Noting that many Asian cultures do use cetaceans as wildmeat, it is likely that both direct and opportunistic direct take occurs (Porter and Lai, 2017).

[31] *http://env.threerunwaysystem.com/en/meef/disclaimer-meef2018010.html*.

Threats to narrow-ridged finless porpoise are being actively mitigated in one area. In the Yellow Sea, Korea, large numbers of finless porpoise are bycaught in several different fishing operations, e.g. stow nets, gill nets, trawl and set nets. The Korean National Institute of Fishery Science (NIFS) has established a five-year plan (2022-27) to develop bycatch mitigation methods for several fishing gears. Stow net modification trails are already underway and gear modified with escape hatches and varying mesh sizes appears to have reduced bycatch (see this report, Item 12.5; SC/68D/HIM/12).

In Hong Kong, the application of virtopsy techniques has greatly improved the ability of veterinarians to assign cause of death to stranded Indo-Pacific finless porpoise. Between 2017 and 2020, 92 finless porpoise were subjected to virtopsy procedures, of which 34.8% causes of death were attributed to human-interactions (vessel strikes and fisheries bycatch). It is hoped that this standard assessment procedure for finless porpoise strandings in Hong Kong will provide management authorities with clearer direction on where to focus management efforts for this species, particularly as the local mortality rate has increased significantly in the last five years (Kot *et al.*, 2021).

16.3.1.7 Advances in Study Methods

Both new technology and the application of more accessible and/or affordable technology has facilitated progress in several areas of study. Imaging technologies, e.g. post-mortem computed tomography (PMCT), post-mortem magnetic resonance imaging (PMMRI), post-mortem ultrasonography (PMUSG), and three-dimensional surface scanning (3DSS), to perform 'virtopsies' are powerful tools that have provided significant new insights to parasite load, disease and trauma. Such technologies augment conventional necropsy practices by enabling image-guided examination and sample collection by veterinarians and pathologists, e.g. Chan *et al.* (2017). In Hong Kong, the use of virtopsy procedures in the local marine life stranding programme has substantially improved the diagnosis of pathological findings and the ability of researchers to determine cause of death of finless porpoise and other species (Kot *et al.*, 2021). Imagery of stranded cetaceans from other areas has also been provided to the Hong Kong virtopsy team, e.g. Granados-Zapata *et al.* (2022), demonstrating that the techniques and protocols developed in Hong Kong can be used regionally to improve understanding of finless porpoise mortality elsewhere.

Previously, this Committee recommended that passive acoustic monitoring techniques be used to determine their usefulness to improve understanding of the distribution and behaviour of finless porpoise, particularly given the difficulty of sighting this small and cryptic animals at sea. The parameters of finless porpoise vocalisations have been well documented (Li *et al.*, 2007; Song *et al.*, 2017), however, acoustic detection thresholds (the minimum number of echolocation clicks in a click train required to confirm presence) are less well studied. In Hong Kong, several different acoustic and visual survey methods have been used to better define these thresholds and then apply them to estimate the percentage of porpoise missed by observers during visual line-transect surveys, as well as to better determine porpoise density in low light or poor visibility conditions. For Indo-Pacific finless porpoise in Hong Kong, the minimum detection threshold for towed acoustic surveys is ≥ 5 Narrow Band High Frequency (NBHF) clicks in any click train, which is similar to that reported for harbour porpoise (*Phocoena phocoena*) (≥ 6 NBHF: (Gillespie *et al.*, 2005) and other species that produce NBHF, such as Heaviside's dolphin (*Cephalorhynchus heavisidii*) (≥ 5 NBHF: Martin *et al.*, 2020).

Unmanned Aerial Systems (UAS) have been used to study both species of finless porpoise. The use of UAS for studying finless porpoise is of particular interest, as their small size, lack of a dorsal fin and cryptic behaviour make them challenging to study using traditional visual methods. In Japan, UAS imagery was used to assess individual and group response to vessel traffic and provided new insights into narrow-ridged finless porpoise social behaviour (Morimura and Mori, 2019). In Hong Kong, surveys for Indo-Pacific finless porpoise were conducted using a variety of UAS models and cameras. It was demonstrated that porpoise can be detected at distances up to 90m, using even the most basic camera, and there was no evidence to suggest that UAS presence at altitudes between 30-90m elicited behaviours indicative of disturbance (Brannan, unpublished data). In Hong Kong, and elsewhere, where porpoise habitats are difficult to survey by vessel, the use of UAS has immense potential as a tool to better understand behaviour and to estimate population density parameters.

16.3.1.8 Progress on Previous Recommendations

In 2021, the Committee highlighted several knowledge gaps with regards to understanding the status, including population structure, of *Neophocaena* spp. throughout their range. This updated review, prepared by the finless porpoise intersessional group, although not exhaustive, does highlight progress on several previous recommendations:

- research efforts have increased on the Indo-Pacific porpoise in the western regions of its distribution;
- progress has been made on determining the frequency and cause of mortality; and
- passive acoustic monitoring techniques have been assessed and are being used to provide improved density estimates and behavioural patterns.

The Committee commended the finless porpoise intersessional correspondence group on its growing collaboration and data sharing and although progress made on previous recommendations was noted, the Committee again expressed its concern over the status of the genus *Neophocaena* throughout its range. The Committee requested the group to continue to work in the intersessional period, to coordinate data collection and analyses wherever possible and to progress towards an assessment of the genus throughout its range.

16.3.2 Atlantic humpback dolphins (Sousa teuszii)

Minton presented the annual report of the Consortium for the Conservation of the Atlantic Humpback Dolphin (CCAHD, 2021). The report highlighted the increasing participation of range-countries, the higher number of range-state nationals taking leadership roles, the launch of a trilingual website[32] with multiple downloadable resources[33], successful fund-raising for, and implementation of, government engagement and research projects, and the establishment of a foundation under Dutch law. Research projects involving interview surveys and boat-based surveys conducted by CCAHD partner organisations are currently underway in Congo, Gabon, Cameroon, Liberia, The Gambia, Senegal, and Guinea. Continued fundraising efforts will enable partners to implement the priority actions identified in the CCAHD Priorities Report (CCAHD, 2020). These priorities address multiple recommendations made by the IWC SC in previous years.

Keith-Diagne presented preliminary results of Atlantic humpback dolphin (*Sousa teuszii*) research conducted in the Saloum Delta, Senegal (SC/68D/SM/12). The Delta hosts one of the largest and potentially least depleted populations in the species' known range. The CCAHD prioritised this area for research and the African Aquatic Conservation Fund (AACF) has initiated a long-term research and conservation programme. Beginning in July 2021, two dedicated surveys were conducted to map distribution, habitat use and threats, and to obtain imagery suitable for photo-ID. Encounter rates were comparable to those documented in 2015 (Weir, 2016), but the distribution of encounters was concentrated in the north (as opposed to the south) of the Delta. More than 14,000 images were collected and are being processed for a photo-ID catalogue that will provide the basis for generating mark-recapture abundance and population trend estimates, as well as information on individual ranges and reproductive parameters, body condition, and health over time. One Sound Trap (ST) and one F-POD were deployed and recovered at two locations beginning in July 2021 and have yielded about 30 days of continuous recording on the ST and 60 days of automated detection on the F-POD. Initial review indicates that both units documented click trains congruent with dolphin vocalisations. Three more units were deployed in March/April 2022. Carcass recovery and sampling began in 2018. To date, three *S. teuszii* carcasses have been examined and genetic samples collected. Environmental DNA collection will begin in June 2022. Two awareness raising meetings were held for Senegal government stakeholders/partners, and training was provided for five African researchers from Senegal, The Gambia, Mauritania, Nigeria, and Cameroon.

In discussion, it was noted that there is a petition to list *S. teuszii* as an endangered species under the United States Endangered Species Act (ESA), with the goal of leveraging the United States Government to provide support for conservation of the species. The CCAHD is providing technical support and resources for the ESA review process, as well as for the CMS Concerted Action (CA) for the species. It was recognised that both the petition and the CMS CA were potentially significant in drawing attention to the plight of the species.

The apparent change in distribution between the 2015 study by Weir (2016) and this study was noted, and it was confirmed that the differences in distribution of encounters were not due to discrepancies in effort but likely representative of a shift in habitat use from the southern area of the Delta to the northern area, however, the drivers underlying such a shift are currently unknown.

The Committee noted that a comparison of the 2015 and current photo-ID dataset could be used to estimate population size and examine shifts in individual habitat use. The Committee encouraged all data holders to conduct a comparison of the 2015 and current photo-ID datasets, and offered its assistance to facilitate this process, if required.

In discussion, it was noted that direct threats to *S. teuszii* in the Saloum Delta are not yet fully assessed but the greatest one is likely bycatch. It was noted that direct hunting of *S. teuszii* has not been observed or reported, as yet. As bycatch events are difficult to observe and document, future research will include mapping of fisheries effort and interview surveys, to obtain data for bycatch risk assessments.

The Committee commended CCAHD on the excellent progress in developing a research and conservation workplan, obtaining funding and implementing a suite of projects on a species for which this Committee has expressed considerable concern. The Committee reiterated its strong support of the CCAHD workplan and requested that an update be provided at next year's Committee meeting.

16.3.3 Vaquita (Phocoena sinus)

Rojas-Bracho summarised the 2021 vessel-based survey (17 October to 3 November) (SC/68D/SM/06) and the Expert Elicitation (EE) analysis of the survey results. This survey was conducted in the same way as those conducted in 2019 and 2020 (Rojas-Bracho *et al.*, 2020; 2021;), primarily to address three objectives:

(1) Determine how many unique individuals (adults and potential calves) were sighted;
(2) Determine how many individual calves (only) were sighted; and
(3) Determine whether any poor health indicators were observed when vaquitas were sighted.

[32] *https://www.sousateuszii.org/*.
[33] *https://www.sousateuszii.org/resources/*.

Rojas-Bracho noted that a manuscript covering both survey periods (2019 and 2021) had been submitted to a scientific journal, examining the question of whether vaquitas are doing better than had been expected given the data on abundance and trend collected since 2018.

Surveys in 2021 were conducted from two vessels (R/V *Narval* from the Museo de la Ballena y Ciencias del Mar and M/V *Sharpie* from Sea Shepherd Conservation Society), using previously developed techniques to combine acoustic and visual monitoring (Rojas-Bracho *et al.*, 2021). In 2021, there were only five days of weather suitable (Beaufort >3) to survey within the Zero Tolerance Area (ZTA: as defined by the Mexican Government in 2020). Survey effort of the ZTA was also hindered by the large numbers of pangas and illegally deployed gillnets. Nonetheless, vaquita were sighted eight times over 5 days and all appeared in good health, although no images of sufficient quality were obtained for photo-ID therefore, it was not possible to conduct a mark-recapture analysis estimate incorporating previous data. Thus, an Expert Elicitation (EE) was used to estimate the number of unique calves and the total number of unique vaquitas (including calves) encountered during the surveys (SC/68D/SM/07). The EE process was the same as that used in 2019 (Rojas-Bracho *et al.*, 2021) and included the 2019 recommendation that an 'evidence dossier' should be compiled for each sighting during the survey itself to maximise the level of detail.

The EE for the 2021 survey concluded that the median distribution for the number of calves observed was 1.5, with approximately equal probability of 1 or 2. For the unique number of vaquitas sighted (including calves), the most likely values were 7 and 8. The final distribution indicated a 78% belief that the true number of unique vaquitas sighted was between 6 and 10. Overall, the EE results suggested that the number of calves (and correspondingly the total number of unique vaquitas) seen in the ZTA had decreased between 2019 and 2021. Because the surveys covered only the ZTA, where acoustic data indicate the highest chances of encountering vaquitas, the EE estimates should be interpreted as minimum values. A large portion of the historical range of the species, where vaquitas could still be present in low densities, has not been surveyed, either acoustically or visually, since 2018.

Jaramillo Legoretta presented background information on the use of passive acoustic techniques to study vaquita relative abundance and distribution since 1997 (SC/68D/SM/10). In the period 1997-2007, recording equipment was deployed from a vessel and the acoustic data were used to infer population trend. Comparison of acoustic results with 1997 and 2008 abundance estimates, generated using a visual distance sampling approach, demonstrated that acoustic data are reliable for inferring relative abundance (Taylor *et al.*, 2016).

Beginning in 2011, a monitoring program that used autonomous acoustic detectors (C-PODs) was implemented in a grid of 46 sites inside the Vaquita Refuge. Through 2018, the programme detected an average annual population decline of 45%. A 2015 abundance estimate of 59 individuals (95% CRI 22-145), was followed by a 2018 acoustic data-based estimate of only about nine individuals remaining (95% CRI 6-19) (SC/68D/SM/10). In 2017 and 2018, acoustic activity was detected mainly towards the southwestern portion of the Refuge. In 2019, after an increase in illegal fishing activities, over 60 moorings and C-PODs were lost, and acoustic detections by those remaining decreased markedly. Similar to previous years, acoustic activity was primarily detected in the southwestern portion of the Refuge, mainly inside the ZTA. Loss of equipment during the 2021 sampling period reduced sampling to only 31 sites out of the usual 46. As in 2019, sampling was also attempted in the ZTA between October and November. Again, over 50 moorings and C-PODs were lost. In 2021 acoustic activity was again detected mainly in the ZTA, higher in the western and central portions, and occasionally towards the eastern area.

Acoustic sampling in 2022 will be attempted only inside the ZTA and during neap tides, when fishing effort decreases significantly; in 2019 and 2021 this strategy was effective in minimising equipment loss. During a pilot study in April 2022, vaquita acoustic activity was detected at two of three sites monitored inside the ZTA, showing that vaquitas were still using at least this portion of their habitat.

Taylor presented evidence from several reports available online that refute recent claims that illegal fishing has been reduced within the ZTA, the last stronghold of vaquitas (SC/68D/SM/09). Earlier recommendations by the Vaquita Recovery Team (CIRVA - Comité Internacional para la Recuperación de la Vaquita) had stressed that vaquitas could be saved from extinction only if gillnets were banned throughout their range and fishermen adopted viable vaquita-safe fishing methods. The October/November 2021 vaquita survey within the ZTA took place during shrimp season. The launching of fishing vessels during daylight hours with gillnets clearly visible onboard was observed both within the harbour next to the Navy station and from a site further towards the San Felipe town centre. Illegal gillnetting was observed on all survey days; on 1, 2 and 3 November, for example, minimum counts within the ZTA were 72, 66 and 117 vessels, respectively. On 3 November vessel locations were plotted to document the hindrance of survey efforts[34]. The total length of gillnets deployed in the ZTA on 3 November 2021 was estimated to be between 117km (1km net/panga) and 234 km (2km net/panga). Using the lower estimate of km gillnet per panga, there was enough gillnet deployed to traverse five complete lengths of the ZTA (5x24km). Observations from land during the winter months when totoaba and curvina fishing occurs also showed high levels of illegal fishing activities in both the 2020/21 and the 2021/22 seasons with a maximum count of 58 pangas recorded on 10 January

[34]See IUCN – SSC Cetacean Specialist Group *http://iucn-csg.org*.

2022. This was at a time when an accord between the Mexican Navy and the Sea Shepherd Conservation Society was in place and illegal fishing was allegedly reduced within the ZTA. If vaquitas are to be saved from extinction, at a minimum, the ban on gillnet fishing in the ZTA must be enforced, and current evidence demonstrates this is not happening.

The Committee commended Rojas-Bracho, Jaramillo Legorreta, Taylor and their teams of science and conservation collaborators, including volunteer observers monitoring the presence of vessels and gillnets in and adjacent to the ZTA, cooperating fishermen and those involved in net-removal operations, for their continued efforts to save the vaquita.

In discussion, it was noted that the 'trigger plan' currently being applied by the Government of Mexico allows up to 65 fishing vessels at a time to fish with gillnets inside the ZTA (24 September 2020, Article 17 Enforcement Plan). The ZTA remains a no entry zone, however, gillnet fishing activities are carried out without respecting the regulations established by the relevant authorities. During the 2021 vaquita surveys, on 1, 2 and 3 November minimum counts within the ZTA clearly exceeded the 'trigger' number, however, no observed enforcement of the no-entry regulation was subsequently conducted. This clearly indicates there have been numerous occasions when the 'trigger plan' is not being enforced and gillnetting is allowed unchecked. The Enforcement Plan, including trigger factors, is mandated to be reviewed every six months and it seems that a review is essential given the current observed failings. It was further noted that Article 2 (Sept. 24, 2020[35]) prohibits the use of gillnets for fishing in, or transport within, delimited areas and especially within the ZTA, transport of gillnets in the marine zone or in terrestrial areas less than 10 km from the coast and, construction, or sale of gillnets in the marine zone, or in the towns nearby, and that there was unambiguous evidence that no enforcement takes place. It was opined that the Enforcement Plan review must improve the strategy for prompting enforcement activities, e.g. the triggering factors could include detection of violations outside the ZTA itself, such as violations that occur during transportation of nets by road, where it would be much easier to quantify violations and take actions, as compared to the difficulty of counting pangas directly inside the ZTA, where their presence increases the risk to remaining vaquitas.

The impacts of widespread, unregulated gillnet use on other large vertebrate species in the Upper Gulf of California was also discussed as a matter of grave concern over the bycatch of other cetaceans, including large whales, in addition to pinnipeds, turtles, elasmobranchs and other marine wildlife, with no monitoring or management of this mortality. It was highlighted that a resident population of bottlenose dolphins found only in the Upper Gulf of California have been killed as bycatch in parallel with vaquitas since gillnets were first introduced in the region, and the current abundance and status of this dolphin population is unknown (IWC, 2017h).

The Committee expresses extreme frustration that despite decades of warnings and recommendations to the Commission and the Government of Mexico, and the adoption of IWC Resolutions and promises of action, the situation is increasingly dire even though the singular threat – bycatch in fishing gear – is well known. The vaquita will certainly become extinct in the near future, with the IWC apparently powerless in preventing the extinction of the species, unless the well-understood requisite actions to eliminate the risk of entanglement in illegal gillnets are effectively implemented. These illegal nets continue to be deployed throughout the vaquitas' range, and the range of other megafauna, even in the so-called ZTA.

Attention: C, CC, CG Mexico

The Committee recalls its previous concerns and recommendations regarding the declining status of the vaquita and reiterates the urgent recommendations of the past six Committee meetings, detailed in Annex Q.

*The Committee **draws attention to** evidence that clearly indicates the vaquita population is still decreasing and that the threat of gillnet entanglement, including in and near the Zero Tolerance Area (ZTA), is increasing. Contrary claims of vaquita recovery in some media are false and have been refuted by this Committee given the multiple lines of evidence presented. Gillnetting within the ZTA has increased since 2018 due to the continuation of illegal fishing for totoaba, and the openly conducted and increased illegal fishing for shrimp and finfish.*

*The Committee **strongly recommends** that to provide the best possible assessment of the declining vaquita population, the acoustic monitoring and visual survey work planned between May 2022 and June 2023 be fully funded and that the Mexican authorities take steps to assure that the field teams can carry out this work safely and efficiently and **requests** that an update be provided of this monitoring at the next SC meeting.*

*The Committee **emphasises** that between 6 and 10 (0.78 probability) vaquita remain and the species is close to extinction solely due to entanglement in gillnets and **stresses** that any inferred demographic gain from the small number of vaquita births documented since 2019 has probably been offset by unrecorded bycatch given that:*

[35]1 Diario Oficial de la Federación. Acuerdo por el que se regulan artes, sistemas, métodos, técnicas y horarios para la realización de actividades de pesca con embarcaciones menores y mayores en Zonas Marinas Mexicanas en el Norte del Golfo de California y se establecen sitios de desembarque, así como el uso de sistemas de monitoreo para tales embarcaciones (Sept. 24, 2020), available at: *http://www.dof.gob.mx/nota_detalle.php?codigo=5601153&fecha=24/09/2020*; see also Ex. A: Legal Fishing Guide for The Upper Gulf of California.

(i) nets that kill vaquitas are still in the water;
(ii) very little monitoring of beaches (for stranded carcasses) has taken place since the start of the pandemic; and
(iii) calves and young individuals are the age classes most vulnerable to bycatch.

*The Committee **urges** the Government of Mexico to fully permit and fund the implementation of alternative fishing gears for shrimp and legal finfish to help communities eliminate the need to fish illegally by providing viable, legal livelihoods that do not endanger vaquitas and other megafauna species.*

Attention: SC, S,
*The Committee **notes** that the Agreement to ban gillnets including Article 17 on Inspection and Surveillance Functions is not achieving its main purpose, which is to remove fishing vessels and gillnets from inside the Zero Tolerance Area (ZTA) of the Upper Gulf of California therefore, the Committee **strongly recommends** that a review and revision of the Enforcement Plan be urgently undertaken and this review should include additional and strengthened actions that aim to effectively cease the manufacture, sale, transport and use of gillnets, all of which are currently prohibited by law.*

An emerging issue was highlighted with regards to the recent approval, by the Standing Committee of the Convention on International Trades of Endangered Species of Wild Flora and Fauna (CITES), to permit the international, commercial trade in captive bred totoaba meat by Earth Ocean Farms (EOF); an aquaculture operation based in La Paz, Mexico. Concerns were raised that given the difficulty in identifying captive bred versus wild caught totoaba, this legal trade will obscure the continued expansion of illegal gillnetting for wild totoaba. It was noted that both the Mexican Government and EOF have committed to prohibit the trade of swim bladders from captive bred totoaba and that all swim bladders from EOF operations (currently stored and future) will be destroyed, until approval from the CITES Standing Committee, however, concerns remained that the commercial breeding operation will mask illegal fishing and thus exacerbate the decline of the vaquita.

Attention C, CG, S, IGO; CITES
*The Committee **expressed concern** over the certification of mariculture facilities (currently Earth Ocean Farms) to export totoaba products due to the impossibility of discriminating between illegal and legal products thus providing an expanded avenue for the continued trade in illegal catches that, in turn, will incentivise the illegal setting of gillnets in the vaquita's habitat.*

*The Committee further **noted** that CITES has agreed that IWC are the primary body that advises on whale issues, however the decision by the CITES Standing Committee to approve trade that directly impacts the survival of the vaquita was done so without consultation with IWC. The Committee, therefore**, requests** that the Secretariat sends a letter to CITES expressing the considerable concerns of the Committee and to also **respectfully request** that members of this Committee be included in any visit(s) planned by CITES to Mexico to assess the totoaba trade-vaquita paradigm.*

16.3.4 Strait of Gibraltar killer whales

SC/68D/SM/03 provided an update on over 250 interaction events involving killer whales (*Orcinus orca*) and vessels along the Atlantic coast of the Iberian Peninsula and adjacent waters. Interactions consistently involved 14 individual whales, most of them juveniles, that occur in four groups. Analysis shows that most of the vessels 'targeted' in these interactions were medium-sized (<15m), spade-rudder sailing vessels (average speed 6kn), that could have been either sailing or motoring. Interactions occurred year-round but peaked between June and September, the summer and early autumn months. Although interactions were recorded throughout daytime and night-time hours, there was a peak at midday. Interactions lasted an average of 35 min. The behaviour of the killer whales when interacting with boats was not considered aggressive, although no clear motive for this novel behaviour was apparent. It appeared to be curious and playful, something that could have arisen spontaneously or could have been catalysed by a specific event and then carried forward into further interactions. As interactions intensified in certain areas, several mitigation measures, to protect both whales and boat users, were introduced. These included a temporary ban on sailing vessels entering specific areas and in Portuguese waters, and an advisory notice to whale-watching boats to stay away from these killer whales. A study is underway seeking to understand the motivation for this behaviour. The research will be conducted from a medium-sized sailing vessel that will manoeuvre in a variety of ways, e.g. stop, accelerate, reverse, change direction, etc., to see what actions provoke particular types of whale behaviour and to document what seems to trigger interactions. Two types of noise deterrents will also be tested, i.e. metal tubes and pilot whale vocalisations.

In discussion, it was suggested that special attention be given to addressing existing assumptions concerning whale behaviour, in particular the current media misrepresentation of the behaviour as 'aggressive'.

The Committee thanked the authors for presenting such a thorough overview, encouraged the continued monitoring of the whales and supported the proposed study aimed at better understanding the potential triggers of this behaviour. In conclusion, the Committee agrees to continue the Intersessional Correspondence Group (ICG) and invited an update at next year's meeting.

16.3.5 Management of the Solitary Sociable Dolphin in Northwest Spain

Simmonds presented a report from the ad hoc Working Group on the Spanish Solitary Dolphin, concerning a male juvenile common bottlenose dolphin (*Tursiops truncatus*) known as 'Confi'. The dolphin has been living on the coast of Galicia, northwest Spain, since December 2019 in a region that is popular with swimmers, divers and fishermen. His increasingly tactile interactions with people triggered a request from the Spanish Government to the IWC for advice. An ad hoc working group was established and met twice intersessionally. At the first meeting, information on solitary sociable dolphins was reviewed, with particular focus on the behaviour progression (Eisfeld *et al.*, 2010; Nunny and Simmonds, 2019) and unpublished information on similar situations with a bottlenose dolphin in Ireland and a pantropical spotted dolphin (*Stenella attenuata*) in Hong Kong. Solitary social dolphins typically display increasingly tactile behaviour if their interaction with people is prolonged. These behaviours have the potential to injure people, sometimes seriously, and the dolphins themselves are at a higher risk of being injured or killed by human activities. 'Confi' appears to fit the typical sequence model of a solitary sociable dolphin; including biting, preventing swimmers from leaving the water, knocking the mask and regulator from a diver, biting the airlines of shellfish divers. The local NGO Coordinadora para o Estudo dos Mamíferos Mariños (CEMMA), has been monitoring the dolphin regularly, mapping his range and behaviour. To ensure the welfare and safety of both, the ad hoc group recommended that a discrete management plan be developed that clearly defines what constitutes disturbance and harassment. Other recommendations included: providing information in the form of boards and brochures; establishing 'Guardians of Information' and 'Godmothers' or 'Godfathers' (i.e. points of contact to relay information to CEMMA and the authorities); the establishment of a permanent evaluation committee; and the establishment of a veterinary assistance team. In discussion, it was noted that a solitary sociable dolphin in the Netherlands had died as a result of anthropogenic trauma (Ijsseldijk *et al.*, 2020). This highlighted the Committee's concern that both dolphins and humans were at risk if such events and interactions were not properly managed. The Committee agrees to maintain the *ad hoc* working group and provide support to the Spanish authorities, and others, who may require guidance.

16.3.6 Lahilles dolphin (Tursiops truncatus gephyreus)

SC/68D/SM/08 presented the annual progress report on the work of the Lahilles dolphin (*Tursiops truncatus gephyreus*) Task Team, which was established in March 2021. In 2020, the Committee recommended that:

- an assessment of population status in Argentina be conducted;
- authorities should be encouraged to take immediate action to reduce the level of bycatch (particularly in southern Brazil);
- monitoring should be continued to permit the assessment of life-history parameters, trends in abundance and the prevalence and etiology of chronic skin diseases; and
- a health assessment programme should be implemented.

In 2021, no significant progress was made on the assessment of population status in Argentina. Although no significant actions were taken to reduce the level of bycatch, there were no reported deaths at Patos Lagoon Estuary and Laguna in southern Brazil for the first time in 20 years. In discussion, it was noted that this apparent reduction in mortality could have been a result of a change in fisheries dynamics and/or cryptic mortality. In southern Brazil and Uruguay, photo-ID surveys resumed at seven sites. Preliminary results indicate that there are fewer than 300 individuals across these seven sites, with an apparent survival rate of 0.89 (CV and reference). In Argentina, photo-ID surveys have not been conducted since 2012. There has been no progress on documenting the prevalence and etiology of chronic skin diseases or the implementation of a health assessment programme, due to difficulties with securing funding.

In 2021, this Committee also encouraged the Task Team to;

- coordinate the regional efforts between Argentina, Uruguay and Brazil to estimate and monitor population parameters;
- seek ways to work cooperatively with fishing communities and fisheries authorities to reduce bycatch; and
- explore potential synergies with the franciscana CMP.

Two virtual meetings were held with the Southern Brazil-Uruguay (SBU) and Argentina research teams, during which information was exchanged regarding the usual activities each group conducts, the main goals for the next year, and the priority actions for the next five years. Five different projects were funded (four in SBU and one in Argentina) to conduct photo-ID studies, train surveillance agents, conduct interviews with fishermen and promote conservation of Lahille's bottlenose dolphins and cooperative fishing through community-based tourism. In September 2021, a workshop was held in Laguna, Brazil, where 40 participants were trained in mark-recapture analytical techniques. Surveys for the next two field seasons were planned and a virtual space of sharing dorsal fin catalogues was created, which now contains 280 individuals from seven different locations. In addition, more than 30 agents from three different governmental agencies (IBAMA, ICMBio and PATRAM) participated in a training programme designed to build the skills and capacity required to combat illegal fisheries at a regional scale, with a focus on the Patos Lagoon Estuary. A citizen surveillance app was also developed, specifically to record illegal fishing activities in coastal areas, and both sightings and strandings of Lahille's bottlenose dolphins.

The Committee thanked Fruet for the update and commended the task team on the progress made despite the challenges of the global pandemic. The Committee requested that the task team provide a report at next year's meeting.

16.3.7 Review of previous recommendations

At SC68B a review and consolidation of previous recommendations was initiated, and an Intersessional Correspondence Group (ICG) was established to further assess the recommendations on small cetaceans included in the new IWC Database of Recommendations (IWCDoR). The goal of this exercise is to eventually assess which recommendations led to significant progress in that particular issue, and characterise any factors or components that contributed to successful (= effective) recommendations to guide future efforts. Progress has been made in compiling information on individual IWCDoR records into a database, identifying related and equivalent recommendations and tracking responses to the recommendations and progress in completing any specified actions. Trujillo and Jimenez presented the killer whale and the franciscana as examples of how this process works. It was suggested that an approach for identifying and tracking related or equivalent recommendations, the timeliness with which the recommendations were implemented and changes in public policy, if any, due to implementation of the recommendations. The proposed framework will also identify recommendations that have not been addressed and will allow the Committee to assess a more appropriate approach to effecting action or developing a new strategy to fulfil the recommendations of this Committee

The examples presented indicated that having engaged and responsive national governments and state or provincial agencies, positively influenced the recommendation outcome. Future recommendation review will also assess the effectiveness of recommendations made where no one individual or group was identified to drive the proposed process or when multiple agencies are requested to take action, but no individual or group takes responsibility for converting the recommendation(s) into policy. Recommendations requiring inter-organisational coordination or collaboration, such as with CMS or IUCN, were encouraged, as findings thus far suggested that this is more likely to result in positive action and progression towards a more favourable conservation status for the species or population in question. It was noted that one important outcome of making formal recommendations is that funding bodies view this as expert support of a related research proposal and thus research groups are more likely to obtain funding, especially in the initial stages of a project.

The Committee recognised the progress made on database compilation and welcomed the inclusion of more members to the ICG. It was highlighted that future analyses should be mindful of how the change in recommendation format and the ICG should develop a process and provide comparisons in the framework design. It was noted that some recommendations can take many years to be disseminated, understood, agreed and implemented before any progress is observed and this will complicate analysis. It was suggested that for these instances, a detailed history of how a recommendation has been translated into action should be incorporated into the analysis. It was reiterated that when populating the database with older recommendations, that are not in the current required format, any revision or refocus of the original recommendation must be avoided.

Once all recommendations have been inserted into the database, the ICG will be divided into species and/or regional groups, and will evaluate the effectiveness of relevant recommendations. It was suggested that as an initial target, ten species should be assessed. It was also suggested that the analyses include: the identification of bottlenecks in the implementation of recommendations, determination of what topics progress effectively and what topics should be priorities moving forward. Although challenging, it was acknowledged that where appropriate, recommendations made by other sections of the committee that affect small cetaceans should be integrated into the database.

The Committee commended Trujillo and Jimenez on the progress made on the review and agrees to maintain the Intersessional Correspondence Group on the Review of Recommendations and to expand its membership. The Committee also agrees to progress in the analyses of the recommendations made for ten species.

16.3.8 Other

16.3.8.1 Integrated Conservation Planning for Cetaceans (ICPC)

In 2021, the Committee received information on the goals and objectives of the Integrated Conservation Planning for Cetaceans (ICPC) team. SC/68D/SM/11 briefly reviewed ICPC with a focus on progress made since May 2021. ICPC is a sub-group within the IUCN Species Survival Commission's Cetacean Specialist Group. The ICPC team was formed in response to the desperate situation for an increasing number of endangered riverine and coastal dolphin and porpoise species and populations and the need for research and management to build our understanding of species biology and the threats these species and populations face. Six ongoing projects aiming to fill critical knowledge gaps were reviewed.

Atlantic humpback dolphins (Sousa teuszii) – Conservation Action Plan Project. In 2020 scientists involved with the ICPC, as well as the IWC and CMS, collaborated to form the Consortium for the Conservation of the Atlantic Humpback Dolphin. Boat-based field surveys in the Saloum Delta, Senegal and in the Tristao Islands, Guinea, will be completed in 2021. Standardised interview surveys of fishing communities will be conducted in seven range countries, commencing in 2022, with a goal of better understanding species distribution.

*Indus (*Platanista minor*) and Ganges River dolphins (*Platanista gangetica*) – Capacity Building Project.* The frequent entrapment of Indus and Ganges dolphins in irrigation canals in Pakistan and India has resulted in the translocation

of dolphins from the canals back to the river mainstem on a regular basis. New alliances have been formed that will build urgently needed capacity through training local first responders and collecting data in order to improve long-term conservation efforts.

*Franciscana dolphins (*Pontoporia blainvillei*) – Health Assessment Project.* Up to six franciscanas will be caught, tagged and released off the coast of Argentina to document movement patterns relative to coastal fisheries. During the process of handling for tagging, health assessments will be conducted by experienced veterinarians.

*Franciscana dolphins (*Pontoporia blainvillei*) – Neonate and Juvenile-Adult Rehabilitation Protocols.* Live-stranded franciscana dolphins, especially neonates that typically die within hours of stranding, require rapid response. A neonate care protocol has been developed and juvenile and adult franciscana handling procedures have been improved. The development of mobile animal care units is underway.

*Lahille's bottlenose dolphins (*Tursiops truncatus gephyreus*) – Epigenetic Aging Analysis Project.* Improved knowledge of age structure, population demography and health status will provide a broader basis for protection of this subspecies that totals only around 600 individuals. To fill one data gap, a pilot study is underway to develop a skin-based, epigenetic technique to estimate age.

Capture myopathy – Critical Data Gaps Project. A virtual workshop was held in 2021 with the primary goal of developing a better understanding of capture myopathy, which is an essential veterinary consideration for hands-on conservation work with small cetaceans. The workshop report is in the final stages of review and will be shared with the scientific community upon completion.

*Yangtze Finless Porpoise (*Neophocaena asiaeorientalis asiaeorientalis*) – Steps towards a One Plan Approach.* In 2019, a workshop considered the Chinese government's Action Plan for Saving the Yangtze Finless Porpoise, which states the goals of increasing the size of the *ex situ* metapopulation and increasing the number of *ex situ* reserves. A further virtual workshop is planned for late 2022, to conduct a PVA that analyses the risks of extinction and loss of genetic diversity by including both the *in situ* and *ex situ* populations as components of a range-wide metapopulation.

Discussion focused on the objectives of the ongoing projects, progress with the Yangtze finless porpoise abundance surveys, prospective new ICPC components and the potential for coordination with IWC on additional projects. Taylor noted that the goal of developing a neonate (and eventually juvenile/adult) rehabilitation protocol for franciscanas was to learn as much as possible from stranded animals in order to learn more about individual variability in stress response and other aspects of health assessment, given the high number of neonate strandings. Cipriano noted that in cases such as the franciscana, although ICPC held a workshop and is developing health assessment protocols, including coordination with a long-term tagging programme[36], the main conservation planning effort for this species is related to development of the CMP, and ICPC wishes to help with that. Wang Ding explained that the planned range-wide abundance survey for Yangtze finless porpoises had been delayed because of recent COVID-19 outbreaks in China, which delayed both observer training and the survey start. Taylor noted that ICPC intended to limit the number of projects it supports in order to focus on making progress on the most critical issues. Identifying potential projects and prioritizing conservation needs, in parallel with discussion of how subpopulations are assessed within the IUCN assessment programme, will be the subject of a 2-day workshop to be held prior to the Society for Marine Mammalogy Conference, 30-31 July 2022, in Florida, USA. SC members are welcome to participate either in person or virtually. Further discussion included the potential of *ex situ* measures to distract from or divert resources from the *in situ* programmes. Taylor clarified that in all ICPC projects, research will be oriented to addressing critical knowledge gaps, supporting *in situ* conservation and helping conservation scientists become better prepared to handle conservation emergencies.

16.4 South Pacific Island Small Cetaceans

16.4.1 Review of SPREP work on small cetaceans

K. Baird presented an overview of the South Pacific Islands region and the role of the Secretariat of the Pacific Regional Environment Programme (SPREP). The region, as defined by the Noumea Convention and the Convention of Migratory Species (CMS) Memorandum of Understanding (MoU) for the Conservation of Cetaceans and their Habitats in the Pacific Islands Region (CMS, 2007), consists of the marine areas under the jurisdiction of each State or Territory between the Tropic of Cancer and 60° South latitude, and between 130° East longitude and 120° West longitude. The region stretches over some 10,000km from east to west and 5,000 km from north to south, with a combined economic exclusion zone (EEZ) of approximately 30 million km². It contains 22 Pacific Island Countries and Territories, as well as a portion of the Australia continent, both the North and South Islands of New Zealand, and a portion of the Hawaiian Islands. Regionally, the role of SPREP is to provide environmental advice to Pacific Island member countries and territories. Baird drew attention to two Items: SPREP Regional Marine Species Action Plans (RMSAPs) and the Pacific Ocean Cetacean MoU. RMSAPs provide guidance on the conservation priorities of five species groups within the Pacific region: cetaceans, sharks and rays, marine turtles, dugongs and seabirds. The first RMSAP was published in 2003, and currently, updated iterations are planned for

[36]The Sarasota Dolphin Research Program, *https://sarasotadolphin.org/*.

2022 and 2026. The Pacific Ocean Cetacean MoU was established under the auspices of CMS and encompasses 15 member countries and territories in the Pacific region. The fourth meeting of signatories was held in 2021, during which several gaps were identified, both finance and technical, that need to be addressed before the MOU conservation goals can be met.

16.4.2 Review of regional long term research programmes

Constantine reported the results from continued genetic monitoring of New Zealand's endemic Hector's dolphin subspecies, the Māui dolphin (*Cephalorhynchus hectori maui*), during 2020 and 2021, following the same methods as previously reported for surveys conducted in 2001-07, 2010-11 and 2015-16 (Constantine *et al.*, 2021). The primary objectives were to estimate the abundance and effective population size of Māui dolphins in 2020-21 and to document the movements of individuals of this subspecies and migrant South Island Hector's dolphins (*C. h. hectori*) using DNA profiles derived from biopsies. DNA profiles from biopsies collected during the 2020-21 surveys were also matched with all other biopsies collected since 2001, including tissue samples from necropsies of beachcast individuals.

Small-boat surveys dedicated to the collection of biopsies from Māui dolphins were conducted along the northwest coast of Te Ika-a-Māui/the North Island of Aotearoa New Zealand, from just south of the entrance to the Kaipara Harbour in the north to the Mokau River, Taranaki, in the south during the austral summers of 2020 (11-27 February) and 2021 (13 February-15 March). A total of 84 biopsies were collected during these surveys from individual dolphins aged 1 year and older (50 in 2020 and 34 in 2021). DNA profiling was undertaken for all samples, including genotyping of up to 25 microsatellite loci (average of 24.94 loci/sample), genetic sex identification and mitochondrial DNA (mtDNA) control region sequencing.

Based on DNA profile matching, 32 individuals were identified from the 50 samples collected in 2020 and 24 individuals from the 34 samples collected in 2021, with 13 individuals recorded in both surveys. These totals provide a minimum census of 43 individual dolphins (22 females and 21 males) alive at some point during the 2-year study period. Of this total, one male and one female that were sampled in 2020 were identified as South Island Hector's dolphin migrants based on their distinct mtDNA haplotypes and genotype-based population assignment procedures. The female South Island Hector's dolphin was first identified in 2010, while the male had not been sampled previously. With the addition of this male, four live South Island Hector's dolphins (two females and two males) have now been sampled in association with Māui dolphins since 2001. Despite the intermingling of the two subspecies, there is no evidence to date of interbreeding between the South Island Hector's and Māui dolphins (i.e. all subspecies identifications have been consistent with diagnostic differences in mtDNA and assignable differentiation of microsatellite genotypes).

Five DNA samples have been collected from beachcast Māui dolphins since the previous survey in 2015-16: four in 2018, including one female and her near-term foetus, and one in 2021. Two of the four individuals reported in 2018 had previously been sampled alive: an adult male that was first sampled in 2001 and the pregnant female, which was first sampled in 2004. The remaining two samples collected in 2018 were from young individuals – a neonate and the near-term foetus. The sample collected in 2021 was from a female of adult length but did not match any previously sampled dolphins.

Based on the sampling locations, individual movements within the sampling period were typically over short distances (i.e. less than 10km). The maximum distances travelled were 32km over 15 days by a male in 2020 and 31 km over 29 days by a female in 2021, both of which travelled between south of the Manukau Harbour and near Port Waikato. Although the dolphins did not travel as far as in previous surveys, the evidence that some individuals move throughout the typically observed range of Māui dolphins is consistent with the expectation of random intermingling for capture–recapture models.

The census abundance (N_c) of Māui dolphins in 2020-21 was estimated to be 54 individuals aged 1 year or older (1+) (95% CI=48-66) within the survey area, using a two-sample, closed-population model. This estimate applies to the number of individuals alive during either sampling year and is comparable to the previous estimates based on the genotype surveys in the same area in 2015-16 and 2010-11. An effective population size (N_e) of 35 (95% CI = 21-67) was estimated from the genotypes of the 41 Māui dolphins sampled in 2020-21 using the one-sample linkage disequilibrium method. This is unchanged from the previous estimate for 2015-16 but lower than estimates for 2010-11 and 2001-07. The smaller size of N_e relative to the capture-recapture N_c estimate is consistent with the expectation that N_e represents only the individuals of the parental population that contributed successfully to the next generation.

Retrospective matching of DNA profiles for all samples collected from 2001 to 2021 resulted in a total count of 137 individual Māui dolphins, 118 of which were sampled alive only, 16 of which were sampled beachcast (dead) only, and three of which were sampled alive and then dead two, 14 and 17 years later. During the reconciliation of this 'DNA register', one individual that was sampled in 2015 and previously reported to be unmatched was found to be a match to an individual sampled in 2002 and 2006. This error in identity did not affect the previously reported closed-population estimates but does reduce the total DNA register by one. One male was sampled in both 2001 and 2020, confirming a minimum survival of 20 years, given the minimum age of 1 year old at the time of sampling. The complete 21-year record of captures and recaptures is available for further abundance estimates using open-population models.

These results highlight the importance of individual identification and genetic monitoring using biopsies and DNA profiling. The register of DNA profiles now spans 21 years and is providing new information on the life history parameters,

local movements and numbers (both N_c and N_e) of Māui dolphins, as well as the long-distance dispersal of South Island Hector's dolphins into their range. Future work should include using reduced representation genomic sequencing to generate thousands of nuclear loci, which will enhance the power of genetic monitoring and allow patterns of relatedness amongst individuals to be determined.

In discussion, all agreed that these numbers are small and concerning, regardless of small differences related to variations in the statistical analysis used to estimate the 2020-21 abundance. There was also agreement that it was difficult or impossible to estimate trends in abundance given the confidence limits on all recent abundance estimates for Māui dolphins, and that protection of the tiny population is important regardless of the exact numbers and should be continued. Some members stated that the measures determined to be necessary to adequately protect Maui dolphins were in place, while others thought that additional measures were needed. Since 2012, the Committee has repeatedly highlighted the critically endangered status of the Māui dolphin and the ongoing threats to its habitat and has made multiple recommendations to improve the status of this subspecies. Some members again highlighted previous urgent requests to the New Zealand Government to commit to specific population increase targets and timelines for Māui dolphin conservation. The New Zealand Government reiterated their views expressed in 2021 that measures implemented in 2020 meet this target and recommendations should be updated to reflect the most recent information; for context see (IWC, 2021c, p.96). The Committee noted that a delayed intersessional meeting aimed to address several recommendations for the Māui dolphin population will be conducted before the next SC meeting (see Item 12.7, this report) and it was requested that all other previous recommendations made by this Committee be reviewed by the Recommendation Review ICG (see Item 16.3.7, this report) to provide an update at the next Scientific Committee meeting.

Attention: SC-SM, SC-HIM, CC, C, CG-New Zealand
*The Committee **draws attention to** the critically endangered status of the Māui dolphin (Cephalorhynchus hectori maui) and the 2021 population estimate of only 54 individuals and **re-emphasises** the inherent and irresolvable uncertainty surrounding information on most small populations, which point to the need for precautionary management.*

*The Committee **agrees** to include the Māui dolphin as one of the ten species to be assessed by the Recommendation Review ICG working on the review of previous recommendations in the 2022-23 period.*

Garrigue provided a review of small cetaceans of New Caledonia, which encompass 1.3 million km^2 of water, including 24,000km^2 of lagoon. Fourteen delphinids have been identified: killer whale (*Orcinus orca*), short-finned pilot whale (*Globicephala macrorhynchus*), false killer whale (*Pseudorca crassidens*), melon-headed whale (*Peponocephala electra*), pygmy killer whale (*Feresa attenuata*) , Risso's dolphin (*Grampus griseus*), rough-toothed dolphin (*Steno bredanensis*), common dolphin (*Delphinus delphis*), spinner dolphin (*Stenella longirostris*), pantropical spotted dolphin (*S. attenuata*), striped dolphin (*S. coeruleoalba*), Fraser's dolphin (*Lagenodelphis hosei*), common bottlenose dolphin (*Tursiops truncatus*) and Indo-Pacific bottlenose dolphin (*T. aduncus*). Both bottlenose dolphin species are observed within the shallow lagoon waters while all others occur offshore, in relatively deep waters. The common bottlenose dolphins that occur in New Caledonia are a large oceanic form, with evidence of limited gene flow between China-Taiwan, New Zealand and Palmyra-Kiribati-Hawaii. The Indo-Pacific bottlenose dolphins that occur in New Caledonia are a small coastal form and appear to be differentiated from other Pacific Islands populations. At least six isolated lagoon communities are threatened and require conservation action. They number in the low hundreds, with very low mtDNA diversity and strong mtDNA structure (Bonneville *et al.*, 2021; Oremus *et al.*, 2015a).

Poole provided a written update on small cetacean research in French Polynesia, which encompass 5 million km^2 and comprise 118 islands in five archipelagoes (the Marquesas, Society, Tuamotu, Gambier and Austral Islands). Fourteen species of small cetaceans have been identified: the killer whale, the short-finned pilot whale, false killer whale, melon-headed whale, pygmy killer whale, Risso's dolphin, rough-toothed dolphin, spinner dolphin, pantropical spotted dolphin, Fraser's dolphin, common bottlenose dolphin, Cuvier's beaked whale (*Ziphius cavirostris*), Blainville's beaked whale (*Mesoplodon densirostris*) and the dwarf sperm whale (*Kogia simus*). Most of these species are widespread within French Polynesia, however, pygmy killer whales and pan-tropical spotted dolphins are known only from the Society Islands and Marquesas, respectively. Research has been conducted in all five archipelagoes, with most effort directed towards spinner dolphins and rough-toothed dolphins in the Society Islands (e.g. Oremus *et al.*, 2007; 2012). The small resident population of spinner dolphins at Moorea (148; 95% CI 121-181), despite being a largely closed community, has an incredibly high level of genetic diversity due to gene flow between it and other islands. The behaviour and distribution of this population is being impacted by increased boat traffic and sedimentation, due to poor developmental and agricultural practices. At Tahiti and Moorea, rough-toothed dolphins are deliberately injured (and possibly killed) by fishermen, as they remove bait from the hooks of the long-line fishery.

SC/68D/SM/04 presented work on the photo-ID-based age estimation of false killer whales utilizing information on sex, relative size, markings and morphology. A protocol for deriving age estimates of false killer whales in Hawaiian waters using information curated from a long-term photo-ID catalogue was developed. The protocol integrates several qualitative

lines of evidence (e.g. morphometric features, parentage, markings) into a quantitative framework for deriving age point estimates. Further, confidence ratings based on the strength and weaknesses of supporting evidence were developed to directly account for uncertainty in age estimates and scale the plausible range of ages (minimum and maximum) specific to each individual. While originally intended to inform a concurrent study on epigenetic aging of this population, our protocol provides a compelling alternative for estimating the age of individuals with common metrics from photo-ID catalogues and for which advanced genetic aging methods of biological samples (e.g. biopsies) are not feasible.

The Committee thanked Baird for the presentation and noted that this innovative approach for estimating the age of individuals was a valuable, and relatively low-cost alternative to epigenetic aging methods if photo-identification catalogues are already available.

16.4.3 Threats to small cetaceans of the South Pacific Islands

Miller presented an overview of threats to small cetaceans of SPREP member countries and territories. Regionally, 22 small cetacean species have been documented in the region, however, it is likely that the species reported represent only a minimum of the actual species diversity. Threats discussed included: incidental catch and fishing gear interactions, direct harvesting, pollution, vessel traffic, pathogens and introduced species, resource depletion and climate change. Estimates of cetacean bycatch in the region are limited by the small amount of fishing vessel monitoring, e.g. observer coverage is less than 1% for South Pacific long-line vessels (1987-2000), 5% for purse seiners (1994-2000) and only 2% for Solomon Island line-and-pole fishing trips (1988). This level of observation is inadequate to determine true bycatch numbers, however, from the limited information available, false killer whales, short-finned pilot whales, Risso's dolphins, rough-toothed dolphins and bottlenose dolphins are all believed to be heavily impacted throughout the region. With respect to impacts from tourism, species of regional concern include spinner dolphins, bottlenose dolphins and short-finned pilot whales.

Addressing knowledge gaps in this region will require:

- increased quality and quantity of data collected;
- improved understanding of cetacean diversity, distribution, population structure and threats;
- more in-country partnerships and support for cetacean conservation; and
- mainstreaming of relevant national and regional environmental initiatives.

Possible means to encourage greater observer coverage on fishing vessels and thereby more robust estimation of bycatch rates and better documentation of species affected were discussed, in particular, the high rates of interaction between false killer whales and long-line fisheries. In response to a question about the potential use of electronic monitoring (EM) systems, Miller explained that the current focus is on fish bycatch and regulation compliance, rather than cetaceans; observers are not provided with much equipment and may have to take photos of specimens with personal cell phones, and they are typically located in positions far from bycaught animals; and there has been some consideration of expanding the genetic 'barcoding' programme for tuna to include cetaceans but this is a long way off. K. Baird added that EM is being trialled by some Pacific Island countries, such as Fiji. It was also pointed out that it was difficult for organisations like the Western and Central Pacific Fisheries Commission (WCPFC) to make decisions by consensus on such issues, and countries are usually reluctant to develop monitoring systems for additional fisheries if they are likely to reveal a larger scope for a problem that already has compliance issues.

Childerhouse presented an overview of potential threats to small cetaceans in the South Pacific Island region from deep sea mining activities. To date, 31 exploration permits have been issued by the International Seabed Authority (ISA), with no commercial exploitation permits yet issued. There are currently no recognised international best practice guidelines for minimising or mitigating environmental impacts, though these are to be developed by the ISA, prior to June 2023. In most potential mining locations, the biological environment is very poorly understood and the potential impacts on small cetaceans will likely vary considerably, depending on the cetaceans' usage of the area (e.g. breeding, feeding, migrating); importance of the area to the species or population (e.g. whether they can undertake the same activities elsewhere); sensitivity (e.g. whether the species can tolerate increased sedimentation or noise, or they can switch prey); conservation status (e.g. endangered versus non-threatened); and the exact nature and extent of the mining operation (e.g. whether sedimentation is highly localised or operational noise is only slightly above ambient).

Attention: SC, R

*The Committee **welcomes** the information provided on the small cetaceans of the South Pacific Islands and the threats that they face.*

*The Committee **agrees** that future communication and collaboration with the Secretariat of the Pacific Regional Environment Programme (SPREP), and other regional bodies, was needed to better understand and mitigate threats to the small cetaceans of the region, particularly with regards to small cetacean bycatch which for some species, e.g. false killer whales, is extremely high.*

*The Committee **agrees** to establish an Intersessional Correspondence Group to consider the status of small cetaceans in the South Pacific region and to establish future research and action priorities.*

Beasley and Amepou reported on the continued and likely unsustainable bycatch of Australian humpback (*Sousa sahulensis*) and snubfin (*Orcaella heinsohni*) dolphins in gillnet fisheries in the Kikori Delta, Papua New Guinea (SC/68D/SM/16). Very little is known of the number of individuals or their habitat use, however, both species appear to exist as small, localised populations of only a few hundred, i.e. approximately 100 humpback dolphins and 200 snubfin dolphins. By-catch in the gillnet fisheries was documented during dolphin abundance surveys conducted in 2013 and 2015, by-catch levels had increased significantly to at least 3-4 dolphins/month; over a period of three months (November 2021-January 2022) a total of 13 snubfin dolphin carcasses were recovered, 11 of which were confirmed to have been by-caught in large-mesh gillnets. In discussion, new information from March 2022 recorded a further 56 snubfin and one humpback dolphin deaths, additional to the data presented in SC/68D/SM/16. This increase in bycatch is an unintended consequence of a newly developed fishery targeting fish swim-bladders for export to China. Fishermen earn at least PGK1000 (USD$300) for one good-quality swim-bladder, which equates to more than a month's salary, thus resulting in a fishery that is very difficult to manage. The fishermen of the Kikori Delta do not want to catch dolphins and have requested the assistance of international bodies, including this Committee, to reduce bycatch. This situation parallels the dire situation facing Mexico's endemic vaquita (*P. sinus*), which has been pushed to near extinction by an illegal fishery for swim-bladders of the totoaba fish *(Totoaba macdonaldi*). In discussion, that urgency of developing strategies to reduce bycatch was highlighted and it was further noted that in order to better manage this and other threats, the stock structure and connectivity of the Kikori Delta dolphins must be better understood.

Attention: S, G: Papua New Guinea, SC: HIM, SM, CC: BMI, Marine Mammal Bycatch Expert Panel
The Committee ***draws attention to*** *the unsustainable levels of bycatch from the two small populations of Australian humpback (*Sousa sahulensis*) and Australian snubfin dolphins (*Orcaella heinsohni*) in the Kikori Delta, Papua New Guinea, and* ***agrees*** *that there is an urgent need for collaborative action (i.e. research, community/government consultation and by-catch mitigation) to reduce dolphin mortality as a matter of priority and:*

(1) ***agrees*** *to offer technical support to the Piku Biodiversity Network (PBN, University of Canberra) for continuation and extension of their monitoring studies and for developing strategies to reduce inshore dolphin by-catch in the Kikori Delta, in coordination with the Bycatch Mitigation Initiative and the Marine Mammal Bycatch Expert Panel; and*
(2) ***requests*** *that the Secretariat contact the Government of Papua New Guinea to advise them of concerns surrounding the high and increasing bycatch of dolphins in the Kikori Delta, which is driven by high prices for swim bladders exported to China.*

Oremus presented an overview of traditional drive hunting of small cetaceans in the Solomon Islands, which has been practiced for centuries by a few villages on the island of Malaita. Following the controversy over the Solomon Islands live dolphin trade in 2003, a workshop was convened by the IUCN Species Survival Commission in 2008 to assess the status of the target species, Indo-Pacific bottlenose dolphins (Reeves and Brownell, 2009). The workshop provided an opportunity to initiate contact with the Solomon Islands government in 2009, and through this collaboration and with support from the IWC Small Cetacean Voluntary Conservation Fund, the South Pacific Whale Research Consortium was able to assess the sustainability of the live dolphin trade and collect information on other species and traditional activities, particularly dolphin drive hunting (IWC, 2013b).

Following the international attention resulting from the workshop, in 2010, the Earth Island Institute (EII) signed an MOU with some of the villages involved in the drive hunt, which offered financial support to communities to develop alternative activities to drive hunting. In January 2013, however, the village of Fanalei on Malaita, resumed the traditional hunt and over eleven hunts, 1,698 individuals were captured, comprising three different species: pantropical spotted dolphins, spinner dolphins and common bottlenose dolphins. An analysis of available hunting logbooks indicated that a minimum of 15,444 dolphins were landed on Malaita between 1976 and 2013 although this is likely a vast underestimate as only 21 years of hunting logbooks were available from a 35-year period and the spatial coverage of available records was also highly variable (Oremus *et al.*, 2015b).

The EII initiative both failed to stop the hunt and created opposition in the Fanalei community. Fanalei's elders did not understand the attention they attracted with regards to traditional practices, which they want to preserve even though the community has concerns over the drive hunts sustainability. This echoes the concerns stated with regards to the gillnet fishery in Kikori; where income is limited and communities' daily sustenance is derived directly from fishing or hunting, with few other options available to sustain local livelihoods, research and conservation action must be conducted with sensitivity and in full collaboration with local people.

Attention: S, G: Government of the Solomon Islands SC: Statistics Department
The Committee ***draws attention*** *to the likely unsustainable drive hunt for small cetaceans practiced by some villages on Malaita, Solomon Islands, and noted elders from at least one village were also concerned that their traditional practice was not sustainable.*

(cont.)

*The Committee **agrees** that a variety of studies are needed to better understand the impact of drive hunts on dolphin populations and the socio-economic context of the hunting, including, collection of additional hunt records, studies of genetic population structure, genetic diversity and abundance and new social and anthropological assessments, **encourages** the re-establishment of collaboration with hunting communities, as per previous research supported by the IWC, as a first step towards assessing both dolphin conservation and human cultural implications of the drive hunt and, **recommends** that drive hunt records from 2013 onwards be collected in order to better understand the potential impacts to the local cetacean populations, and to update previous work funded by this Committee on total take estimates and capture trends.*

*The Committee **requests** that the Secretariat write to the appropriate agency of the Government of the Solomon Islands to offer assistance in reviewing the annual records of the drive-hunt and offering the Committee's expertise in assessing the status of small cetaceans in Solomon Island coastal waters.*

16.5 Review direct takes and live captures of small cetaceans

The Committee received the summary of takes of small cetaceans. These data were extracted from National Progress Reports, online reports of the Japan Fisheries Agency and other information provided to the Committee. NAMMCO's reporting of small cetacean takes was particularly noted as contributing significantly to the Committee's understanding of the status of small cetacean species in the North Atlantic area. It was noted that the summary table of takes now spans more than 23 years, for some species and areas. The dataset can be requested from the Secretariat (*statistics@iwc.int*). The Committee notes its great appreciation for all who compiled and reviewed data on directed takes. Allison, the IWC Head of Statistics, retired in the intersessional period and this Committee expressed sincere thanks to Allison for leading the collation of the small cetacean take data, for over two decades, and especially for the last three years, during which Allison expended considerable effort working with all parties to verify the figures in the dataset. Allison has facilitated the research, collation, and management of an extensive data resource with which this Committee can now progress its work.

At SC68C, it was noted that the virtual nature of recent meetings makes detailed discussion of some topics challenging, however, progress on the analyses of the table of takes should be initiated as a matter of priority. A working group was established to develop a framework for analyses intersessionally. Katara has recently been appointed Lead for Statistics and, on a first review of the compiled data, has proposed that a gap analysis be initiated to identify: (i) opportunities for trend and comparative analyses to be conducted immediately, particularly the killer whale take information, including (ii) where additional data, such as effort, abundance estimates, population structure, environmental conditions and trade statistics, would facilitate a more in-depth review of the impact of takes on certain small cetacean populations. The existing tables of direct takes include data on multiple species and various countries rely heavily on National Progress Report submission, however, the usefulness of other datasets, available in open, online databases, published literature and other sources, should be assessed with a view to including them in future analyses. The work will be supervised by Katara, in collaboration with Porter, with the possibility of the assistance of an IWC intern or postgraduate student who can dedicate the time required to initiate the analyses. Progress on this work and a more detailed workplan will be presented at the 2023 meeting of the SC.

Attention: SC

*The Committee **reiterates** its previous recommendation to make progress on the analyses of the data in the direct take tables, compiled by the Committee.*

*The Committee **agrees** to progress on this matter via an intersessional working group (co-Convenors: Porter and Katara) and report to the Committee in 2023.*

16.5.1 Direct takes

On review of the direct takes tables, it was noted in discussion that the takes of killer whales (*Orcinus orca*) in Greenland (both West and East) are of concern and that there is a need for a full assessment of this population, or populations, impacted by these hunts. It was further noted that recent evidence suggests that harbour porpoise (*Phocoena phocoena*) in West Greenland may be genetically distinct and constitute a distinct ecotype (Olsen *et al.*, 2022) therefore, the current level of takes reported from that area, compounded by the significant level of estimated bycatch, is also concerning.

The Committee discussed in depth the reported takes of narwhals (*Monodon monoceros*) in southeast Greenland and noted the recent publication that concludes that excessive hunting has affected life history and population dynamics of this population (Garde *et al.*, 2022). Naalakkersuisut, the executive body for the government of Greenland, recently issued hunting quotas for 2022 totalling 50 narwhals in three 'management areas' in southeast Greenland (Ittoqqortoormiit, Kangerlussuaq and Tasiilaq). This decision adds greatly to the risk that narwhals will be extirpated and no longer present in southeast Greenland due to overhunting. Issuance of the 50-narwhal quota for 2022 implicitly reversed Naalakkersuisut's previous plan to reduce the total quota to 20 by 2023 (NAMMCO, 2021).

Over three meetings since 2019, the Scientific Council of the North Atlantic Marine Mammal Commission (NAMMCO, 2019; 2021; 2022) has considered stock structure, genetic diversity, abundance, range, sex- and age-distribution and

pregnancy rates for narwhals in southeast Greenland and examined impacts on them from hunting and commercial trade, climate change and other anthropogenic stressors. The Committee noted that were no sightings of narwhals in recent surveys of the area. The Council has repeatedly reiterated its concern for the 'high risk of extirpation of the stocks if harvest at any level continues' (NAMMCO, 2021) and 'strongly reiterated' advice to reduce the hunt to zero in all three management areas. It has 'underlined that all available knowledge and data, including hunter knowledge, had now been exhausted to update the assessment' and 'did not expect new surveys planned for 2022 to change its advice' (NAMMCO, 2022). The Committee also noted that for the human communities that rely on hunts for sustenance and livelihood, sustainable management has to be a priority.

The advice from NAMMCO to set zero quotas is unprecedented in its gravity and urgency, but Naalakkersuisut has not yet adequately responded to the situation; the quota was exceeded at least once in each management area in 2020 and 2021 (Annex R) and the government recently set quotas for 50 narwhals for the three management areas for 2022 (NAMMCO, 2022).

Attention: S, SC, CC, G-Greenland
*The Committee **expresses serious concern over** the imminent risk of extirpation of the narwhal (Monodon monoceros) population present in southeast Greenland due to overhunting. The Committee **recommends** that Naalakkersuisut, the executive body for the government of Greenland, immediately reduce the quota for the southeast Greenland hunt of narwhals to zero.*

*The Committee **recommends** that the Secretariat write a letter to Naalakkersuisut to express its **serious concern** over these continued hunts and to immediately reduce the hunting quota for southeast Greenland narwhals to zero.*

In discussion, the Committee also noted the high number of Atlantic white-sided dolphins (*Lagenorhynchus acutus*) reported as direct takes in recent years. The Atlantic white-sided dolphin is hunted in Norway, Newfoundland, Greenland, Canada, and the Faroe Islands (Cipriano, 2018). The Faroe Island dolphin hunts, which include Atlantic white-sided dolphins, takes place year-round, peaking in August and September (Bloch and Mikkelsen, 2018). Between 1872 and 2018, Faroese catch records record 12,067 Atlantic white-sided dolphins as direct takes (Bloch and Mikkelsen, 2018). Although catch frequency decreased after 2006, the Committee noted with concern that 1,423 individuals were killed in a single drive hunt, in September 2021. This is believed to be the largest ever take of the species.

At its 26th meeting, the ASCOBANS Advisory Committee expressed concern over this hunt and requested the ASCOBANS Secretariat to write a letter to the Faroe Islands to question the sustainability of the hunt (ASCOBANS, 2021). ASCOBANS also established an Intersessional Working Group on *Lagenorhynchus* species to: (1) review the available information on population structures and trends, distributions, abundances, mortalities, reproductive outputs, health, diet, behaviour, and data gaps; and (2) review issues that pose a conservation threat (ASCOBANS, 2021). The ASCOBANS Secretariat stated that IWC participation in this working group was welcome and Simmonds was appointed to coordinate with the ASCOBANS Secretariat and members of this Committee to assist in this work.

The EU and its Member States that are Parties to the International Convention for the Regulation of Whaling, with the exception of Denmark, also formally expressed concerns, via IWC Circular Communication IWC.CCG.1488[37], over the sustainability of the hunt and highlighted the need for scientific investigation, taking into account additional threats faced by the species.

Attention: S, SC, CC, G-Faroe Islands
*The Committee **draws attention to** the serious concerns expressed via IWC Circular Communication (IWC.CCG.1488)[37] and by the ASCOBANS Advisory Council with regards to the high number of Atlantic white-sided dolphins (Lagenorhynchus acutus) reported as direct takes in recent years, particularly by the Faroe Islands in 2021, which have occurred without a full assessment of the status of the Atlantic white-sided dolphin at species and population level.*

*The Committee **reiterates its longstanding recommendation** that no small cetacean removals (live capture or directed harvest) should be authorised until a full assessment of status has been made (IWC, 2021c).*

*The Committee **recommends** that the Secretariat write a letter to the Faroe Island Government **stating concern** with regards to the sustainability of the Atlantic white-sided dolphins hunts and to convey this Committee's advice that no small cetacean removals should be authorised until a full assessment of the status of this dolphin population has been undertaken.*

16.5.2 Live captures

SC/68D/SM/05 reported on the readaptation of a beluga to the natural environment. A male beluga named Gary was caught in 2012 and kept in an artificial environment for six years before being released into Sakhalin Bay in 2018, with a

[37] *https://archive.iwc.int/?r=19399*.

Table 27

Proposals Approved for Funding from the Voluntary Research Fund for Small Cetaceans.

Principal Investigator	Title	Anticipated Final Report (SC Year)
Gopal Khanal	Understanding the effects of trans-boundary barrage operations on the Nepal-India border for Ganges River dolphin habitat and population dynamics (*Platanista gangetica)*	SC 2023
Laura J May-Collado	Rapid assessment of the occurrence and conservation status of Guiana dolphins at the northern periphery of their range in Central America (*Sotalia guianensis)*	SC 2023
Yurasi Briceño	More knowledge, less mortality: education for the conservation of Guiana dolphins (*Sotalia guianensis*), Lake Maracaibo, Venezuela	SC 2023
Joanna Alfaro Shigueto	Assessing the conservation status of Burmeister's porpoises in Peru – trialling tools for estimating abundance and bycatch of this cryptic and poorly known species (*Phocoena spinipinnis)*	SC 2024
Mariano Alberto Coscarella	Population assessment and dynamics of Lahille's bottlenose dolphins in Argentina (*Tursiops truncatus gephyreus)*	SC 2026

satellite tag attached. The beluga moved at variable speed along the west coast of Sakhalin, reached the southern coast in one month, and passed the La Perouse Strait, before entering the northern waters of Hokkaido, Japan. The whale then left Japanese waters, travelled through the Sea of Japan and entered the waters of South Korea, after which he returned to Russian waters, whereupon the satellite tag stopped transmitting. Overall, 91 days of tracking data were obtained. An analysis of the track showed that the beluga mostly travelled in sight of the coastline at shallow depths, which is not a typical migration pattern for the Sakhalin-Amur beluga population. Based on movement speed and delays near river mouths, it is believed that the beluga successfully regained foraging skills.

The Committee noted that there are few data available on the behaviour of cetaceans following their release from captivity and welcomes the insights provided by this detailed 91-day record of the post-release behaviour of this beluga. In discussion, Guscherov stated that the estimated age of this beluga at capture was two years, based on colouration (dark grey) and body length (2.3m). There was no opportunity to extract and section a tooth while in captivity to confirm age. The beluga's ability to identify, pursue and capture suitable prey for at least three months post-release, given his age at capture, was noted as remarkable, which Gushcherov explained was likely due to the conditions of his captivity; the beluga was kept in an open bay, inside three large-mesh net cages, through which small fish passed freely. Gushcherov reported that the beluga was repeatedly observed 'sucking' fish through the mesh of the nets of the pontoon enclosure. It was opined that the beluga's tendency to remain in shallow water post release was likely an artefact of his upbringing in a shallow-water environment, leading to a disinclination to moving into deeper water.'

16.6 Status of the voluntary fund for small cetacean conservation research

The Voluntary Fund for Small Cetacean Conservation Research currently totals £86,839, of which £41,215 is unallocated (SC/68D/O/04rev1). Since April 2021, contributions have been received from the Government of Netherlands, Animal Welfare Institute, Campaign Whale, Cetacean Society International, Dolphin Connection, Humane Society International, LegaSeas, Natural Resources Defence Council, OceanCare, ProWildlife and Whaleman Foundation. The Secretariat has updated the Small Cetacean Voluntary Fund webpage with a full list of donors, completed and ongoing projects and new publications.

The Committee expressed its sincere gratitude for these contributions and noted that the Fund is intended to support critical conservation research projects of direct relevance to the work of the small cetacean sub-committee.

16.6.1 Recommendations for 2021-22 projects

At SC68C, the Small Cetacean Voluntary Fund Review Panel recommended five projects for funding. These projects were approved at the 2021 Virtual Meeting of the Commission. Three projects have commenced and two will start within the next few months. The progress of each project will be reported to this committee yearly and final reports for all projects will be submitted between 2022-26 (Table 27).

A proposal was presented to the Committee that requested funds to support an information gathering expedition to remote hunting communities in the Solomon Islands. Data gathering will include inspection of the village hunt logbooks and interviews with hunters. The data gathered will update the long-term dataset (1976-2013) archived by the IWC of the small cetacean takes in this region. This proposal was approved by both the Small Cetacean Voluntary Fund Review Panel and the Committee.

16.7 Workplan

The workplan was discussed both in session and via the 'Comments document'. Several ICG/AG were noted as long term and ongoing: Franciscana Review, Poorly Documented Take of Small Cetaceans, Recommendation Review, Guiana Dolphin Review, Small Cetacean Task Team Steering Committee, Lahille's Dolphin Task Team, South American River Dolphins CMP

Table 28

Final workplan for matters related to small cetaceans.

Topic	Intersessional 2022/24	Annual Meetings (2023-24)
Franciscana Review (ICG)	Porter and Trujillo. Coordinate outcomes of CMP across sub-committees	Report progress
Poorly Documented take of Small Cetaceans (ICG)	Porter (Convenor), Ingram, Hodgins, Avila. Continue development of framework for SM work on Aquatic Wildmeat	Report progress
Recommendation Review (ICG)	Trujillo (Convenor), Porter, Jimenez, Couto di Tullio. Make progress on new review framework and establish regional and species assessment teams	Report progress
Sotalia guianensis (ICG)	Domit (Convenor). Continue review of the Guiana dolphin	Report progress
Small Cetacean Task Team Steering Committee (AG)	Simmonds (Convenor), Donovan, Genov, Parsons, Porter, Reeves, Rojas-Bracho, Staniland, Thomas, Trujillo. Provide ongoing advice and support to established Task Teams and consider any new proposals	Report progress
Lahille's Dolphin Task Team (ICG)	Vermeulen (Convenor), Fruet (Convenor), Berninsone, Von Fersen, Laporta, Daura-Jorge, Coscarella, Smith (pending). Develop research priorities for the next 5 years and identify funding opportunities.	Report progress
Direct Takes (ICG)	Porter, Katara and Fisher. Make progress on the analyses of direct take data of small cetaceans compiled by the SC since 1977	Report progress
Tursiops Taxonomy (ICG)	Rosel and Cipriano. Develop Tursiops taxonomy database and monitor new publications related to this issue	Report progress
Strait of Gibraltar, Killer whale (ICG)	Esteban (Convenor) García-Bellido, Rose, Sequeira, Simmonds, Porter. The ICG will continue to compile information on the novel behaviour of the Strait of Gibraltar killer whale subpopulation and when required, will seek input from other marine mammal behaviour experts and suggest appropriate management actions	Report progress
Management of the Solitary Sociable Dolphin in Northwest Spain (AG)	Simmonds (Convenor), Aymerich, Eisfeld-Pierantonio, Fernandez, García-Bellido Capdevila, Garcia-Párraga, López-Piñeiro Pérez, Nunny, O'Callaghan, Porter, Staniland, Torres. The AG will continue to assess information pertaining to the dolphin and its' interactions, providing advice to the Government of Spain, if requested and through established communication plan, address any significant developments as quickly and efficiently as possible	Report progress
The South Pacific Island SM Group	Porter (Convenor), Amepou, Beasley, Baird, K., Baird, R., Baker, Childerhouse, Constantine, Donoghue, Garigue, Orams, Poole	Report Progress
Finless Porpoise (marine) (ISG)	Porter and Brannan (Convenors), Bohadi, Bopardikar, Bradley, Chansu, Cheng, de la Paz, Ham, Hao, Jog, Kot, Li S-L, Li T-Y, Masrini binti Muhamad, Mi, Mustika, Naruki, Natoli, Nithyanandan, Peter, Ponnampalam, Roshan, Soojin, Stokes, Sutari, Tomoyoshi, Wang Ding, Yang	

coordination, analyses direct takes of small cetaceans and Tursiops Taxonomy Review. In addition, several groups were re-established during the meeting as they remain useful; the Strait of Gibraltar Killer Whale Advisory Group and the Management of the Solitary Dolphin of Northwest Spain Advisory Group. A new group was formed to plan work on the small cetacean of the South Pacific Islands (The South Pacific Island SM Group)

Several ICG were noted as completed or moved to other parts of the Committee:

- sub-committee Coordination, to improve communication across SC so that sub-committees can better coordinate discussion, when appropriate; and
- ICPC/SM Communication platforms, to provide an easy mechanism for communication across various conservation initiatives, particularly the IUCN ICPC and SM.

The final workplan is presented in Table 28.

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 issues of concern; and (v) emerging technologies

Discussion of this Item has been postponed to the next meeting.

17.1.2 Review responses to Modelling and Assessment of Whale Watching Impacts (MAWI) questionnaire

Discussion of this Item has been postponed to the next meeting.

17.2 Update on IWC's General Principles for Whale Watching after intersessional discussion with the Conservation Committee and Secretariat

SC/68D/WW/01 summarised the work of the Conservation Committee's (CC) Standing Working Group (SWG) on Whale Watching since SC68C. In two rounds of review by email, in 2020 and 2021, the SWG fulfilled its plans, as outlined at SC68C, to edit and endorse the revised General Principles for Whale Watching. The SWG asked the Committee for any final

comments, particularly on whether to cross-reference the Convention on Migratory Species (CMS) (Resolution 11.29)[38] and/or Species-specific Guidelines for Boat-based Wildlife Watching[39] before consideration by the CC and Commission at IWC68. In response, the Committee concluded that a link to the CMS resolution made sense, but there was no need to link to the species-specific guidelines (which omit cetaceans), as the CMS will be referencing the IWC Whale Watching Handbook and its cetacean-specific guidelines. The Committee approved and endorsed these revised General Principles with no further edits.

Attention: SC, CC, C, S
*The Committee **agrees** that posting the revised General Principles for Whale Watching to the IWC website is a matter of urgency. The Committee **endorses** the revised General Principles communicated by the Conservation Committee's Standing Working Group on Whale Watching at SC68D and **recommends** that the Conservation Committee present this version to the Commission at IWC68 for approval and endorsement, after which the General Principles should be posted to the IWC website by the Secretariat with due dispatch (including a link in the Whale Watching Handbook).*

It was also noted that the CMS expects to provide an update on the development of its guidelines for in-water interactions with aquatic mammals (CMS, 2017; Notarbartolo di Sciara and Frisch-Nwakanma, 2018) by the next meeting.

17.3 Progress with regional reviews of whale watching

17.3.1 Sri Lanka

No papers were submitted under this Item. Discussion has been postponed to the next meeting.

17.3.2 Latin America

SC/68D/WW/02 described the first web-based citizen science initiative in Argentina, E-WHALE, aimed at cetacean monitoring. Data on species, group sizes, distribution and seasonality in San Matías Gulf, collected via E-WHALE, were presented. A total of 500 sightings of eight cetacean species were recorded over a period of nine months. There was a strong relationship between researchers and the whale watching operators prior to the launch of E-WHALE, which was a key factor in building the sightings reporting network. This novel citizen science platform may provide valuable data regarding cetacean threats, which would contribute to appropriate conservation strategies.

The Committee welcomed this paper and urged the authors to confer with other Committee members with appropriate expertise regarding the best methods for utilising and analysing data on animal presence/absence collected using these types of citizen science platforms.

SC/68D/WW/04 described a prospective new whale watching site inhabited mainly by sei whales near Rada Tilly and Comodoro Rivadavia in Chubut province, Argentina. Data on seasonality and relative abundance showed whales were present in high densities from March to July. As many as 70 sei whales were reported in the area simultaneously, feeding on swarming prey, including squat lobster. Aerial surveys to determine an abundance estimate are underway.

In discussion, it was noted that this was a rare opportunity to establish an information baseline before whale watching operations commence. Impacts should thus be easier to recognise once an industry is established and, moreover, sei whales are only infrequently the target of whale watching. The researchers are working with provincial and local authorities to undertake an experimental impact study (with deliberate approaches, making observations from a land station), with the goal of developing preliminary whale watching guidelines, and a species guide has already been produced for the public. Additional data from this site, including photo-ID data, will be presented at future meetings.

17.3.3 Timor-Leste

No papers were submitted under this Item.

17.3.4 Indian Ocean Sanctuary

No papers were submitted under this Item. It was noted that any papers submitted under this Item in the future would also be of value to the Working Group on Sanctuaries, which is planning a review of the Indian Ocean Sanctuary and could cross-reference any relevant whale watching papers. The advisory group on communication with the Indian Ocean Rim Association (IORA) will continue (see Annex M) and updates will be reported back to the Committee at future meetings.

Attention: S
Secretariat to identify a point of contact with the new chair of IORA, South Africa, and communicate this to the Advisory Group on communication with the Indian Ocean Rim Association (IORA) at the earliest opportunity.

[38] *https://www.cms.int/en/document/sustainable-boat-based-marine-wildlife-watching-2.*
[39] *https://www.cms.int/en/document/species-specific-guidelines-boat-based-wildlife-watching.*

17.4 Collaborative work within the IWC

This Item catalysed a comprehensive discussion of communications, particularly public outreach, regarding the whale watching products, resources and recommendations of the Committee and the CC. While collaboration and communication *within* the IWC amongst sub-committees and between the Committee and the CC continues to be addressed, the Committee is also concerned about the promotion of its work on whale watching to a wider audience, including researchers, the whale watching industry, managers and the public.

Attention: SC, CC, S
*The Committee **agrees** that its whale watching-related work needs wider promotion, beyond the IWC. It is of note that many researchers, managers, whale watching participants (tourists) and whale watching operators remain unaware of the whale watching outputs of the Committee. Therefore, it **recommends** the preparation of a comprehensive communications plan, with a budget, in an effort to ensure dissemination of the whale watching outputs of the Committee and the Conservation Committee to as wide an audience as possible, using social media, podcasts, webinars and other available platforms. The Committee **agrees** to form a steering group (see Annex M), which will prepare this plan and present it at the next meeting, coordinating with the Secretariat, which is already developing a promotional plan for the Whale Watching Handbook (see Item 17.4.1).*

Committee members who know of whale watching topics of broad interest or interesting whale watching case studies should contact the steering group (see Annex M) intersessionally for inclusion in the communications plan.

17.4.1 Update on the IWC's Whale Watching Handbook

SC/68D/WW/01 also offered an update on the Whale Watching Handbook. The Handbook's searchable database of scientific literature was updated in December 2021 and now features the details and abstracts of 501 reports and peer-reviewed articles on whale watching. The Secretariat is continually engaged in keeping this table up to date. As of April 2022, thanks to generous support from the CMS, all existing content has been translated from English into French and Spanish. Secretariat staff have been trained to update and edit Handbook content. The Secretariat will now continue working with countries and experts on updates or requests and will begin scoping for new content. Any minor updates of the Handbook will be undertaken in accordance with the editorial protocol endorsed at SC68B. Promotional activities in 2021 were placed in the context of the 75th anniversary of the IWC and included dissemination of the Handbook's factsheets via schools and the IWC website and flagging the Handbook in a range of presentations and articles (e.g. Wilson, 2022). The Secretariat is developing a new promotional plan for the Handbook and there will be renewed efforts in 2022 to increase support for the French and Spanish language versions of the Handbook. The SWG welcomes input from the Committee.

The Committee once again praised the Handbook, an excellent resource with global value, and a product that reflects very well on the overall workstream of the IWC. It thanked Minton again for her exemplary work on this IWC product. The Committee also offered thanks to Greg Donovan, who originally conceived the idea for the Handbook at the inaugural meeting of the CC's SWG on Whale Watching.

17.4.2 Communication with the Conservation Committee's Standing Working Group on Whale Watching

In discussion of SC/68D/WW/01, it was noted that communication with the CC's SWG would improve with the nomination of a Committee member (in addition to the WW co-Convenors and the chair or vice-Chair of the Committee) to the SWG. Parsons agreed to join this group. The revival of an intersessional correspondence group on communication with the SWG was delayed but will now proceed.

Attention: SC, S
*The Committee **reiterates** its agreement to reconstitute a standing intersessional correspondence group on communication between the Conservation Committee's Standing Working Group on Whale Watching and the Committee's sub-committee on Whale Watching. Iñiguez, a member of both groups, will serve as Convenor. Membership and Terms of Reference for this group can be found in Annex M.*

The SWG has requested the Committee submit names of industry representatives for possible membership in the SWG, where there are now two vacancies. The Committee noted that the intersessional correspondence group will include this request in its Terms of Reference (see Annex M).

It was also noted that Item 1.5 of the SWG's workplan (included as Annex B of WW/01) calls for a review-to-date of implementation of the IWC Strategic Plan for Whale Watching to help identify priorities. This comprehensive review of outputs was to come within two years of commencing work on the Strategic Plan's actions, to allow activities to be refocused if required. The completion of this review would also allow the Committee to offer its input into the workplan and its implementation, an ongoing request from the SWG. This review, which has been delayed due to the COVID-19 pandemic, should also improve communications with the SWG.

Table 29

Summary of the workplan 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 the next meeting.

Topic	Intersessional	Next meeting	Intersessional	Subsequent meeting
Assess the impacts of whale watching on cetaceans – PRIORITY (i) Short-term impacts (ii) Mid- and long-term impacts (iii) Swim-with operations (iv) Emerging issues of concern, e.g. solitary sociable and out of habitat cetaceans (v) Emerging technology, e.g. drones and other emerging technology in the context of whale watching	Prepare papers	Papers to be presented	Prepare papers	Papers to be presented
MAWI (questionnaire, updates)	Email correspondence and work	Paper to be presented	Email correspondence and work, if needed	Paper to be presented, if needed
Review whale watching in priority regions/areas or on priority populations identified intersessionally	Intersessional correspondence and work, including soliciting papers	Papers to be presented	Intersessional correspondence and work, including soliciting papers	Papers to be presented
Intersessional correspondence groups	Email correspondence and work	Receive reports	Email correspondence and work	Receive reports
Collaborative work with other sub-committees, particularly regarding platforms of opportunity and citizen science data	Email correspondence and work	Papers to be presented, receive updates	Email correspondence and work	Papers to be presented, receive updates
Collaborative work with Conservation Committee (SWG on Whale Watching), including communications output	Intersessional correspondence and work, including developing communications plan and budget	Present update on SWG WW; present communications plan and budget	Intersessional correspondence and work	Present updates on SWG WW work and communications plan outputs

Attention: SC, CC
*The Committee **recommends** that the comprehensive review of the outputs of the IWC Strategic Plan for Whale Watching, be undertaken intersessionally by the SWG, which will now include the WW co-Convenors (Suydam and Urbán), the Chair or vice-Chair of the Committee (Zerbini or Porter) and another member of the Committee (Parsons).*

Finally, it was re-emphasised that Objective 3 of the Strategic Plan (research and data collection) is particularly relevant to the Committee and the SWG once again requested the Committee's active participation in implementing this objective and its related Items. The intersessional correspondence group should also discuss ways to progress this and report back at the next meeting.

17.4.3 Collaboration with other SC sub-committees on platforms of opportunity and citizen science

It was noted that the Society for Marine Mammalogy's 24th Biennial Conference on the Biology of Marine Mammals will host a workshop on 31 July 2022 focused on citizen science studying tourism vessels, acoustic impacts on marine mammals, examination of best practices and possibilities for the future. In addition, it was noted that there is an obvious connection between whale watching and photo-ID efforts, and future collaboration between the sub-committee on whale watching WW and the *ad hoc* working group on photo-ID should be pursued.

17.5 Progress on previous recommendations

Discussion of this Item has been postponed to the next meeting.

17.6 Biennial workplan

A two-year workplan is given in Table 29. It was noted that the discussion of the Committee's workplan with regard to whale watching is routinely intertwined with the workplan of the Conservation Committee's SWG and the revived intersessional correspondence group on communication with the SWG should help focus the workplan in this regard.

A discussion of the Committee's standing agenda Item to conduct regional reviews of whale watching concluded that, given the virtual nature of the recent meetings (previous meetings reviewed whale watching in the region of the meeting's venue), a new methodology for identifying regions or target species for which a review is needed. Notwithstanding this need, the Committee concluded that keeping a review of Latin America as a standing Item on the agenda is appropriate, given the region's rapidly expanding whale watching industry. Indeed, a major updated review of this region's whale watching is overdue. It was also suggested that, when considering a methodology for identifying priority target species for review, species of conservation concern that are the focus of intensive whale watching industries, often odontocetes, should be given particular attention.

It was also noted that the Committee should be more proactive and systematic about collaborating with other sub-committees that use data from whale watching platforms of opportunity and citizen science (see Item 17.4.3).

Attention: SC
*The Committee **agrees** to establish an intersessional correspondence to discuss the future of the sub-committee on whale watching, including, inter alia, who to invite as invited participants, how and where to solicit primary papers and how and when to collaborate with other sub-committees using data from whale watching platforms of opportunity and citizen science (see Item 17.4.3). This intersessional correspondence group will also identify a methodology for identifying regions and/or target species to view with regard to whale watching (see Item 17.3). The group will provide a summary of its discussions to the Committee at the next meeting.*

During further discussion of the biennial workplan, previous consideration of solitary sociable cetaceans was referenced. It was noted that this is a topic upon which IWC contracting governments have requested advice from the Committee. The topic, which had been removed from the agenda, was added back to the workplan (see Table 29) under 'emerging issues of concern' and will be addressed by the intersessional working group on human-induced changes in cetacean behaviour.

18. WHALE SANCTUARIES (SAN)

18.1 Updates from relevant sub-committees on new information relevant to the Southern Ocean Sanctuary management plan

18.1.1 Preparation for the decadal review of the Southern Ocean Sanctuary (SOS)

The SOS was established in 1994 and Paragraph 7(b) of the Schedule, which established the SOS, specifies that the Sanctuary '…shall be reviewed ten years after its initial adoption and at succeeding ten-year intervals...'. In 2003, the Commission directed the Committee to undertake the first in a series of decadal reviews of the SOS (1994-2004) (IWC, 2004, pp.47-50). A second review of the SOS was performed in 2014-16 following terms of reference provided by the Commission (IWC, 2016e; 2017i). Thus, 2024 will mark the third decade of the Southern Ocean Sanctuary and preparations need to be made for the scheduled review.

The stages of the review process are as follows (IWC, 2016d):

(a) A Steering Group is formed (chaired by the SAN Working Group Convenor). The terms of Reference of this Steering Group are to:
  (i) Solicit contributions and collate the necessary information to assist with the review of the scientific aspects of the sanctuary in question;
  (ii) Identify potential external scientists with recognised expertise in research fields relevant to the review of the Sanctuary to attend the Scientific Committee meeting and assist with the review; and
  (iii) Coordinate the review of the scientific aspects of the SOS.
(b) The Steering Group will receive suggestions from SC members for potential external reviewers with recognised expertise in research fields relevant to the review of the Sanctuary, to assist with the review of the Sanctuary in question.
(c) Names of suggested reviewers are provided to the Chair of the Steering Group.
(d) The Steering Group liaises with potential invited experts.
(e) A final list of external reviewers to attend the Scientific Committee is developed.
(f) Invite the external reviewers to attend the Scientific Committee meeting
(g) Documents for the Sanctuary review are submitted.
(h) A review of the Sanctuary is conducted.
(i) A Joint meeting of the Scientific Committee and the Conservation Committee is scheduled to discuss the review held.

At SC/68C (see Item 18.4) the workplan in Table 30 was agreed:

In addition, it was agreed at SC68C (see Item 18.3) that an update of the document SC/66B/SAN/01 (De La Mare *et al.*, 2016), a compendium of information about research relevant to the SOS, would be of great help to the Sanctuary review process. A drafting group (with Bell as Convenor) was established.

18.1.2 Form a Southern Ocean Sanctuary Review Steering Group

This Steering Group will:

(a) develop a *pro forma* for information to be submitted to the SOS review;
(b) solicit nominations for SOS reviewers and develop a list of potential candidates; and
(c) plan the SOS review meeting.

Table 30

Southern Ocean Sanctuary Review workplan.

	2022	2023	2024
Establish Southern Ocean Sanctuary (SOS) review Steering Group	X		
Update the Sanctuary review Terms of Reference	X		
Develop a list of SOS reviewers	(intersessionally)		
Finalise SOS reviewers		X	
Receive documents relevant to SOS review	X	X	X
Conduct SOS review			X

The Steering Group will comprise Bell, Lauriano, Leaper, Parsons (Chair), Slooten and Zerbini.

In addition, the drafting group led by Bell will update SC/66B/SAN/01 (De La Mare *et al.*, 2016). The Steering Group will incorporate this document in the SOS review.

18.1.3 Discuss Terms of Reference

Taking into consideration previous instructions from the Commission to the Committee for Review of Sanctuaries (IWC, 2002b) and Resolution 2002-1 providing guidance to the Committee on the Sanctuary review process (IWC, 2003a), the following terms of reference for the review of Sanctuaries were developed (IWC, 2016e):

(a) provide advice on the status and trends of whale stocks in the Sanctuary in so far as these are known. Assess the present and potential threats to whale populations and their habitats in the area of the Sanctuary and how the Sanctuaries address this;

(b) consider whether the Sanctuary is consistent with other measures to protect whales from anthropogenic and other environmental factors;

(c) assess the effects of the Sanctuary in terms of:

  (i) the protection of whales in breeding areas, feeding grounds, and/or migratory routes; and

  (ii) international agreements concerning biodiversity and conservation of nature;

(d) evaluate whether the Sanctuary allows for the conduct of scientific research useful for meeting IWC objectives or coordinated integrated research and monitoring programmes across the range of issues of global relevance; and

(e) provide advice on whether the sanctuary is consistent with the precautionary approach.

At SC68C, the Committee agreed (Item 18.3) that the Terms of Reference for the review of the SOS should be discussed, taking into account the broadening scientific range covered by the Committee; for example, the role of ecosystem functioning as discussed in the Standing Working Group on Ecosystem Modelling.

The Committee encourages papers and information on ecosystem modelling relevant to the SOS to be submitted to the Steering Group for inclusion in the review. Due to the major impacts of climate change in the Southern Ocean, the Committee agrees that climate change should be explicitly noted as an anthropogenic factor in Item (b).

18.1.4 Discuss the Southern Ocean Sanctuary Review process

In discussion, it was noted that in previous years the Steering Group had collated a list of ten possible reviewers, from which three were chosen to assist the SC with the Review. For consistency, one of the reviewers in the most recent Review (completed in 2016) had participated in the previous Review (2004). The Committee agrees that a similar model should be followed. However, it was agreed that, during the intersessional collation and preparation of the sanctuary review report, other individuals from the short list of reviewers could be asked to provide expert opinion and participate in intersessional discussions if required.

The Committee approves the Southern Ocean Sanctuary Review process as outlined above.

18.1.5 Receive the State of the Cetacean Environment Report

SC/68D/E/12 (2022 State of the Cetacean Environment Report) was received in the Environmental Concerns Sub-Committee. This year's focus was the polar regions; therefore, there were several studies of significance related to the Southern Ocean Sanctuary. Climate warming, as exemplified by a massive ice shelf collapse in East Antarctica and significant reductions in Antarctic sea ice, is expected to exacerbate threats to cetaceans. For example, pollutants as diverse as mercury and microplastics that are currently stored in ice will be set free. Underwater noise is also predicted to increase in the Southern Ocean because ice-free waters are generally louder and this will be affected by earlier melt and later freeze-up, shipping is predicted to increase during the extended ice-free months and sound propagation may change with temperature. The Southern Ocean and Antarctica are highly sensitive to environmental changes, with the greatest anthropogenic threat being climate change. There are gaps in our knowledge of major aspects of the ecology of krill, as key whale prey; a potential decline of krill or a shift to a salp-dominated ecosystem is of key concern.

Table 31

Priorities for the Southern Ocean in relation to UN Decade goals.

Goal: A healthy and resilient ocean
Improve understanding of key drivers of change and their impacts on Southern Ocean species and food webs.
Improve understanding of sea ice, including its role in ecological processes of the Southern Ocean.
Improve understanding of Southern Ocean biogeochemical cycling. The Southern Ocean plays a key role in biogeochemical cycling, particularly in regulating air-sea exchange of carbon dioxide in the global carbon cycle.
Improve societal understanding of Southern Ocean issues and appreciation of the Southern Ocean for its global value in Earth systems and unique environment.
Goal: a predicted ocean
Enhance and expand observational capability to support predictions.
Improve and enhance Southern Ocean modelling capability.
Goal: a sustainable and productive ocean
Increase the suite, types and reliability of measurements, including those focused on ecosystem change, needed to inform management and policy.
Ensure a sustainably harvested and productive Southern Ocean by working towards a stronger interface between science and policy.
Ensure science-based and effective MPAs and uphold sustainable fisheries management

It was noted that the focus region of next year's SOCER will be the Indian Ocean, making it a valuable source of information for an Indian Ocean Sanctuary Review (if instructed by the Commission, see Item 18.2.1 below).

18.1.6 Receive documents on the Southern Ocean Sanctuary

SC/68C/HIM/04 highlighted instances of whale bycatch in the Southern Ocean trawl fishery for krill (see Item 12.2.2). It was noted that data and documents regarding levels of bycatch and ship strikes in the SOS should be included in the SOS review. The Committee encourages the submission of such data and documents at future Committee meetings.

The 1st Southern Ocean regional workshop (Hoffman *et al.*, 2022), which took place on 16 February 2020 in San Diego (CA, USA), was conducted to provide the Southern Ocean community inputs to the Science Action Plan of the UN Decade of Ocean Science for Sustainable Development (UN Decade). The workshop identified several priorities under each of the goals of the UN Decade, which are synergistic and complimentary to the work of the Committee (see Table 31).

The report also highlighted several cross-cutting priorities, including remote sensing in the Southern Ocean; communicating with the public to raise awareness about Southern Ocean issues; using the UN Decade to promote Southern Ocean science and awareness; and also to:

> *'implement a coordinated, international, circumpolar observational program to elucidate processes that: (1) allow life histories of key species in the Southern Ocean ecosystem to be quantified; (2) allow a total carbon budget to be developed; (3) provide coverage of the annual cycle; and (4) quantify the role of sea ice in regulating ecosystem productivity'.*

It was noted that the UN Decade may provide a platform for engaging national programs in such an effort.

Attention: SC, S

*The Committee **agrees** that there are many areas of common interest and synergy between the UN Ocean Decade priorities for the Southern Ocean and the work of the Committee and **recommends** that the Secretariat contact the Intergovernmental Oceanographic Commission (IOC) of UNESCO (coordinators for the UN Decade of Ocean Science for Sustainable Development) to discuss ongoing and future communication and possible collaboration between the IWC and the UN Decade.*

18.1.7 Plan joint work with the ASI Sub-Committee to review Southern Ocean Sanctuary whale stocks and abundance

Discussion on this Item has been postponed to the next SC meeting.

18.1.8 Plan joint work with the WW Sub-Committee to review whale watching in the Southern Ocean Sanctuary

Discussion on this Item has been postponed to the next SC meeting.

18.1.9 Other Southern Ocean Sanctuary Review matters

As part of its work assessing the ecosystem function of cetaceans, the EM Sub-Committee is engaged in summarising estimates of the current and pre-exploitation abundances of the large baleen whale species in the Southern Ocean. The results will provide insight into the extent to which these populations have recovered from their near-extirpation as a result of whaling in the 20th Century. The Committee encourages the submission of documents and relevant information on ecosystem modelling research that could contribute to updating De La Mare *et al.* (2016) and contribute to the SOS review.

18.2 New information for other sanctuaries

18.2.1 Discuss review of the Indian Ocean Sanctuary (IOS)

No documents were received under this Item.

Table 32

Proposed workplan for matters related to whale sanctuaries.

	2023	2024
Finalise SOS reviewers	X	
Receive documents relevant to SOS review	X	X
Conduct SOS review		X
Receive documents relevant to the IOS	X	X
Receive guidance from Commission on IOS review	X	

The Commission adopted the IOS in 1979; its designation was reviewed and renewed in 2002. Therefore, 2022 will mark the end of the second decade since the review of the IOS. The Committee reiterates its request for guidance from the Commission on whether they wish the Committee to commence planning for a review of the IOS after the SOS review has been completed.

18.2.2 Whale watching in the Indian Ocean Sanctuary (joint with WW)

No documents were received under this Item; however, it was noted that papers on whale watching in the IOS may be forthcoming at the next meeting and SAN looks forward to conducting a joint session with WW next year on this topic.

18.3 Progress on previous recommendations

Discussion on this Item has been postponed to the next meeting.

18.4 Biennial workplan

The workplan is in Table 32.

Funding for the Southern Ocean Sanctuary Review (to be conducted during a two-day pre-meeting in 2024) was discussed and a budget request was prepared, reviewed and endorsed by the Committee.

Proposed Agenda for the Ad Hoc Working Group on Whale Sanctuaries at the next meeting

01. Introductory Items
    - 1.1. Opening remarks
    - 1.2. Election of Chair
    - 1.3. Appointment of rapporteurs
    - 1.4 Adoption of Agenda
    - 1.5 Documents available
02. Preparation for the decadal review of the Southern Ocean Sanctuary (SOS)
    - 2.1. Finalise SOS reviewers
    - 2.2. Discuss the SOS Review process
    - 2.3. Receive documents on the SOS
    - 2.4. Plan joint work with ASI to review SOS whale stocks and abundance
    - 2.5. Plan joint work with the WW Sub-committee to review whale watching in the SOS
    - 2.6. Other SOS review matters
03. Discuss review of the Indian Ocean Sanctuary (IOS)
    - 3.1. Receive the State of the Cetacean Environment Report
    - 3.2. Receive documents on the IOS
    - 3.3. Whale watching in the IOS (joint with WW)
    - 3.4. Receive guidance from Commission on IOS review Workplan and budget considerations
04. Adoption of report

19. EXTINCTION INITIATIVE

Simmonds presented the work of the Extinction Initiative which grew out of a concern for the increasing number of endangered populations and species of cetaceans. and the bleak prognosis for many of those taxa. The Initiative is a communications tool, which will allow the IWC to speak out in a timely manner to address when a species or a distinct population is declared extinct or when there is a grave concern about the survival of such. The issue of extinction now has web pages but the next step is to seek Commission endorsement of the Initiative, specifically the proposal to issue public statements of concern, based on a template presented at SC68C. There has been a minor change to the template (Annex G) with the inclusion of 'and Fragmentation' in relation to the area of 'Habitat degradation'.

Attention: C, CC, SC
*The Committee **reiterates** its support for the work of the Extinction Initiative intersessional group, and for their proposal to seek Commission endorsement for the publication of SC statements of concern.*

In discussion it was noted that, given Commission endorsement, the SM sub-committee intend to swiftly draft a related statement for the Vaquita (Item 16.3.3). The negative effects on ecosystem function from species-loss was raised as an additional issue that could be incorporated. In response it was stated that whilst a number of issues had been considered for inclusion it was felt that a simple clear message would be more effective. There were suggestions as to the best name for the Initiative, such as including the addition of 'Preventing', that could be considered if they don't confuse the progress already made in promoting this important work.

20. IWC LIST OF RECOGNISED SPECIES

Since the last SC meeting, one new species of beaked whale has been described from the Southern Hemisphere. This new species is *Mesoplodon eueu* (Carroll *et al.*, 2021) Ramari's beaked whale. Before 2021, all previous references to this species in the Southern Hemisphere referred to it as True's beaked whale, *M. mirus*. It was considered the only beaked whale with an antitropical distribution – one population in the North Atlantic and the other in the Southern Hemisphere. Now the Southern Hemisphere form is recognised as a separate species (Carroll *et al.*, 2021).

Blue whale subspecies

While the IWC Scientific Committee does not maintain a list of cetacean subspecies, some whale species have long been reviewed and assessed at the subspecies level. The best example of subspecies usage in the SC is the blue whale. The SC has a long history of distinguishing two species of blue whales in the Southern Hemisphere, Antarctic blue whales, *Balaenoptera musculus intermedia* and the Pygmy blue whale B. *musculus brevicauda*. In the SC, we commonly use the following subspecies of blue whales in our work:

- *B. m. musculus* (Linnaeus, 1758). Northern blue whale;
- *B. m. intermedia* (Burmeister, 1871). Antarctic blue whale;
- *B. m. indica* (Blyth, 1859). Northern Indian Ocean blue whale; and
- *B. m. brevicauda* (Ichihara, 1966). Pygmy blue whale.

Recently, two new subspecies of blue whale have been proposed: The Chilean blue whale (*Balaenoptera musculus chilensis*) (Khalaf, 2020) and the Arabian Sea blue whale (*Balaenoptera musculus arabica* (Khalaf, 2021). However, these subspecies names should not be used as a result of the recent review by the Taxonomy Committee under the Society for Marine Mammalogy. In this review they noted the following:

> *'There have been a variety of studies (Branch et al., 2007; 2018; LeDuc et al., 2007; 2017; McDonald et al., 2006; Torres-Florez et al., 2014a) that have provided evidence suggesting blue whales in the eastern South Pacific differ from blue whales elsewhere and may represent a separate subspecies but none have provided a formal subspecies description supplying the information required under the International Code of Zoological Nomenclature for proposing new species or subspecies. Khalaf (2020) summarises information available on the population in the eastern South Pacific, designates an identifiable specimen and type location, and provides a subspecies name. However, the subspecies description is incomplete and, importantly, is diagnosed by bibliographic references alone. This is minimally sufficient to make the name available (see Code, Art. 13.1.2), but no attempt seems to have been made to collect morphological or genetic evidence, despite the ready availability of a skull and nearly complete skeleton. This is poor practice and contrary to Recommendation 13A. We therefore regard the name B. musculus chilensis a nomen dubium and do not recognise it until these faults are remedied. Khalaf (2021) also describes a new blue whale subspecies B. musculus arabica from the Arabian Sea. This work fails to acknowledge that more than one type of blue whale exists in northern Indian Ocean making it impossible to link the new blue whale song described by Cerchio et al. (2020) from this region to the blue whale skeleton from Kuwait. The subspecies is diagnosed only by bibliographic references to characterisations of its song and acoustics alone does not constitute sufficient evidence for taxonomic separation. We therefore regard the name B. musculus arabica a nomen dubium and do not recognise it.'*

21. IWC DATABASES AND CATALOGUES (PH AND GDR)

Due to scheduling conflicts, the *ad hoc* Working Group on Photo-Identification did not meet this year, but some information was submitted to the Committee.

21.1 Guidelines for IWC catalogues and photo-ID databases (PH)

There were no updates to the Guidelines.

21.2 Progress with existing or proposed new catalogues (PH)

Some information was presented to the Committee (see Items 21.2.4 and 21.2.8).

Table 33

Workplan for 2023 and 2024 for PH.

Topic	Intersessional	Next meeting	Intersessional	Subsequent meeting
IWC Guidelines for Photo-ID (21.1)	Review Guidelines for possible updates	Update Guidelines as necessary	Review Guidelines for possible updates	Update Guidelines as necessary
Developments with AI and computer-assisted matching (21.2)	Review progress	Report(s)	Review progress	Report(s)
Southern Hemisphere Blue Whale Catalogue (SHBWC) (21.2.4)	Complete within-region comparisons of southeast Pacific and Australian photos	Report	Continue inter-regional photo comparisons	Report
Madagascar blue whale photo-ID (21.2.4)	Complete within-region comparisons	Report	-	-
Antarctic Blue Whale Catalogue (21.2.5)	Continue acquisition of new photos; compare photos; upload to SHBWC	Report	Continue acquisition of new photos; compare photos; upload to SHBWC	Report

21.2.1 Right whale photo catalogues
21.2.2 Happywhale database
21.2.3 Flukebook
21.2.4 Southern Hemisphere Blue Whale Catalogue (SHBWC)

Currently this collaborative catalogue houses 2,209 individual blue whale photographs from 25 research groups. Progress with the Southern Hemisphere Blue Whale Catalogue is summarised in SC/68D/SH/04. In the last year inter-regional matching was focused on populations in the southeast Pacific and off Australia and New Zealand as these data will be used for upcoming assessment purposes; see Item 8.2.1. The results of matching analyses in the southeast Pacific (SC/68D/SH/10) suggest separate feeding grounds in northern and southern Chile, and migratory linkages between southern Chile and the southern Eastern Tropical Pacific.

21.2.5 Antarctic Blue Whale Catalogue (ABWC)
21.2.6 Fin whale photo catalogues
21.2.7 Humpback whale photo catalogues
21.2.8 Other photo-ID catalogues

The western Pacific gray whale photo-ID catalogue (1994-2021) maintained by the Russia Gray Whale Project (RGWP) will be provided to the IWC Secretariat following SC68D (SC/68D/CMP/16). The implications of making this catalogue available to the gray whale research community via the IWC are discussed in Item 9.1.3. Previously the Committee has recommended that all holders of western gray whale catalogues make their data available to the IWC (IWC, 2021c) for cross-comparisons toward a better understanding of fidelity and movement patterns. The majority of whales in the RGWP catalogue now have left-side, right-side, and ventral fluke identification photographs, allowing for useful images to be collected from almost any body region. SC/68D/CMP/15 outlines the RGWP's most recent photo-ID effort. The movements of 48 photo-identified gray whales between feeding areas in the western Pacific off Russia and breeding areas in the eastern Pacific off México are documented in SC/68D/CMP/09. This represents 12.6% of gray whales identified off Sakhalin Island and Kamchatka. More information about North Pacific gray whales is given under Item 9.1.3.

An innovative approach using identification photos of false killer whales from a long-term catalogue to estimate age is presented in SC/68D/SM/04; see Item 16.4.2. The method is suitable for use on other datasets and Committee members expressed interest in applying it to their own catalogues and data.

21.3 Progress with existing IWC databases (GDR, Secretariat)

The GDR Working Group aims to assess the utility and support required for IWC databases relevant to the work of the Scientific Committee. Specifically, the Group:

(1) collates summary information on all IWC databases relevant to the SC;
(2) summarises data use by the SC for each database;
(3) provides recommendations to improve integration, content and workflows;
(4) reviews technical progress on existing databases or databases under development;
(5) considers needs and specifications for potential new databases, including developing simple technical guidelines on new proposals; and
(6) produces a budget and workplan for the implementation and development of existing and new databases.

21.3.1 Summary of IWC databases and current priorities

SC/68D/GDR/01 presented a review of the current status of IWC databases and data holdings. Work on existing databases included the Southern Hemisphere Blue Whale Catalogue being hosted by the IWC and administered by a local developer. The new Data Manager has continued progress on the Ship Strikes database and begun scoping the development of a Strandings database. The Database of Recommendations went live on the IWC website last year. Work has been on done to add historic recommendations and generate products for each of the sub-committees. The Statistics team have begun work on transforming the POWER/SOWER, Catch, and Abundance Databases into relational databases that are online and searchable to increase accessibility and use of the data.

In summarising the current suite of IWC databases the Secretariat emphasised the need for predictable, ongoing funding. This is more critical now because many of IWC's databases are hosted 'in the cloud' with recurring annual fees. When supporting new and existing databases these ongoing fees must be considered. Currently some costs are met through the SC Research Fund. The Secretariat proposes to communicate with the Commission to adjust the budget to have a permanent line support for data preservation. In the interim, the Secretariat will continue the status quo to request funds through the SC Research Fund.

Fortuna noted having recently received data from the Ship Strikes database that it contained data gaps and errors. It was suggested to have scientists review subset data for their area to identify missing data and resolve any issues. The Data Manager will review the quality control/quality assurance process and work with the Ship Strikes Data Review Group to address concerns with data gaps and errors.

The Committee thanked the Secretariat for the paper and the summary table has been updated and is presented below (Table 34). The Committee agrees the priorities for the further development and support of IWC databases by the Secretariat, as presented in Table 34, were appropriate. It also supported the submission of a funding proposal from the Secretariat to fund cloud services needed to host some of the SC's databases.

21.3.2 IWC National Progress Reports

There has been a great deal of effort to improve the ease of data submission in recent years. Secretariat staff directly assisted countries in their submissions this year, have made additional outreach to African nations and provided training, resulting in the submission of 13 National Progress Reports, a decrease from the 14 received in 2021.

The Committee acknowledged the low reporting rate of National Progress Reports and recommends that an intersessional group should develop a paper for IWC68 that describes the current state of reporting and present options to address the lack of submissions. The function of National Progress Reports is to satisfy part of a condition of the Convention and direction is needed from the Commission on the continuing need for, and role of, National Progress Reports.

Double provided an overview on the development of an R script that facilitates the automated visualisation of annual National Progress Report data. It was noted this aided in Australia's own internal reporting and could incentivise the states and territories to provide data. The applicability of these scripts to National Progress Report data from other countries will be assessed. When complete, these scripts will be able to automatically generate multi-year tables and plots of national data and summaries of all the data within the National Progress Report database.

In discussion there was a suggestion that data holders could be approached by the Secretariat to help reformat their data to fit into the database. There should also be a focus on who is using the data collected and making it useful to them. In this regard it was suggested that these reports should be targeted to regional groups in addition to countries. Having all the data available together in a dashboard so the user can filter and explore the data of interest would help its accessibility.

21.3.3 Review database procedures, evaluate possible integration and consolidation of existing databases, and define rules for accessing data

Future progress on IWC databases and data holdings includes a review the status of existing IWC databases and to liaise closely with those sub-committee members who are developing ideas for databases. These actions are critical in order to consider new database specifications in light of ongoing work in the Secretariat and the potential for interoperability with existing databases. The Committee acknowledged the Secretariat's progress on databases and data holdings and agreed the options for integration and inter-operability should be explored further by GDR's intersessional group.

21.4 Potential future IWC databases (GDR)

21.4.1 IWC database proposal pro forma

The Committee was reminded of the IWC database proposal proforma developed by GDR previously. The proforma is presented in Annex N.

21.4.2 New proposals for IWC databases

The GDR Working Group did not receive any proposals for the development and support of new IWC databases during SC68D. The Head of Science, Conservation and Management noted the Pollution 2025 workshop has recommended the E sub-committee seek SC research funds to support a pollution mapping tool. The GDR Working Group noted its willingness to work with groups to populate the *pro forma*.

Table 34

Current status of IWC databases.

Database/Application	Status	Work required	SC Priority *as set by Scientific Committee* *(If none set, defaults to Medium. Maintenance is always set to Highest)*
Bibliographic reference database (EndNote)	Live	Import Commission papers and Circulars?	Medium
Blue Whale Song Library	Stalled	Develop database (£4,000 available) Assigned to tribalsystems.uk (not done). Recommendation added to the *CRMbhttps://crm.iwc.int/data/blue-whale-songs* by IWC	High
Catch Summary Database	Live	Recommendation to be added to *crm.iwc.int*. Example *crm.iwc.int/individualcatchdatabase*	High
Cetacean Diseases of Concern Intranet	Stalled	Finalise website	Medium
Compendium of Whale Watching Regulations	Retired	None	N/A
Conservation Reporting Database	Under Development	Finalise specifications, Develop database and review at CC 2022. Recommendation: Add to IWC CRM *https://crm.iwc.int/data/conservation-database*	High
Database of Recommendations	Live	Improved - *https://recommendations.iwc.int*	Medium (Default)
Discovery Marking Data	Live	-	Medium (Default)
Entanglement Response	Postponed	Develop database	N/A
Individual Catch Database	Live	Document idiosyncrasies exist within data. Creation of a database of records for which there are no individual data and which conforms to all available summary data on the area, sex and month of these catches, to enable easy creation of catch series. Requires full documentation. Recommendation to be added to *crm.iwc.int* - Example *crm.iwc.int/individualcatchdatabase* and GitHub for versioning and documentation	High
InforMEA project database	Live	Ongoing development of Drupal application and database	Medium (Default)
IWC biopsy sampling database	Under Development	Updates only (in progress)	Medium
IWC photographic cruise database and archive	Live	Updates only (in progress)	Medium
Journal	Live	*JCRM* Issues 20-23 and Special Issues now available online. Backdating previous Issues required	Medium
Meeting Documents	Live	Moved to SharePoint	Medium (Default)
Meeting Registration	Live	For SC68D Microsoft tools were used for registration and automatic addition of users to our office 365 SC groups	Medium (Default)
National Progress Reports	Live	Bulk import from CSV to be tested. Integration of standard FAO areas	Medium
New integrated sightings, photo-ID, database	Stalled	Updates only (funding available)	Medium
Research Requests	Replaced	Replaced by simple form: *https://forms.office.com/r/wEmk6Py8U5*	Medium (Default)
SH Blue Whale Catalogue	Live	Migrated to IWC server	Medium (Default)
Ship Strikes	Live	Bulk import tool (CSV) - Not done. Allow data to be submitted via API directly from country databases	Medium
Small Cetaceans Catches (Bycatch and Direct)	Live	-	Medium (Default)
WNP gray whale catalogue	Under Consideration	Migration to new system	tbc
WW Handbook	Live	Update to CraftCMS v3 and migrate database to PostgreSQL	High

21.5 Biennial workplan

To progress the work of the GDR Working Group an on-line intersessional workshop will be convened in 2022. The workshop will develop options to present to IWC68 to address the lack of National Progress Report submissions. The workshop will also scope all current database and data holdings within the IWC scoping areas of potential integration and consolidation including data submission. The Terms of reference for this would include identifying need, intended users, overlap with external data holdings, the benefit to the work of the IWC now and over the next 10 years. The following are the Terms of Reference:

In order to improve data management within the IWC an intersessional steering group led by Double and Staniland will be formed to plan and convene an online workshop to address the following:

- review data collection procedures across the IWC identifying need, use and overlap with external data holdings. In particular seek ways that processes can be simplified, and streamlined, to increase submission rates and minimise duplication of effort. [with a focus on National Progress Reporting];
- scope areas of potential integration and consolidation of current IWC databases and report on their status;
- define rules/expectations surrounding data accessibility for databases with different levels of IWC support; and
- review any new database requests from SC68D.

22. IWC MULTINATIONAL RESEARCH PROGRAMMES AND NATIONAL RESEARCH CRUISES THAT REQUIRE IWC ENDORSEMENT (ASI)

Multinational research programs (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 for 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. The Committee notes that its report does not represent an official position of the IWC on the legal nature and designation of the waters to be surveyed.

This year, because of the virtual format of the meeting, the Committee did not have time to discuss all of the cruises reports and plans in zoom sessions. Instead, comment sheets were used to provide reviews.

22.1 IWC-POWER and cooperation with Japan

The Committee received the report of the IWC-POWER Steering Group (SC/68D/REP/03) summarising the progress made during the December 2021 online planning meeting by the Steering Group, including plans for 2023 and post-2023 cruises, and a recommendation for a future survey workshop in the autumn of 2022.

The Steering Group highlighted the achievements of the IWC-POWER programme since 2010, recognising that the surveys cover pelagic waters of the central and eastern North Pacific that have rarely if ever been covered by systematic line-transect surveys and had not been surveyed by any means in decades prior to the implementation of the programme. IWC-POWER has important scientific, conservation and management value, and the results have contributed greatly to the work of the Committee.

The short- and medium-term objectives were reviewed and updated by the Technical Advisory Group (TAG). The initial plan was to survey Russian waters of the Bering Sea and east of the Kuril archipelago off Kamchatka, the 'least studied' areas of the central and eastern North Pacific, which would have completed the 'short-term' objectives (IWC, 2012b). However, an official reply from the Russian government was received on May 6 2022 stating that permission to operate in Russian waters was denied. Therefore, after consultations with IWC, NOAA and Japan, the contingency plan of surveying USA waters south of the Aleutian Island Archipelago will be implemented instead. The Steering Group applied for a permit to operate in USA waters. The survey design was optimised to reduce time lost in transit, and 6 days were set aside for experiments (distance angle, photo-ID, biopsies). Sonobuoys will be used to detect and close-in on high priority species when feasible. Collection of additional data on marine debris, sea surface temperature and possibly satellite tagging will be attempted as well. Analyses of these data will form the basis of the medium-term plan and may also result in one or two more cruises aimed at filling specific knowledge gaps before implementing the medium-term programme.

The medium-term objectives were reviewed and updated by the TAG. At least two more cruises are required to complete the initial programme. The planning for the next phase will begin as soon as possible and will be completed by 2024. The un-surveyed areas (e.g. Western Bering Sea area, East off Kamchatka) or new areas (e.g. off California, Chukchi and Beaufort Seas), are likely to be the choice for the 2023 survey plan but will depend on the international situation. In addition to the present work, future cruises 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 etc.)' (IWC, 2020a).

In discussion, the Committee noted the importance of considering how the data will be used for sei whales, particularly as it pertains to additional variance components for the integration of new results with previous estimates. The Committee commended the work undertaken by the Steering Group, the TAG, and Japan to ensure the completion of the 2022 cruise despite the current situation and issues with obtaining a permit to operate in Russian waters, and endorses its report. The Committee also supports the proposal of the Steering Group and TAG to hold a workshop in September 2022 to develop detailed plans for the post-2022 cruises as well as the 2024 Planning Meeting.

The Committee welcomed the results of the 12th annual IWC-POWER cruise (SC/68D/ASI/03), conducted between 2 August and 30 September 2021 in the eastern North Pacific (north of 40°00'N between 135°00'W and 155°00'W, comprised entirely of the High-Sea). The cruise was carried out by the R/V *Yushin-Maru No. 2*. Survey trackline coverage was 77.2 % (1,563n.miles of a planned distance of 2,022n.miles), with a total of 834n.miles in Passing with Abeam Closing mode (NSP) and 729nm in Independent Observer passing mode (IO). Sightings were made of blue (6 schools/7 individuals), fin (79/115), sei (25/40), Bryde's (20/22), sperm (19/22) and killer (1/4) whales and photo-ID data were collected for 69 individuals from 5 species. North Pacific right whale was not sighted during the cruise. A total of 19 biopsy samples were

collected from 3 blue, 9 fin, 4 sei, 2 Bryde's and 1 killer whales. The estimated angle and distance training exercise and experiment were completed. The cruise also documented the distribution and characteristics of floating marine debris. No acoustic survey was conducted. A feasibility experiment of dive behaviour tagging was conducted at the discretion of Japan with tags deployed on 2 fin and 3 sei whales. Results from this cruise will contribute to the work of the IWC-SC on the management and conservation of populations of large whales. The data will be analysed during the coming years and the results presented at upcoming Committee meetings.

In discussion, the Committee stressed the importance of the IWC-POWER cruises and reiterated the small cost to the Scientific Committee compared to the contribution of a vessel and crew. The Committee thanks the Government of Japan, which generously supplies the vessel, crew, and the USA (equipment and researchers), for their continued support of this IWC programme, as well as members of the Technical Advisory Group and the international scientists who have participated in these cruises. In addition to abundance estimates obtained from the programme, the biopsy sampling component is of great value in understanding the stock structure of large whales in the North Pacific and further collection of samples, especially from blue and fin whales, is encouraged in future surveys. The Committee also stressed the importance of covering these offshore areas for which very little information is available and thanked Japan for sharing the data collected during the cruises. Finally, the Committee expressed its sincere thanks to Murase for his excellent leadership in acting as Cruise Leader for the 2021 IWC-POWER.

Attention: SC, C, CG-R

*The Committee **reiterates** to the Commission the great value of the data contributed by the IWC-POWER cruises which have covered 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 Steering Group (SC/68D/REP/03) and **recommends** that the programme continues.*

The Committee also:

(1) ***agrees** that the 2021 cruise was duly conducted following the requirements and guidelines of the Committee (IWC, 2012c) and **looks forward** to receiving abundance estimates based on the data obtained;*
(2) ***endorses** the proposed plans for the 2022 cruise and **looks forward** to receiving a report from this survey at the next meeting of the Committee; and*
(3) ***endorses** the report and workplan for the continuation of work related to the IWC-POWER cruises, including the updated medium-term objectives.*

22.2 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 seven 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'.
(6) 'The right sentinel for climate change: linking foraging ground variability to population recovery in the southern right whale'.
(7) 'Recovery status and ecology of Southern Hemisphere fin whales'.

The Committee welcomed the IWC-SORP Annual Report 2021/22 on the continued progress of research undertaken under the auspices of these themes since last year (SC/68D/SH/07). This progress includes the production of 40 peer-reviewed publications during 2021/22, bringing the total number of peer-reviewed publications produced since the start of the initiative to *ca*. 248. In addition, 190 IWC-SORP related papers have been submitted to the Scientific Committee to date, 22 of them this year. The initiative has directly contributed to at least 11 PhD, 6 Masters and 5 honours theses.

The COVID-19 pandemic has continued to cause major disruption to most IWC-SORP projects through the closure of laboratories, cancellation of voyages and disruption of fieldwork. Limited fieldwork was undertaken in the western Antarctic Peninsula and sub-Antarctic Marion Island. Southern right whale aerial surveys were conducted in South Africa and Australia.

Table 35

Workplan for the Southern Ocean Research Partnership.

Item	Intersessional	Next meeting	Intersessional	Subsequent meeting
Analyses	Continued analysis of data/samples from previous IWC-SORP voyages/fieldwork	Report	Continued analysis of data/samples from previous IWC-SORP voyages/fieldwork	Report
Voyages	Baleen whale and krill research voyages on ships of opportunity along Western Antarctic Peninsula	Report	Baleen whale and krill research voyages on ships of opportunity along Western Antarctic Peninsula	Report
	ARA Almirante Irizar, 2022/23, to Antarctic Peninsula, islands at 61°00'-63°37'S, 53°83'-62°83'W and 60°30'-60°48'S, 44°25'S-46°43'W and Weddell Sea	Report	*ARA Almirante Irizar*, 2023/24, to Antarctic Peninsula, islands at 61°00'-63°37'S, 53°83'-62°83'W and 60°30'-60°48'S, 44°25'S-46°43'W and Weddell Sea	Report
	RV Maria S. Merian cruise MSM115-FINWAP, Feb-Mar 2023, to Elephant Island, Islands at 61°00'-63°37'S, 53°83'-62°83'W and 60°30'-60°48'S, 44°25'S-46°43'W	Report		
Fieldwork	Continued fieldwork around Marion Island 2022/23	Report	Continued fieldwork around Marion Island 2023/24	Report
	Field work around Auckland Islands Maungahuka, July 2022	Report		
Acoustics	Retrieval and redeployment of passive acoustic recorders	Report	Retrieval and redeployment of passive acoustic recorders	Report
Funded research	Progress on IWC-SORP Research Fund funded research projects endorsed by IWC	Report	Progress on IWC-SORP Research Fund funded research projects endorsed by IWC	Report

Images for photo-ID have been collected; satellite tags deployed on southern right and fin whales; biopsy samples collected from southern right and humpback whales; and hundreds of hours of cetacean acoustic recordings have been made and analysed. The support of national programmes in providing research platforms to facilitate these activities, as well as external data contributors, were gratefully acknowledged by the Committee.

A report on the progress of projects funded by the IWC-SORP Research Fund following three open, competitive grants rounds (2016-present) was also provided (SC/68D/SH/08). £24,844 GBP remain unassigned and unspent in the IWC Research Fund Financial Report (SC/68D/O/04). The Committee acknowledged and thanked all contributors to the IWC-SORP Research Fund for their voluntary contributions. The Committee also noted that, since SC68C, vessel time has been secured by IWC-SORP researchers for the 2022/23 austral field season.

The Committee recognises that the scientific research facilitated by the IWC-SORP will contribute to achieving the scientific objectives of the Southern Ocean Sanctuary.

The IWC-SORP ethos is one of open collaboration, communication and data sharing. It welcomes new partners.

Attention: SC, G

Acknowledging the great value of the IWC's Southern Ocean Research Partnership (IWC-SORP) 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 and acoustic data, to IWC-SORP and the wider Committee.*

22.2.1 Workplan

See Table 35.

22.3 IWC-ATLAFCO collaboration for capacity building and cetacean surveys

At SC68C, the Committee formed an intersessional group to consider topics which were of potential interest to the work of COMHAFAT/ATLAFCO. The idea was to provide experts to collaborate with West African scientists to design, organise and run future capacity building workshops with COMHAFAT. The first stage of this process was to gather ideas of where the IWC could offer expertise and training. These ideas were then presented to COMHAFAT to seek input from the member

governments on what topics they felt would be helpful and which, if any, of these topics would be a priority. COMHAFAT confirmed that all of the suggested topics were of interest to their members. The next stage of the process will be to identify suitable experts to address these topics, schedule workshops and seek funding to accomplish specific objectives. The Committee encouraged an intersessional correspondence group (Table 4, Item 3) to continue this work.

22.4 National cruises that require or request IWC oversight

SC/68D/ASI/09 outlines the objectives and methods for the Korean Sighting Survey in spring and autumn 2022-23. The first objective of this survey is to collect information on the distribution and abundance estimation of common minke whales for stock assessment. The second objective is to collect general information on the distribution of other cetaceans in the area. A total of 5,495 n.miles long transect lines will be searched using closing mode with binoculars and naked eyes. Other research activities such as photo-ID will be conducted during the survey.

The Committee endorsed this planned survey and appointed Eun-Ho Kim to provide oversight.

Attention: SC, C, Korea
*National research programs provide valuable information to advance the work of the Committee. The Committee **endorses** the Korean Sighting Survey plan for 2022-23 and **encourages** the submission of abundance estimates and other data from this study in the future in accordance with the Procedures for Submission, Review and Validation of Abundance Estimates (IWC, 2020f) and subsequent amendments thereof.*

22.5 Review and provide advice on plans for future surveys

The Committee welcomed plans to conduct the following research cruises in the intersessional period.

SC/68D/ASI/12 describes the research plan for the cetacean sighting survey in the southwestern Sea of Okhotsk (sub-areas 12 SW and 11) in 2022. The eighth Russian-Japanese sighting survey is planned for 4 August to 4 September (32 days). The survey will be conducted along systematic transects in passing mode, using standard distance sampling techniques. Photo-identification of cetaceans such as killer whales, North Pacific right whales, gray whales and humpback whales will be attempted.

SC/68D/ASI/02 outlines Japan's plan for a systematic vessel-based sighting survey in the North Pacific in 2022. The main objective of this survey is to estimate the abundance of large whale species in the North Pacific Ocean for management and conservation purposes. The survey will be conducted using the research vessels *Yushin-Maru* (YS1) and *Kaiyo-Maru No. 7* (KY7) in August-September 2022 and will cover the area comprised between 35°-44°N, 140°E-153.5°E. Distance and angle estimations, photo-ID, biopsy, and satellite tagging experiments will be also conducted.

SC68D/ASI/04 outlines the objectives and survey procedures of the 2022/23 line transect whale sighting survey under the Japanese Abundance and Stock structure Surveys in the Antarctic (JASS-A program). The main research objectives of JASS-A are: (i) the study of the abundance and abundance trends of large whale species; and (ii) the study of the distribution, movement and stock structure of large whale species. JASS-A also has several secondary research objectives related to oceanography, marine debris and whale biology. The objective of this paper is to outline the objectives, survey procedures and schedule of the 2022/23 JASS-A survey in Area VIE (145°W-130°W) of the South-Pacific region of the Antarctic.

The Committee endorsed these cruise plans.

Attention: SC, C, Russia, Japan
*National research programs of member and non-member IWC nations provide valuable information to advance the work of the Committee. In reviewing plans for national research cruises in 2022, the Committee **endorses** the planned Japanese surveys in the North Pacific and Antarctic, and the planned Russian-Japanese sighting survey in the Sea of Okhotsk. The Committee **encourages** submission of abundance estimates from these studies in the future in accordance with the Procedures for Submission, Review and Validation of Abundance Estimates (IWC, 2020f) and subsequent amendments thereof.*

22.6 Other cruise plans and reports

The Committee welcomed cruise reports from surveys conducted in 2021 and early 2022 by Japan in the Antarctic (Matsuoka *et al.*, 2021) and the North Pacific (Murase *et al.*, 2021; Øien, 2021), by Russia in the Okhotsk Sea (Gushcherov *et al.*, 2021) and by Norway in the Northeast Atlantic (small management area EW-Norwegian Sea, Hakamada *et al.*, 2021). The plans for all of these surveys had been presented and endorsed at SC68C.

SC/68D/ASI/05 provides the results of a sighting survey conducted in the North Pacific in the spring (April-June), autumn (October-November) and winter (January-March) seasons of 2021/22. The research area was between 141°E-150°E, 35°N-46°N with a total effort of 4,956.3 n.miles. In addition to the collection of systematic sighting data, biopsy, photo-ID, and satellite tracking experiments on baleen whales were conducted.

Table 36

Workplan for multinational research programs and national research cruises that require IWC oversight.

Item	Topic	Intersessional	Next meeting	Intersessional	Subsequent meeting	Agenda Item
1	IWC-POWER Cruise in the North Pacific Ocean.	Conduct 2022 survey and planning meeting for the future cruises, including updating medium-term objectives, begin development of medium-term plans	Review cruise report, report from the planning meeting and new abundance estimates from IWC-POWER cruises	Conduct 2023 survey, finalise medium-term plans	Review cruise report, and new abundance estimates from IWC-POWER cruises.	22.1
2	Review and provide advice on plans for future surveys.		Receive, review and provide feedback to research plans to conduct abundance estimates		Receive, review and provide feedback to research plans to conduct abundance estimates	22.5
3	IWC-ATLAFCO collaboration for capacity building and develop cetacean surveys.	Identify experts, schedule workshops, seek funding in support of capacity building	Review progress	Identify experts, schedule workshops, seek funding in support of capacity building		22.3
4	Indian Ocean pan-regional initiative to conduct cetacean surveys.	Develop a plan for a collaborative pan-regional survey initiative across the Indian Ocean to conduct cetacean surveys.	Review progress	Extend and begin implementing the plan for a collaborative pan-regional survey initiative across the Indian Ocean to conduct cetacean surveys.	Review progress	

SC/68D/ASI/06 describes the results of a sighting survey conducted in the North Pacific (between 150°E-155°W, 30°N-53°N) from 4 August to 30 September 2021. The total searching distance in the research area was 3,713.8 n.miles. As with the survey described by SC/68D/ASI/05, this survey also conducted biopsy, photo-ID and satellite tracking experiments, in addition to collecting systematic sighting data.

SC/68D/ASI/10 describes the results of the sighting survey of the Japanese Abundance and Stock structure Survey in the Antarctic (JASS-A) conducted using line transects and distance sampling methods from 11 January to 12 February 2022 in the eastern part of Area VI East (130°W-120°W). The survey included coastal ice-free areas, south of 72°S and the total effort was 1,333.5 n.miles. In addition to collecting systematic sighting and oceanographic data, biopsy, photo-ID, and satellite tracking experiments were conducted.

SC/68D/ASI/11 describes the results of a Russian-Japanese sighting survey conducted in the northern part of the Sea of Okhotsk from August 8 to September 10, 2021. The northern and the southern boundaries were 57°00N and 60°00N, respectively and the western and the eastern boundaries are 139°00E and 157°00E, respectively. The vessel was able to survey 100% of the pre-determined track line (1,299.26 n.miles in closing mode and 963.41 n.miles in passing mode or transit). The document provides some overall results for 2015-21 on the occurrence and behaviour of whales.

SC/68D/ASI/07 reports on the progress of a current six-year program to survey the Northeast Atlantic over the period 2020-25 to get a new estimate of minke whale abundance by the end of this period. In the summer of 2021, the area around the island Jan Mayen, comprising the *Small Management Area* CM, was surveyed with one vessel using double platform methodology. A total of 2,641 n.miles of primary search effort was conducted within the surveyed blocks. The most common species sighted were minke whales, Northern bottlenose whales, fin whales, humpback whales and sperm whales. In addition, sightings were made of killer whales, blue whales, white-beaked dolphins, sei whales, pilot whales and harbour porpoises. Compared to the 2016 survey of this area, fewer minke whales were recorded in the southern part of the survey area. In addition, a survey of harbour porpoises was conducted within the Hardangerfjord in southern Norway.

The Committee expresses appreciation to the countries who have sponsored these surveys providing important contributions to cetacean research.

22.7 Biennial workplan

The Committee agrees to the workplan provided in Table 36. Item 1 in this table (IWC-POWER cruises) has financial implications for the Committee. A research proposal to conduct this work was reviewed, and the Committee strongly endorses this proposal. An intersessional Steering Group has continued to assist with the planning of the IWC-POWER cruises (Annex M). Last year, a steering group was formed to explore an Indian Ocean pan-regional initiative to conduct cetacean surveys. Although little progress was made intersessionally, the Committee encouraged this work to continue its work.

23. SCIENTIFIC COMMITTEE BUDGET FOR THE CURRENT AND NEXT BIENNIUM

In light of the financial deficit of £497,000 facing the Commission in the next biennium, the Committee discussed the implications for its work (see Annex D). If the Commission does not balance its biennial budget, it will become insolvent in 2025. Three possible options to balance the 2023-24 budget will be considered by the Commission at IWC68. All options are intended to establish a new status quo, that is, the Commission will not return to previous patterns of expenditure. Proposed options 1 and 3 will have a substantial impact on the work of the Committee.

Option 1 represents a cut of 48% in the SC meeting budget and a reduction of 21% in the research budget. Option 1 does not include funds for the Secretariat to support a virtual meeting of the SC, which means that if the SC choses to host a virtual meeting, funds to support this would need to be allocated from its research budget, or from external sources. A provision of funds for an ASW workshop has been included since 2024 is a renewal year for quotas.

Option 3 represents a smaller cut of 3% in the SC meeting budget and a reduction of 11% in the research budget. ASW workshops will be funded in renewal years of the ASW quotas.

The Committee stresses that annual in-person meeting SC meetings are the only option under which it can fully achieve Commission objectives. and notes that when the Commission moved to a biennial meetings schedule, it 'endorsed the universal support for continuing with Annual Meetings of the Scientific Committee' (IWC, 2011a) and added Rule of Procedure B(3) at its subsequent meeting, which states 'The Scientific Committee shall meet annually' (IWC, 2012a). The Committee also draws attention to the 2018 independent IWC governance report (IWC Review Team, 2018), which states that the Scientific Committee is 'the jewel in the crown' of the IWC, the amount of work done 'phenomenal' and its quality 'outstanding'.

A move to biennial meetings would reduce the Committee's ability to consider important conservation and management problems and therefore it may not be able to provide the same level of advice to the Commission. The Committee would need to reduce and prioritise its agenda, which will require guidance from the Commission.

Permanent changes to the Committee's meeting schedule and work structure will be needed in order to continue providing comprehensive information on the threats to, and the status of, cetacean stocks to the Commission. It is important to consider options to move the Committee's work forward in an efficient manner under a reduced budget scenario and to this end the Committee formed a Steering Group to address these issues intersessionally (see Annex M for membership and terms of reference).

23.1 Status of funded research, workshop proposals, data processing and computing needs

SC/68D/O/04Rev provides information regarding the position on the Committee's Research Fund at the end of the 2021 financial year. Projects undertaken in 2021 were on or under budget, with no requests from the contingency fund. The remaining balance of the contingency fund at the end of 2021 was £44,848, substantially higher than the target of 10% of the Committee's budget allocation as outlined in the Rules of Procedure (IWC, 2019i).

For 2021, the approved SC Research Fund budget was £226,400 and no voluntary contributions were received into this fund. Expenditure of £125,884 occurred during the year, giving a closing balance for 2021 of £476,883. Of this, £316,321 has subsequently been spent or is committed to existing projects. It should be noted that due to the COVID-19 pandemic, a significant number of projects had to be postponed and these projects were reviewed by the Committee.

23.1.1 Proposals for 2023-24

The Committee proposed a research programme for 2023-24, as shown in Table 37. A rigorous process of scoring and ranking was applied to ensure fair evaluation of each proposal. The total amount requested from the Commission for each year is below that requested for 2022. In-kind support for these projects totals over £2.4m. The Committee did not approve funding for several projects as discussed shown in Table 38. Reasons for non-funding under Item 23.1.1.6.

23.1.1.1 General

Invited Participants

Invited Participants (IPs) are a vital component of the working of the IWC's Scientific Committee. IPs contribute in many ways including as sub-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.

Responding to Commission directives from IWC/68

These funds will assist the SC in responding to any urgent issues under its mandate that may arise at the October Commission meeting.

Contingency Fund

This fund allows for unforeseen overspends, for example, higher than anticipated travel costs or project overruns. No funding has been required since the last Committee meeting.

SC/68D/RP/26 Scientific Committee Communications Initiative

The Committee has a small group exploring how it can improve communication, primarily with the Commission, but also with the general public. These funds will be used to develop a range of communication tools tailored to IWC Commissioners to improve the Committee's ability to communicate its workplan.

Table 37

Scientific Committee approved projects for the biennium, 2023-24.

RP Number	Sub Committee	Project Title	Brought Forward from Previous Years £	Reallocated From Other Projects £	2023 Budget Request £	2023 Total £	2024 Budget Request £	2024 total £
		General						
n/a	ALL	Invited Participants 2023-24	100,000		50,000	100,000	50,000	100,000
n/a	ALL	Responding to Commission directives from IWC68	15,000			15,000		
n/a	ALL	Contingency Fund	44,848	(24,848)		20,000		
26	ALL	Seed Funding - Communications Small Group Meetings/Workshops	15,000			15,000	7,500	7,500
n/a	ALL	Meetings to address delayed agenda Items[1]	108,684	24,848		133,532		
2	ALL	Annual meeting of the Abundance Steering Group	6,000		5,340	11,340	11,340	11,340
7	SH, CMP	SRW catch series, stock structure, and catch allocation review workshop		14,516	1,284	15,800	11,720	11,720
25	SAN	Southern Ocean Sanctuary review					1,985	1,985
		Modelling/Computing						
5	SH	Assessment of Antarctic blue whales			22,362	22,362	-	
11	IA	Assessments: computing to support Secretariat	3,500		17,000	20,500	25,500	25,500
12	IA	NP sei and humpback whale modelling	2,500		-	2,500	2,500	2,500
		Research						
1	ALL	POWER Cruises 2023-24	16,562		16,208	32,770	29,870	29,870
4	SH, CMP	Assessing movement rates of SW Atlantic SRW between Argentina and Brazil			5,808	5,808		
6	SH	Mark recapture analysis of Southern Hemisphere BW photo-ID datasets to estimate regional abundance					18,000	18,000
9	SH	Passive acoustic monitoring of cetaceans from the former Durban whaling ground, western Indian Ocean			1,590	1,590	1,590	1,590
16	CMP, SH	Passive Acoustic monitoring of the Eastern SP SRW			20,200	20,200	11,000	11,000
18	CMP	Assessment of spatiotemporal distribution of humpback and blue whale song along the Arabian Sea coast of Oman			9,650	9,650	9,250	9,250
19	CMP	Continuation of field deployments in 2023-24 for passive acoustic monitoring for humpback, blue and other baleen whales off Oman			17,903	17,903		
22	E	Contaminant mapping in cetaceans: Review of spatial and temporal trends in POPs and heavy metals			10,000	10,000		
24	NH	Assessing endangered baleen whales in the Eastern North Atlantic through passive acoustic monitoring off Senegal			12,420	12,420	10,000	10,000
15	SM	Assessment of the traditional drive-hunt in the Solomon Islands: Collaborating with Indigenous communities and updating the IWC direct take database			2,500	2,500	2,500	2,500
		Databases						
13	HIM, SM	Ship strikes database coordinator			10,000	10,000	10,000	10,000
8	SH, PH	Southern Hemisphere blue whale catalogue 2023-24			3,306	3,306	15,041	15,041
14	GDR, SH, PH	Secretariat database support			6,000	6,000	6,000	6,000
23	NH	Review of the Spanish statistics in the IWC catch database			12,555	12,555		
		Reports						
3	WW	Communicating the science of sustainable, responsible whale watching[2]			1,500	1,500	~~21,050~~	0
20	E	State of Cetacean Environment Report (SOCER) for 2023-24			4,000	4,000	4,000	4,000
		TOTALS	312,094	14,516	229,626	506,236	227,796	277,796

[1]The Budgetary Sub-Committee of the IWC's Finance and Administration Committee has accounted for these monies in reducing the overall deficit with a recommendation for *'these funds be allocated to the Scientific Committee (research fund or meetings fund) to support any adjustments to operations in light of budget cuts.'*

[2]The Committee recommended funding the communications plan only and will consider further funding once this has been reviewed.

23.1.1.2 Meetings/Workshops

Meetings to address delayed Agenda Items

The work of the Scientific Committee is vital to the Commission in providing advice to inform decisions for the management and conservation of cetacean populations. However, over the last three years the work of the Committee has been compromised by the COVID-19 pandemic and this has affected the depth of advice it can provide. During this time, the Committee has met virtually in order to progress the work requested of it as much as possible, and these meetings have provided some benefits, for example, a greater global breadth of expertise and participation. However, the actual meeting time has been reduced by 40% which, coupled with other limitations, has severely reduced progress on nearly all of the Committee's agenda Items. Full, in-person meetings offer a number of advantages that enormously benefit the speed of progress and quality of the Committee's work. These advantages include: (1) allowing small *ad hoc* groups to quickly work through any issues that arise; (2) participation of Committee members from countries in unfavourable time zones when meetings are held virtually; and (3) greater synergy of groups and experts.

While emphasising that annual meetings are essential to address Commission objectives fully and to maintain the IWC's status as the premier worldwide organisation for science-based conservation and management of whales, the Committee acknowledges the possibility of transformational changes to the way it operates (e.g. moving into a biennial meeting structure) as a result of the ongoing work of the Working Group on Operational Effectiveness and the options developed to balance the Commission's budget in the long term. Conscious of these issues, the Committee has set aside monies saved from recent underspends that were a result of holding virtual meetings. Due to the uncertainty over the Committee's operation in the next biennium and the need to compensate for three years of limited progress, funds have been allocated to allow the Committee to meet in-person in 2023, irrespective of the budget option chosen at IWC68. Given the large number of stalled and delayed agenda Items, it is anticipated that two full in-person meetings, or a series of additional targeted workshops, will be required to address the 2023-24 biennium workplan. This is especially true regarding the Committee's need to provide advice to the Commission about aboriginal quotas in 2024 as outlined in the Schedule. In addition, should the decision be made to move toward biennial meetings, hosting in-person meetings in the next biennium to address delayed agenda Items would ensure the advice produced by the SC is as relevant and up-to-date as possible before a transition to biennial meetings from 2024 onwards is initiated.

SC/68D/RP/02 Annual Meeting of the Abundance Steering Group (ASG)

In 2019, the Committee recommended that a permanent pre-meeting for the ASG be established as a normal component of the Annual Meeting of the Scientific Committee (IWC, 2020g). Meetings of 2-4 days have been held annually since then. A pre-meeting is proposed prior to the 2023 and 2024 SC meetings (or approximately the same time of year) for the ASG and relevant experts to meet to advance the two primary objectives of the ASI sub-committee: (1) the intersessional review of abundance estimates required by the Committee's various subgroups; and (2) development of the Committee's Status of Stocks website.

SC/68D/RP/07 Southern right whale catch series, stock structure and catch allocation review workshops

Two workshops will be held to: (1) review the historic circumpolar catch series of southern right whales; (2) review stock structure hypotheses; and (3) identify and propose catch allocation scenarios based on both the catch review and stock structure reviews. The first workshop is proposed as a 4-day intersessional workshop of catch history specialists. Both the availability of new data and the time since the last review suggest a review process of regional catch (and struck and lost) data of southern right whales is timely. The expected outcome is an updated regional estimates of circumpolar southern right whale catches in an agreed catch series necessary for assessments of southern right whale exploitation for past abundance and current recovery levels measures. The second workshop is proposed as a 3-day pre-meeting workshop to review contemporary and historical (19th century) population structure hypotheses and propose probable catch allocation scenarios for the regional populations identified by IWC (2001). The workshops will result in reports containing: (1) an agreed catch series; and (2) catch allocation scenarios for use in upcoming assessments.

SC/68D/RP/25 Southern Ocean Sanctuary Review

The Southern Ocean Sanctuary (SOS) was established in 1994 and Paragraph 7(b) of the Schedule, which established the SOS, specifies that the SOS '…shall be reviewed ten years after its initial adoption and at succeeding ten-year intervals...'. In 2003, the Commission directed the Committee to undertake the first in a series of decadal reviews of the SOS (1994-2004) (IWC, 2004 p.47-50). The third decadal review will be conducted in 2024, as agreed at SC68C. The review process requires collation of documents relevant to the review process, solicitation of potential reviewers and invitation of reviewers to the SC meeting to discuss and present the review (IWC, 2016d).

SC/68D/RP/21 Climate change workshop: Part II

In late 2021 the Committee held a significantly down-sized virtual workshop on this topic. It met for just three 3hr sessions and its report is available (SC/68D/REP/01) in this volume. The originally approved proposal for a climate change workshop

was for an in-person meeting lasting several days, but this could not proceed due to COVID-19 restrictions. The meeting report notes that there is more work that can be conducted on this topic, particularly in the context of 'indirect effects' of climate change on cetaceans (Fauquier *et al.*, 2021). The workshop also recommended a follow-up in-person workshop. This proposal was not recommended for funding, see Item 23.1.1.6.

23.1.1.3 Modelling/Computing

SC/68D/RP/05 Assessment of Antarctic blue whales

A full stock assessment of Antarctic blue whales will be conducted, and will include the following components: (1) revising and updating a time series of historical catches; (2) updated priors for rates of increase in Antarctic blue whales based biological parameters; (3) compilation of abundance and trend estimates for Antarctic blue whales; (4) fitting assessment model to available data in a Bayesian framework; and (5) preparing a report on the results for the Committee in 2024.

SC/68D/RP/11 Essential computing support to the Secretariat

The Committee is currently engaged in an In-depth assessment for Western North Pacific common minke whales and in addition, the Committee will commence an *Implementation Review* for North Atlantic fin whales in 2024. In both cases, the Committee has developed a complex assessment model structure. A key task in this process is to develop and validate the code for the models, 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 alone cannot handle this complete process themselves, so computing support is needed, especially given the recent retirement of an experienced Secretariat staff member in this area.

SC/68D/RP/12 Assessment modelling for In-depth assessments of North Pacific sei and humpback whales, 2022-24

The Committee is currently conducting In-depth assessments for North Pacific sei and humpback whales. Part of an In-depth assessment is evaluating the status of a population using a population dynamics model that is specific to the biological and behaviour parameters of that particular population and fitting it to monitoring data. The population models are spatially structured and are fitted to estimates of absolute and relative abundance, genetics data and mark-recapture data. The population models will be updated following the 2022 SC meeting and the results included in synthesis papers, which will result in an assessment of the status of the population. The project involves developing and utilising population dynamics models as required to progress the work.

23.1.1.4 Research

SC/68D/RP/01 IWC-POWER cruise in 2023 and 2024 including associated workshop/meetings and processing

The Committee strongly advocated the development of an international medium- to long-term research programme involving sighting surveys to provide information for assessment, conservation and management of cetaceans in the North Pacific, especially areas that have not been surveyed for decades. The programme has been running since 2010 and has contributed greatly to the work of the Committee and its assessment work. The amount of money is extremely small when seen in the context of Japan providing the vessel and associated costs which it wishes to continue to do although it has now left the IWC. The IWC contribution is for: (1) IWC researchers and equipment; and (2) to enable analyses and the photographic database to be updated. At least two more cruises are required to complete the initial programme and it is essential planning begins for the next phase as soon as possible with a view to completing this by 2024.

SC/68D/RP/04 Assessing movement rates of Southwest Atlantic southern right whales between Argentina and Brazil

In 2020, the Committee highlighted the need to have a multistate capture-recapture and population dynamic analysis of Brazil-Argentina right whale photo-ID data to assess movement rates between calving grounds in the Southwest Atlantic. Multi-states mark-recapture models with a Bayesian approach will be applied to the data available, expecting the following outcomes: (1) movement rates between breeding grounds over the years; (2) region-specific survival and recapture probability; and (3) influence of micropredation by kelp gulls, calf mortality and density-dependence processes at Península Valdés on movement probabilities.

SC/68D/RP/06 Mark recapture analysis of Southern Hemisphere blue whale photo-ID datasets to estimate regional abundance

The Southern Hemisphere blue whale catalogue (SHBWC) has generated large photo-ID datasets for blue whales in Chile (1,004 identifications) and Australia (243 identifications), contributed to by multiple local catalogue holders (SC/68D/SH/04). Blue whale photo-IDs comprise a mixture of right-side and left-side photographs. Whales have been matched between catalogues and quality coded within the SHBWC, generating multi-year encounter histories for whales for right and left sides. To maximise use of the information contained in the two datasets, these data will be analysed in a mark recapture framework that has been developed to handle multiple marks (Zhang *et al.*, 2019) and accommodate capture heterogeneity. Given the spatiotemporal spread of these datasets, these data will be analysed in an open population framework. These analyses will generate estimates of blue whale abundance for Chile (Northern and Southern Chile) and Australia, using customised models to accommodate multiple connected areas within each dataset.

SC/68D/RP/09 Passive acoustic monitoring of cetaceans from the former Durban whaling ground, South Africa
Seasonal occurrence of whales off the former Durban whaling ground, South Africa, are currently based on historic whale catches from over six decades ago. An acoustic recorder was deployed earlier this year with the goal of using acoustic signatures to separate historic catches of Antarctic and pygmy blue whales from that region and update the knowledge of species occurrence. More acoustic research is planned to determine long-term seasonal acoustic occurrence and behaviour of other whales such as sperm and killer whales that are thought to occur in that region. Effects of noise and environmental conditions on whales will be evaluated. Results of this project will be important for updating management strategies of different whale species and in informing the current use of this ecoregion by different whale species.

SC/68D/RP/16 Passive Acoustic Monitoring of the Eastern South Pacific Southern Right Whale, outputs 2023-24
Eastern South Pacific right whales are critically endangered and the IWC has a Conservation Management Plan for this population. The Committee supports a Passive Acoustic Monitoring (PAM) project that seeks to assist in the identification of a breeding area. Six sites have been selected along the coast of Chile and Peru and two sites have already been covered off central and southern Chile. Northern Chile has been monitored since March 2022, but additional funds are needed to complete a full maintenance cycle of equipment. The next site to monitor in 2023-24 is southern Peru and funds have already been secured. An opportunity to monitor Golfo de Penas has been presented and requires matching funds. Work for 2023-24 includes data collection at southern Peru and Golfo de Penas and analysis of acoustic datasets.

SC/68D/RP/18 Spatiotemporal distribution of humpback and blue whale songs along the Arabian Sea coast of Oman
The use of passive acoustic monitoring techniques is considered essential for resolving population identity, connectivity and seasonal presence for blue and humpback whales in the Northern Indian Ocean (NIO). Illegal Soviet whaling in the 1960s depleted both stocks, potentially severely. Passive acoustic data collection along the Arabian Sea coast of Oman from May 2022 to April 2023 was funded by the IWC and this project focuses on analyses of those new datasets, with the following objectives: (1) continue a dedicated research programme for Arabian Sea humpback whales and NIO blue whales in the waters of Oman, in accordance with previous Committee recommendations; (2) describe spatiotemporal distribution of ASHW and blue whale acoustic occurrence along the Arabian Sea coast of Oman through an assessment of singing activity; (3) develop an archive of acoustic data to assess occurrence of other cetaceans (including Bryde's and sperm whales) in the study area.

SC/68D/RP/19 Continuation of field deployments in 2023-24 for Passive Acoustic Monitoring of humpback, blue and other baleen whales off Oman
This project builds on historical archives (2011-14) and IWC SC funded PAM in deep water off the coast of Oman in 2021-22 by allowing for deployment and recovery of four units off the Arabian Sea coast of Oman from April 2023 to April 2024. This will be conducted in partnership with that described above and in SC/68D/RP18.

SC/68D/RP/22 Contaminant Mapping in Cetaceans: Review of spatial and temporal trends in POPs and heavy metals
The global review of PCBs, DDT and mercury in cetaceans will be updated. This will result in the documentation and mapping of decadal trends to provide an update of the current status of mercury and key persistent organic pollutants in cetacean populations at a global scale. This project builds on previous work that produced a Contaminant Mapping Tool, which displays published data on the concentrations of key persistent organic pollutants and mercury in cetacean tissues from the 1970s to the 2010s. The purpose of this tool is to allow researchers to quickly view, and explore visually, trends in the concentrations of commonly monitored contaminants in different species over time.

SC/68D/RP/24 Assessing endangered baleen whales in the eastern North Atlantic through Passive Acoustic Monitoring off Senegal, West Africa
Passive acoustic monitoring (PAM) is an important tool for improving our understanding of stock structure and distribution for endangered baleen whales. Critical data gaps exist for multiple species of large whales in the North Atlantic Ocean. In the eastern North Atlantic, the coasts of Mauritania and Senegal are believed to be important winter habitats for stocks of humpback, sei and Bryde's whales. This project will contribute PAM data for assessing protected species distribution and stock structure, as well as potential impacts of anthropogenic noise. In particular, these data will be used to: (1) assess baleen whale presence and timing of occurrence off the coast of Senegal; (2) assess stock identity for humpback whales off Senegal, comparing with the endangered Cape Verde/Northwest Africa distinct population segment; (3) assess occurrence and potential stock identity of sei whales off Senegal, by comparing vocalisations with those recorded in the Gulf of Maine; (4) assess the potential presence and vocal characteristics of Bryde's whales; (5) assess prevalence and potential impacts of local seismic survey exploration; and (6) build the capacity of Senegalese scientists to conduct PAM surveys.

SC/68D/RP/15 Assessment of the traditional drive-hunt in the Solomon Islands: collaborating with Indigenous Communities and Updating the IWC direct take database
An assessment of the Solomon Islands dolphin drive-hunt was funded by the Small Cetacean Voluntary Fund in 2012-15 (Oremus *et al.*, 2015b). The hunt's traditional methods appear to have remained consistent throughout the available

written history. Meticulous hunt logs are maintained and have been published in academic records from 1976 to 2013. The hunt has been ongoing since 2013, and recently the Committee was made aware that the communities who conduct the hunts were willing to share their 2013-22 records with researchers. This project will support local travel of Solomon Islands government Fisheries Officers to the remote villages that conduct the hunts to copy the hard records kept by the hunting communities and to conduct interviews with hunters to update both this Committees record of direct takes and to document any changes in practise and update our understanding of the hunter's perspective of the cetacean population's occurrence and distribution.

SC/68D/RP/17 Development of a GIS (meta) database on information on human activities that might have an adverse impact on southern right whales

One of the two research objectives of the SWA Right Whale CMP is the development of a database in a geographic information system context, to compile a sensitivity atlas. In this project a GIS database will use information on right whales obtained from different sources (sightings, satellite tags, monitoring activities, etc.) overlapped with human activities (fishing, shipping, seismic exploration, oil and gas exploration etc.). This will allow placement of multiple threats to the population on a geographic information system. This proposal was not recommended for funding, see Item 23.1.1.6.

SC/68D/RP/10 Rock 'n Whales: can we detect blue and fin whale acoustic presence from a land-based seismic station in the equatorial Atlantic Ocean?

Existing data from a seismic land station located over 1,100km from the Brazilian coastline at the Saint Peter and Paul's Rock will be processed to quantify the acoustic presence of blue and fin whales in the equatorial mid-Atlantic Ocean, where there has been little research effort. There is data available from 2011-17, and the aim is to process this for whale bioacoustic signal detection and classification from 2011-13 to provide information about occurrence and seasonality of blue and fin whale acoustic activity in the equatorial mid-Atlantic Ocean and compare results from this land-based seismic station with those of other research groups. This proposal was not recommended for funding, see Item 23.1.1.6.

23.1.1.5 Databases

SC/68D/RP/13 Progressing the development and use of the IWC ship strikes database

The purpose of this work is to further develop the ship strikes database and to ensure the increased reporting of ship strike incidents into the database including through: (1) systematic outreach to data providers; (2) review and provision of data; (3) promoting access to information in the database; (4) increasing use of the database; (5) outreach to other organisations This funding will continue work that has been undertaken on the database since 2021, which could be undertaken in two different ways depending on the endorsement by the Commission. It is proposed that this work would continue to be undertaken by the ship strikes data manager and funding would cover an appropriate portion of the costs of this position. If the coordinator cannot be retained for 2023 then this work would be delivered by another means, to be determined by the Chair of the Committee and Chair of the ship strikes Working Group in liaison with the Secretariat and Convenor of HIM. A key task for the data manager is to progress submission of data from national databases into the global IWC effort. This will be reliant on external factors but making progress on including these large existing data sets into the IWC database is likely to take a substantial proportion of the coordinators time.

SC/68D/RP/08 Southern Hemisphere Blue Whale Catalogue 2023-24

The Southern Hemisphere Blue Whale Catalogue (SHBWC) is an international collaborative effort to facilitate cross-regional comparison of blue whale photo-IDs catalogues. To date more than 2,000 individual blue whales have been contributed to the SHBWC from researchers working on areas off Antarctica, Chile, Peru, Ecuador-Galapagos, Eastern Tropical Pacific, Australia, Timor Leste, New Zealand, Indonesia, Sri Lanka and Madagascar. The Committee is currently working on the Comprehensive Assessment of non-Antarctic Southern Hemisphere blue whales, with emphasis on Australia, southeast Pacific blue whales and New Zealand. The SHBWC is assisting in matching catalogues in order to deliver regional photo-ID based mark recapture assessments of blue whale abundance.

SC/68D/RP/14 Ongoing SC database hosting and server management by IWC Secretariat

The IWC Secretariat hosts and manages several databases for the SC. These have annual service costs associated with them including web/database servers, storage, backups, software licences and other associated infrastructure costs. This funding will allow continuation of the hosting and management services required for SC databases. This funding does not contribute towards any salary.

SC/68D/RP/23 Review of the Spanish statistics in the IWC catch database

Modern whaling in Spain started in 1921 and, with some interruptions, ended in 1985. During this period, approximately 21,000 whales were caught. The IWC catch databases are incomplete for some years and contain discrepancies with the internal documentation held by the University of Barcelona and the Museo Massó, especially regarding the individual catch records. The expected outcome of the project is improving the accuracy of catch records in the IWC catch database for this particular region.

Table 38

Projects not approved for funding during SC68D.

RP Number	Sub-committee	Project Title	2023 Budget Request £	2023 Total £	2024 Budget Request £
21	E	Climate Change Workshop Part II	42,680	42,680	
17	CMP	Development of GIS (meta) database on information on human activities that might have an adverse impact on SRW (JP2)	3,240	3,240	10,020
10	SH	Rock 'n Whales: can we detect blue and fin whale acoustic presence from a land-based seismic station in the equatorial Atlantic Ocean?	13,740	13,740	6,240
		TOTAL	**59,660**	**59,660**	**16,260**

23.1.1.6 Reports

SC/68D/RP/03 Communicating the science of sustainable, responsible whale watching

The IWC SC and CC produce evidence-based advice on the best practices for sustainable, responsible whale watching. One major product of the SC/CC has been the Whale Watching Handbook, a first-class resource for whale watchers, operators and managers, based on the best available science and practices. The SC/CC is also working on General Principles for sustainable, responsible whale watching. The Committee also produces recommendations every year, for the IWC, its Parties, and beyond. However, many of the target audiences for the work are still unaware of their existence. This project aims to promote and market the whale watching work of the SC and CC to key audiences through a communications plan involving, *inter alia*, social media, video, podcasting. and other forms of outreach. The Committee recommended funding the communications plan only and will consider further funding once this has been reviewed.

SC/68D/RP/20 Compilation of the State of the Cetacean Environment Report (SOCER) for 2023-2024 including the 2nd 5-year global compendium

The SOCER is produced in response to several Commission resolutions requesting regular updates on the state of the world's oceans as relevant to cetaceans. The SOCER is an appendix to the SC report and available online on the IWC website.

23.1.1.7 Unfunded Proposals

The Committee received a large number of applications to its research fund this year and proposals underwent a rigorous review process to assess a range of factors including scientific methodology, alignment of SC and Commission priorities and capacity building, in addition to value for money and timeliness. With an unknown but anticipated more limited budget than in previous years, proposals were ranked both within sub-committees and across the Committee as a whole, with highest priority given to those that were directly linked to progressing those areas of work that are critical to fulfilling the most immediate priorities such as population assessments. This ranking was done through evaluation by all Convenors, the SC Chair and the Head of Science, Conservation and Management. The projects in Table 38 were not considered to directly advance the Committee's research needs or were not considered to be of high enough priority for funding from the SC research fund in 2023-24 (see Table 38).

23.1.2 Funded proposals in previous years still ongoing

The projects in Table 39 received funding and were approved by the Commission in prior years and are continuing to progress (see Table 39). The value of these projects was reviewed by the Committee and their continuation recommended. The majority of these projects were delayed or postponed due to COVID-19.

23.1.3 Report on fund reallocations and contingencies for the Research Fund, Voluntary fund for Small Cetaceans and IWC-SORP Voluntary Fund

Table 40 shows the funds that were reallocated within the research funds at this meeting. A proportion of the Contingency Fund was reallocated as the Committee noted that it was substantially above the permitted level of 10% of research budget.

Small Cetaceans Research Fund

The Voluntary Fund for Small Cetacean Conservation Research currently stands at £86,839, of which £41,215 is unallocated. Since April 2021, the Small Cetaceans Fund gratefully received voluntary contributions totalling £16,741 from the Government of the Netherlands, Animal Welfare Institute, Campaign Whale, Cetacean Society International, Dolphin Connection, Humane Society International, LegaSeas, Natural Resource Defence Council, OceanCare, ProWildlife and Whaleman Foundation.

At its Virtual Special Meeting in 2021[40], the Commission approved the funding of five new projects, which are all progressing as expected. Annual, interim reports will be reviewed by the Committee at its meetings, with final reports expected 2022-26.

[40] *https://archive.iwc.int/?r=19380&k=09bd8f033f.*

Table 39

Projects approved by the Commission in prior years that are continuing to progress.

Project title	Sub-Comm	Funds to be spent in 2022 £	Funds remaining for 2023 £	Funds remaining for 2024 £
Invited Participants 2022			50,000	50,000
Amount to support Commission Recommendations			15,000	
Responding to Commission Developments			108,684	
Contingency Fund			44,848	
R67025 Pre-Meeting of the Abundance Steering Group	ASI		6,000	
R67003 Simulating Line Transect Data	ASI		750	
R67026 SWA Right Whale CMP Workshop	CMP	7,600		
R67027 CAHW CMP Workshop	CMP	11,460		
R67028 Franciscana Workshop	CMP	16,600		
R67043 Western Gray Whale CMP	CMP		10,500	
R68C002 Chile-Peru SRW CMP Workshop	CMP	8,750		
R67004 Quantitative assessment of threats to Arabian Sea humpback whales	CMP	3,641		
R67006 Population Dynamics SR Whales Peninsula Valdes	CMP	1,400		
R67009 Abundance Estimates Franciscana Buenos Aires	CMP	1,775		
R67036 ASHW Songs India	CMP		2,762	
R67037 ASHW Body Conditions & Fisheries Mapping	CMP		6,412	
R67040 Franciscana Aerial Survey	CMP		23,820	
R68C009 Chile-Peru SRW Acoustics	CMP		19,400	
R68C011 ASHW Conservation	CMP		14,845	
R66032 Strandings Emergency Response	E		9,915	
R67007 Ecosystem Functioning Workshop 2020	EM		20,550	
R66023 IA NP Humpbacks	IA		10,000	
R67013 Implementation Review NP Minke Whales	IA		15,000	
R67010 In-depth Assessment of NP Sei Whales	IA		2,500	
R67031 Computing Support to WNP Minke	IA	6,000		
R68C005 HW Tag Data Analysis	IA		9,860	
RO004 Essential Computing Support (refer to R67031 too)	IST	4,000	3,500	
R67023 Amendment of RMP Guidelines	IST		1,250	
R68C001 NA Humpback Workshop	NH		16,960	
R68C007 MEGARA 2022	NH	6,000		
RO002 POWER Cruise	SEC	39,220	16,562	
RO007 Secretariat Database Support	SEC	6,000		
R66006 JCRM SOWER	SEC			16,740
Seed Funding - Communications Small Group	SEC		15,000	
R67033 Acoustics Blue Whale Oman	SH		2,000	
R67035 Mid-Latitude Antarctic Blue Whale Acoustics	SH		1,500	
R68C003 SH Blue Whale Catalogue	SH		11,500	
R68C004 Madagascar Blue Whale Photographs	SH		400	
R68C006 SRW Australia Aerial Survey	SH	6,492		
R68C008 Antarctic BW Stock and Movement	SH		16,076	
R68C010 Blue Whale Acoustics Oman	SH		2,003	
R67041a SH Blue Whale Catalogue	SH	812		
R67041b SH Blue Whale Catalogue - Chile	SH		7,800	
R66017 Data Archiving NI Ocean Humpbacks	SH		1,875	
R66036 Development of Permanent Blue W Reference Library	SH		4,000	
R67030 Chile & Peru Whale Watching Workshop	WW		4,210	
TOTAL		**105,000**	**487,232**	**69,740**

Table 40

Projects where funds were identified for reallocation during SC68D.

Project Title	Reallocated £	Notes
Exploration of Survey Methods - West Australian BSD Humpbacks	(4,000)	Project paid for by Australian Government. Reallocated to 'SRW catch series, stock structure, and catch allocation review workshop'
SRW Australia Aerial Survey	(10,516)	Not all funding required due to additional funding from Australian Government. Reallocated to 'SRW catch series, stock structure, and catch allocation review workshop'

Southern Ocean Research Partnership Fund

The Committee was updated on the progress of projects funded through the Southern Ocean Research Partnership (SORP; SC/68D/SH/08). Despite the challenges of COVID-19 and consequent unavoidable delays, significant progress had still been made in delivering these projects. No new allocations of funding were made for 2022 or 2023. £24,844 remains unallocated in the SORP Fund.

Contributions to the IWC Small Cetaceans Fund, SORP Fund and other voluntary funds are welcomed.

24. COMMITTEE PRIORITIES FOR THE BIENNIUM 2023-24 AND INITIAL AGENDA FOR 2023

Each sub-group developed their priorities and workplan for 2023-24 (see relevant sections of this report). Those workplans will be used by the Chair and vice-Chair to develop a draft agenda for the next Scientific Committee meeting to present to the Commission at IWC68 for their review and endorsement.

25. WORKING METHODS OF THE COMMITTEE

25.1 Updates on Rules of Procedure and Handbook of the Scientific Committee

The Commission requested the Committee regularly revise and update their Rules of Procedure (RoP) and Handbook. In light of the potential changes to the SC meetings' structure outlined in the Budgetary Sub-Committee options, the SC handbook revision has been paused. Once Commission has made a decision and the implications for the Committee's working methods are fully understood the SC Chairs and the Secretariat will review, revise, and update the handbook for consideration by the Committee. Once endorsed by the Committee, the revised documents will be presented to the Commission for consideration and endorsement. The Chair notes that some Committee members may be contacted for advice and input on these revisions. Committee members are encouraged to raise questions or offer comments regarding the Handbook but should first contact the Chair and vice-Chair prior to fully developing proposed revisions.

25.2 Reporting to the Commission and related matters

The Committee's report for SC68D will be made available to the Commission and the public as soon as possible following the completion of the meeting. The Commission has directed the Committee to complete the final Scientific Committee Report draft report within 21 days of the meeting closing. The Heads of Delegation will review, revise as necessary, and endorse the 2022 Committee report by correspondence. The final draft of the Committee's report will be available in time for the 60 day submission deadline for IWC68. Given the two year postponement of IWC68 the Committee's work from four years: 2019, 2020, 2021 and 2022 will need to be presented. The ex-Chair Suydam, current Chair, and vice-Chair will work with the Secretariat and Convenors to provide an appropriate summary under these challenging circumstances.

Double presented a proposal for communicating the work of the Scientific Committee at IWC69 and beyond. The objective of this initiative is to develop new communications tools and material tailored to a non-technical audience, primarily IWC commissioners. The proposal was developed by a small steering group comprising incoming and outgoing SC leadership and members of the Scientific Committee and Secretariat. Double stressed the importance of transparency, balance and inclusivity, and proposed a process for selecting content through the existing network of SC Convenors, noting that final decisions rest with the Chair and vice-Chair of the Scientific Committee.

The principal opportunity for engaging with the Commission is the biennial meeting, and the communications tools proposed are: a new, image-rich and succinct summary document to be circulated one month prior to Commission meetings; an audio-visual presentation delivered at plenary; a series of summary factsheets and a 'science hub' staffed in-person and remotely, answering questions and displaying information about the work of the Committee.

The challenges of COVID-19 and the unprecedented four-year intersessional period have dictated that the Communications Initiative begins at IWC69 and the SC will take the opportunity at IWC68 to outline the proposal and seek feedback from the Commission on whether this approach will best meet their requirements.

It was proposed that the unspent seed funding should be carried over to the 23-24 biennium. As some of this fund may be used in support of the SC presentation at IWC68, an additional budgetary request of £7.5k was proposed to ensure enough funds remained to deliver the proposed outputs of the Communication Initiative at IWC69.

The initiative was welcomed and its importance recognised. Double was thanked for his presentation and work invested to date. In discussion, it was noted that the proposed topic selection criteria might be too broad in some places and too restrictive in others, and could risk disadvantaging SC groups whose critical work is long-term and ongoing. More leeway on the number of topics put forward was suggested for groups with larger agendas. Consultation between Convenors and their sub-committees was suggested as a transparent method of selecting topics.

More information was sought on the role and composition of the steering group and the extent to which they might filter information between the Committee and the Commission. Perception of bias amongst steering group members was raised as a concern and widening the membership to include Convenors was also suggested. Double stressed that the role of the steering group is to develop and support the initiative and to provide guidance on effective communication material but,

importantly, the role of this group is not to filter or select content. This point will be made clearer in future iterations of the Initiative documentation and in Terms of Reference for the Steering Group. Membership of the steering group may change, rotate or expand when the initiative reaches its implementation phase.

The previous 2 year summary reports of the Scientific Committee and revised method for producing recommendations were also highlighted as useful examples.

Further consideration was requested on what actions the Scientific Committee is asking Commission to take in response to the information provided. It was suggested that the group should consult some Commissioners for their views on reverting to the previous approach to plenary, where Scientific Committee presentations were provided for each agenda Item, rather than at the beginning of the session. Circulation of factsheets on a monthly basis was proposed, to avoid information-overload prior to Commission and allow time for further enquiry and dialogue.

It was agreed that all feedback would be carefully assessed and additional comments sought from the SC members who also attend Commission. The aim being to refine and submit the proposal to the Finance & Administration Committee of the Commission at IWC68 and gaining a clear mandate to proceed and launch the Communications Initiative at IWC69.

25.3 Capacity building and succession plan for Scientific Committee

The Committee continues to pursue and enhance a succession plan. For example, the work of Punt continues to be followed by Wilberg as part of ensuring ongoing modelling expertise within the Committee. On 31 March 2022, after more than 37 years with the IWC Secretariat, Cherry Allison retired from the Secretariat. The Committee expresses deep appreciation for the many decades of guidance, analyses and advice provided by Allison to the work of the Committee. The Committee is also grateful that Allison will continue to work with the Committee as an independent scientist and IP. An intersessional Small Group comprised of Secretariat and Committee representatives was formed after SC68C to continue planning for succession of the programming and implementation of population models, within both the Committee and the Secretariat (Annex M). A recruitment panel composed of representatives from the Secretariat as well as one representative from the Intersessional Small Group conducted a recruitment process to find a new Lead for Modelling and Statistics. Isidora Katara was hired in March 2022 and is now working full time for the Secretariat. Isidora is a marine biologist with twenty years of experience in multi-disciplinary research topics related to the sustainable use of aquatic resources and ecosystems. She has an interest in biostatistics, modelling and bioinformatics. Her work has focused on developing the evidence base for policy, management and conservation and includes conducting research for governmental institutes, participating in RFMOs and collaborating with international organisations. The Committee welcomes Isidora and looks forward to working with her in the future.

25.4 Update on Data Availability requests and consideration of potential updates/clarifications

The Data Availability Group (DAG) oversees the data request procedures outlined in the IWC Data Availability Agreement (DAA). The rules for data availability, summary lists of the available data, protocols for data access, agreement forms and contact points can be found on the IWC website. The databases maintained by the IWC can become available to researchers depending on agreed access rules, relevant procedures, and levels of IWC support. The process of reviewing the governance and management of databases is ongoing and focuses on data accessibility of databases with different levels of IWC support.

25.5 Committee involvement in the IWC Database of Recommendations

The Secretariat has, after extensive work, made the DoR available online[41]. A summary of historical records for Commission, SC and CC meetings is presented in SC/68D/GDR/01. Bulk upload via an Excel spreadsheet template has also been designed to assist data entry. Improvements to, and population of, the database will continue to progress intersessionally and Resolutions and Recommendations from workshops will now be prioritised for back entry. The Secretariat provided an extract of recommendations from 2020 and 2021 for each Sub-Committee so that Convenors would be able to review these during the meeting to track progress and plan next steps. Convenors were also asked to update progress on their recommendations to feed back into and update the database.

25.6 Governance Review

The IWC's Working Group on Operational Effectiveness (WG-OE) has been leading the Commission through a process to review the recommendations from the Independent Panel report that launched the Governance Review in 2018. The WG-OE is a sub-committee of the Finance and Administration Committee and is open to all contracting governments and observers. A series of workshops, in-person and virtual, have been held over the past three years; several drafting groups have produced documents that propose changes to the structure of the Commission and either new or revised Rules of Procedure and Terms of Reference. The four primary papers are as follows:

(1) potential reforms to Commission structure and meeting operations;
(2) potential 'low-hanging fruit' Items, including those relating to the Rules of Procedure;

[41] *https://recommendations.iwc.int/*.

(3) IWC Strategic Principles and Terms of Reference for Working Group on Strategic Plan; and
(4) budget reform strategy.

The original mandate of the WG-OE has expanded to include the preparation of a 5th paper regarding the current Rules of Procedure (RoP) for payment of annual contributions. The WG-OE was tasked at the Virtual Special Meeting of the Commission in September 2021 to consider possible modification to the penalties for late payment of contributions (e.g. suspension of voting rights).

After having planned to meet in person in the margins of the SC meeting, the WG-OE is now planning a virtual WG-OE meeting in July 2022 (specific date TBD). In addition, an in-person meeting will be held during the pre-meeting days in the lead up to IWC68 in October. The proposed WG-OE papers will be submitted to the IWC Secretariat on 8 August 2022 for translation and preparation for posting within the 60-day deadline of 18 August 2022 for IWC68.

25.7 Joint Conservation Committee-Scientific Committee Working Group

The Joint Working Group (WG)[42] of the Conservation and Scientific Committees first met in 2015. The overall aim of the group is collaboration: collating and prioritising the conservation recommendations of the two groups and developing effective strategies to communicate and implement them. Since its first meeting, the WG has attempted to meet each year, either in-person or virtually, and usually shortly after the meeting of the Scientific Committee. The WG did not meet in 2019 or 2020. Regular meetings ensure the latest research and advice of the Scientific Committee can be considered by the WG. Meeting reports of the WG are available on the IWC website.

A key output of the WG is the Database of Recommendations (DoR). The DoR was developed in order to aid collaboration between the two committees, but its potential wider benefits were quickly identified. It now holds recommendations of the Commission and all its sub-groups including legally binding Schedule Amendments, Resolutions and recommendations agreed at sub-group meetings and workshops[43].

Terms of reference for the WG were revised in 2021 and a small intersessional group was formed to design a process for helping Commission prioritise conservation issues. An update of this work will be presented to the WG's forthcoming meeting.

This year's joint CC/SC meeting is anticipated for July 2022.

26. PUBLICATIONS

The *J. Cetacean Res. Manage.* (JCRM) is the IWC's peer-reviewed scientific journal. The IWC Secretariat's Head of Science, Conservation and Management is its Editor and the Editorial Board is comprised of members of the Committee. Recognising that the vast majority of readers now access JCRM digitally, and to search for specific papers, topics or authors, the new page layouts maximise clarity and make pages easier to read on-screen. Volume 22 was published at the end of 2021 with 11 scientific papers and was the first volume to be published in our new style. Recently, the team introduced new initiatives to streamline the submission and review process and this has been proving a successful move. The Journal is now accessible from the IWC website and is free to access and download. JCRM's visibility is much improved with the introduction of Digital Object Identifiers (DOIs). A digital repository known as LOCKSS is also now used to 'future-proof' articles, ensuring every paper published is conserved independently of either JCRM or the IWC. Work continues on raising the profile of JCRM, mainly via the IWC website and social media. Management of the JCRM is done in-house by the Secretariat and the Editorial Board volunteer their time, thus there are negligible costs to the IWC. Volume 23 of the JCRM is well underway and five papers are now available on the website. The Editorial Board are sad to announce that Jen Jackson will be stepping down as a section Editor. The Board would like to thank her for fantastic help and wish her all the best. The Board hopes to invite a new candidate to join the team. As always, tremendous thanks is given to the Editorial team for their tireless work and to all the expert reviewers who have helped to ensure the Journal maintained its rigorous scientific standards. An appeal is made, as always, for SC members to consider reviewing manuscripts to support the work of the Journal. The IDCR/SOWER Cruises and RMP commemorative special issues of JCRM are being reviewed by the Editorial Board and options are being considered on ways this work can be progressed.

The Report of the Scientific Committee meeting (and intersessional workshops) is published annually as a Supplement to JCRM and the report of the 2021 Committee meeting (SC68C) held virtually will be available online[44].

27. ADOPTION OF REPORT

The report was adopted by correspondence on 27 June 2021.

[42] *https://iwc.int/management-and-conservation/conservation-committee/ccsc-joint-working-group*.

[43] *https://recommendations.iwc.int/view.*

[44] *https://www.iwc.int*.

REFERENCES

5OES and Environment Society of Oman. 2021. *Marine Mammal Atlas of Oman*. Rev 1.0. Accessed on 30/11/2021. [Available from: *https://doi.org/10.6084/m9.figshare.13514948.v1*].

Adulyanukosol, K., Thaongsukdee, S. and Kittiwattanawong, K. 2012. Cetaceans and mass strandings in Thai waters. *J. Cetacean Res. Manage.* 12(2): 151-58.

Agrelo, M., Daura-Jorge, F.G., Rowntree, V.J., Sironi, M., Hammond, P.S., Ingram, S.N., Maron, C.F., Vilches, F.O., Seger, J., Payne, R. and Simoes-Lopes, P.C. 2021a. Ocean warming threatens southern right whale population recovery. *Science Advances* 7(42). [Available at: *https://doi.org/10.1126/sciadv.abh2823*].

Agrelo, M., Sironi, M., Marón, C., Vilches, F., Rowntree, V., Groch, K., Renault-Braga, E.P. and Cooke, J. 2021b. Working plan for assessing movement rates between breeding grounds of southwest Atlantic southern right whales applying multi-state analysis. 10pp. Paper SC/68C/SH/16 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 10pp. [Paper available from the Office of this Journal].

Aguilar, A. and Borrell, A. 2022. Unreported catches, impact of whaling and current status of blue whales in the South European Atlantic Shelf. *Sci. Rep.* 12: 5491. [Available at: *https://doi.org/10.1038/s41598-022-09570-6*].

Alter, S.E., Simmonds, M.P. and Brandon, J.R. 2010. Forecasting the consequences of climate-driven shifts in human behavior on cetaceans. *Mar. Pol.* 34: 943-54. [Available at: *https://doi.org/10.1016/j.marpol.2010.01.026*].

Amano, M., Miyazaki, N. and Kureha, K. 1992. A morphological comparison of skulls of the finless porpoise *Neophocaena phocaenoides* from the Indian Ocean, Yangtze River and Japanese waters. *Journal of the Mammalogical Society of Japan* 17(2): 59-69. [Available at: *https://doi.org/10.11238/jmammsocjapan.17.59*].

Amr, Z.S. 2021. The state of biodiversity in Kuwait. IUCN, Gland, Switzerland; the State of Kuwait Environmental Public Authority. [Available at: *https://portals.iucn.org/library/sites/library/files/documents/2021-030-En.pdf*].

Anderwald, P., Daníelsdóttir, A., Haug, T., Larsen, F., Lesage, V., Reid, R.J., Víkingsson, G. and Hoelzel, A.R. 2011. Possible cryptic stock structure for minke whales in the North Atlantic: Implications for conservation and management. *Biol. Cons.*144: 2479-89.

Andrews, R.D., Baird, R.W., Calambokidis, J., Goertz, C.E.C., Gulland, F.M.D., Heide-Jørgensen, M.P., Hooker, S.K., Johnson, M., Mate, B., Mitani, Y., Nowacek, D.P., Owen, K., Quakenbush, L.T., Raverty, S., Robbins, J., Schorr, G.S., Shpak, O.V., Townsend Jr, F.I., Uhart, M., Wells, R.S. and Zerbini, A.N. 2019. Best practice guidelines for cetacean tagging. *J. Cetacean Res. Manage.* 20: 27-66.

Agreement on the Conservation of Small Cetaceans of the Baltic, N.E.A., Irish and North Seas,. 2021. Report of the 26th Meeting of the ASCOBANS Advisory Committee. [Available at: *https://www.ascobans.org/en/document/report-26th-meeting-ascobans-advisory-committee*].

Ashok, K., Garrobe Fonollosa, L., Cerchio, S., Willson, A., Sarrouf Willson, M., Al Harthi, S., Baldwin, R., Cholewiak, D. and Rendell, L. 2022. Variation of Sperm Whale Occurrence and Acoustic Behaviour in the Western Indian Ocean using a Deep Learning Click Detector. Presentation to the Society for Marine Mammalogy UK and Ireland Regional Student Chapter, 12th January 2022.

Aulich, M.G., McCauley, R.D., Miller, B.S., Samaran, F., Giorli, G., Saunders, B.J. and Erbe, C. 2022. Seasonal distribution of the fin whale (*Balaenoptera physalus*) in Antarctic and Australian waters based on passive acoustics. *Frontiers in Marine Science* 9(864153).

Aznar-Alemany, O., Sala, B., Plön, S., Bouwman, H., Barceló, D. and Eljarrat, H. 2019. Halogenated and organophosphorus flame retardants in cetaceans from the southwestern Indian Ocean. *Chemosphere* 226: 791-99. [Available at: *https://doi.org/10.1016/j.chemosphere.2019.03.165*].

Baker, C.S., Steel, D., Calambokidis, J., Falcone, E., González-Peral, U., Barlow, J., Burdin, A.M., Clapham, P.J., Ford, J.K.B., Gabriele, C.M., Mattila, D., Rojas-Bracho, L., Straley, J.M., Taylor, B.L., Urbán, J., Wade, P.R., Weller, D., Witteveen, B.H. and Yamaguchi, M. 2013. Strong maternal fidelity and natal philopatry shape genetic structure in North Pacific humpback whales. *Mar. Ecol. Prog. Ser.* 494: 291-306. [Available at: *https://doi.org/10.3354/meps10508*].

Baldwin, R., Collins, T., Minton, G., Findlay, K., Corkeron, P., Willson, A. and Van Bressem, M.F. 2010. Arabian Sea humpback whales: canaries for the northern Indian Ocean? Paper SC/62/SH20 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished). 5pp. [Paper available from the Office of this Journal].

Baldwin, R., Willson, A., Myant-Best, C. and Shum, E. 2021. Marine Mammal Atlas of Oman. [Available at: *https://doi.org/10.6084/m9.figshare.13514948.v1*].

Barlow, J., Calambokidis, J., Falcone, E.A., Baker, C.S., Burdin, A.M., Clapham, P.J., Ford, J.K.B., Gabriele, C.M., LeDuc, R., Mattila, D.K., Quinn II, T.J., Rojas-Bracho, L., Straley, J.M., Taylor, B.L., Urban R., J., Wade, P., Weller, D., Witteveen, B.H. and Yamaguchi, M. 2011. Humpback whale abundance in the North Pacific estimated by photographic capture-recapture with bias correction from simulation studies. *Mar. Mam. Sci.* 27(4): 793-818. [Available at: *https://doi.org/10.1111/j.1748-7692.2010.00444.x*].

Barros, N.B. and Clarke, M.R. 2002. Diet. pp.323-27. *In*: Perrin, W.F., Würsig, B. and Thewissen, J.G.M. (eds). *Encyclopedia of Marine Mammals*. Academic Press, San Diego.

Beasley, I. and Davidson, P.J.A. 2007. Conservation status of marine mammals in Cambodian waters, including seven new cetacean records of occurrence. *Aquatic Mamm.* 33(3): 368-79. [Available at: *https://doi.org/10.1578/AM.33.3.2007.368*].

Bedriñana-Romano, L., Hucke-Gaete, R., Viddi, F.A., Johnson, D., Zerbini, A.N., Morales, J., Mate, B. and Palacios, D.M. 2021. Defining priority areas for blue whale conservation and investigating overlap with vessel traffic in Chilean Patagonia, using a fast-fitting movement model. *Sci. Rep.* [Available at: *https://doi.org/10.1038/s41598-021-82220-5*].

Bedrinana-Romano, L., Hucke-Gaete, R., Viddi, F.A., Morales, J., Williams, R., Ashe, E., Garces-Vargas, J., Torres-Florez, J.P. and Ruiz, J. 2018. Integrating multiple data sources for assessing blue whale abundance and distribution in Chilean Northern Patagonia. *Divers. Distrib.* 00: 1-14. [Available at: *https://doi.org/10.1111/ddi.12739*].

Bishop, J., Ismail, W., Al-Yamani, F., Saburova, M., Alsaffar, A., Lennox, A., Khvorov, S., Yousef, A., Klimova, T., Al-Rifiae, K. and Al-Mansouri, H. 2013. Marine Line. In: Omar, S.A. and Roy, W.Y. *Ecology and Environment of Boubyan Island in Kuwait*. Kuwait Institute for Scientific Research, Kuwait. 167-239.

Bloch, D. and Mikkelsen, B. 2018. Catch history and distribution of white-sided dolphin (*Lagenorhynchus acutus*) of the Faroe Islands. Paper AC24/Inf.4.1.b presented to the 24th Meeting of the ASCOBANS Advisory Committee, 25-27 September, Vilnius, Lithuania.

Bonneville, C.D., Derville, S., Luksenburg, J.A., Oremus, M. and Garrigue, C. 2021. Social Structure, Habitat Use and Injuries of Indo-Pacific Bottlenose Dolphins (*Tursiops aduncus*) Reveal Isolated, Coastal and Threatened Communities in the South Pacific. *Front. Mar. Sci.* 8: 606975. [Available at: *https://doi.org/10.3389/fmars.2021.606975*].

Borchers, D., Pike, D., Gunnlaugsson, H. and Víkingsson, G. 2009. Minke whale abundance estimation from the NASS 1987 and 2001 aerial cue-counting surveys taking appropriate account of distance estimation errors. *NAAMCO Sci. Publ.* 7: 95-110.

Borchers, D.L., Øien, N., Gunnlaugsson, T. and Burt, M.L. 1998. Minke whale abundance in the NVS stratum of the CM Management Area from NASS95. Paper SC/50/RMP10 presented to the IWC Scientific Committee, April 1998 (unpublished). 9pp. [Paper available from the Office of this Journal].

Bøthun, G. and Øien, N. 2011. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 7. Estimates used for catch limit calculations in northeast Atlantic minke whales. *J. Cetacean Res. Manage. (Suppl.)* 12: 107-10.

Bøthun, G., Skaug, H.J. and Øien, N. 2009. Abundance of minke whales in the northeast Atlantic based on survey data collected over the period of 2002-2007. Paper SC/61/RMP/02 presented to the IWC Scientific Committee, 2009 (unpublished). [Paper available from the Office of this Journal].

Boys, R.M., Beausoleil, N.J., Betty, E.L. and Stockin, K.A. 2021. Deathly Silent: Exploring the Global Lack of Data Relating to Stranded Cetacean Euthanasia. *Animals* 11(1460). [Available at: *https://doi.org/10.3390/ani11051460*].

Boys, R.M., Beausoleil, N.J., Betty, E.L. and Stockin, K.A. 2022a. When and how to say goodbye: An analysis of Standard Operating Procedures that guide end-of-life decision-making for stranded cetaceans in Australia. *Marine Policy* 138: 104949. [Available at: *https://doi.org/10.1016/j.marpol.2021.104949*].

Boys, R.M., Beausoleil, N.J., Pawley, M.D.M., Littlewood, K.E., Betty, E.L. and Stockin, K.A. 2022b. Fundamental Concepts, Knowledge Gaps and Key Concerns Relating to Welfare and Survival of Stranded Cetaceans. *Diversity* 14(338). [Available at: *https://doi.org/10.3390/d14050338*].

Bradford, A.L., Oleson, E.M., Forney, K.A., Moore, J.E. and Barlow, J. 2021. Line-transect abundance estimates of cetaceans in U.S. waters around the Hawaiian Islands in 2002, 2010, and 2017. *NOAA Tech. Mem.* NMFS-PIFSC-115. [Available at: *https://doi.org/10.25923/daz4-kw84*].

Brakes, P., Carroll, E., Dall, S.R.X., Keith, S.A., McGregor, P., Mesnick, S., Noad, M., Rendell, L., Robbins, M. and Rutz, C. 2021. A deepening understanding of animal culture suggests lessons for conservation. *Proc. Roy. Soc. B* 288: 20202718. [Available at: *https://doi.org/10.1098/rspb.2020.2718*].

Branch, T.A. 2007. Abundance of Antarctic blue whales south of 60°S from three complete circumpolar sets of surveys. *J. Cetacean Res. Manage.* 9(3): 253-62.

Branch, T.A. 2008. Current status of Antarctic blue whales based on Bayesian modeling. Paper SC/60/SH7 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 10pp. [Paper available from the Office of this Journal].

Branch, T.A., Monnahan, C.C., Širovic, A., Al Harthi, S., Allison, C., Balcazar, N.E., Barlow, D.R., Calderan, S., Cerchio, S., Double, M.C., Dreo, R., Gavrilov, A.N., Gedamke, J., Hodge, K.B., Jenner, C.S., Leroy, E.C., McCauley, R., Miksis-Olds, J.L., Miller, B.S., Panicker, D., Rogers, T., Royer, J.Y., Samaran, F., Shabangu, F.W., Stafford, K.M., Thomisch, K., Torres, L.G., Torterotot, M., Tripovich, J.S., Warren, V.E., Willson, A. and Willson, M.S. 2021. Monthly movements and historical catches of pygmy blue whale populations inferred from song detections. Paper SC/68C/SH/17 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 36pp. [Paper available from the Office of this Journal].

Branch, T.A., Stafford, K.M., Palacios, D.M., Allison, C., Bannister, J.L., Burton, C.L.K., Cabrera, E., Carlson, C.A., Galletti Vernazzani, B.G., Gill, P.C., Hucke-Gaete, R., Jenner, K.C.S., Jenner, M.N.M., Matsuoka, K., Mikhalev, Y.A., Miyashita, T., Morrice, M.G., Nishiwaki, S., Sturrock, V.J., Tormosov, D., Anderson, R.C., Baker, A.N., Best, P.B., Borsa, P., Brownell, R.L., Childerhouse, S., Findlay, K.P., Gerrodette, T., Ilangakoon, A.D., Joergensen, M., Kahn, B., Ljungblad, D.K., Maughan, B., McCauley, R.D., McKay, S., Norris, T.F., Rankin, S., Samaran, F., Thiele, D., Van Waerebeek, K. and Warneke, R.M. 2007. Past and present distribution, densities and movements of blue whales in the Southern Hemisphere and northern Indian Ocean. *Mammal Review* 37(2): 116-75.

Brandão, A., Ross-Gillespie, A., Vermeulen, E. and Butterworth, D.S. 2021. Updated extension of a photo-identification based assessment model to southern right whales in South African waters to allow for the possibility of an early abortion of the calf in the model. 36pp. Paper SC/68C/SH/05 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 36pp. [Paper available from the Office of this Journal].

Braulik, G.T., Ranjbar, S., Owfi, F., Aminrad, T., Dakhteh, S.M.H., Kamrani, E. and Mohsenizadeh, F. 2010. Marine mammal records from Iran. *J. Cetacean Res. Manage.* 11(1): 49-64.

Buchan, S., Hucke-Gaete, R., Stafford, K. and Clark, C. 2018. Occasional acoustic presence of Antarctic blue whales on a feeding ground in southern Chile. *Mar. Mam. Sci.* 34(1). [Available at: *https://doi.org/10.1111/mms.12441*].

Buchan, S.J., Pérez-Santos, I., Narváez, D., Castro, L., Stafford, K.M., Baumgartner, M.F., Valle-Levinson, A., Montero, P., Gutiérrez, L. and Rojas, C. 2021. Intraseasonal variation in southeast Pacific blue whale acoustic presence, zooplankton backscatter, and oceanographic variables on a feeding ground in Northern Chilean Patagonia. *Prog. Oceanog.* 199: 102709. [Available at: *https://doi.org/10.1016/j.pocean.2021.102709*].

Buckland, S.T. and Cattanach, K.L. 1992. Report of the sub-committee on North Pacific minke whales, Appendix 10. Revised minke whale abundance estimates for the Okhotsk Sea and adjacent Pacific area. *Rep. Int. Whal. Comm.* 42: 177.

Burkhardt, E., Van Opzeeland, I., Cisewski, B., Mattmuller, R., Meister, M., Schall, E., Spiesecke, S., Thomisch, K., Zwicker, S. and Boebel, O. 2021. Seasonal and diel cycles of fin whale acoustic occurrence near Elephant Island, Antarctica. *Royal Society Open Science* 8(5). [Available at: *https://doi.org/10.1098/rsos.201142*].

Busquets-Vass, G., Newsome, S.D., Calambokidis, J., Serra-Valente, G., Jacobsen, J.K., Aguíñiga-García, S. and Gendron, D. 2017. Estimating blue whale skin isotopic incorporation rates and baleen growth rates: Implications for assessing diet and movement patterns in *mysticetes*. *PloS One* 12(5): e0177880. [Available at: *https://doi.org/10.1371/journal.pone.0177880*].

Calambokidis, J. and Barlow, J. 2020. Updated abundance estimates for blue and humpback whales along the U.S. West Coast using data through 2018. U.S. Department of Commerce. *NOAA Tech. Mem.* NMFS-SWFSC-634. [Available at: *https://www.cascadiaresearch.org/files/publications/Calambokidis%26Barlow%202020%20UpdatedBlue%26HumpbAbund%20NOAA%20TM-634.pdf*].

Calambokidis, J., Falcone, E.A., Quinn, T.J., Burdin, A.M., Clapham, P.J., Ford, J.K.B., Gabriele, C.M., LeDuc, R., Mattila, D., Rojas-Bracho, L., Straley, J.M., Taylor, B.L., Urban R, J., Weller, D., Witteveen, B.H., Yamaguchi, M., Bendlin, A., Camacho, D., Flynn, K., Havron, A., Huggins, J. and Maloney, N. 2008. SPLASH: Structure of populations, levels of abundance and status of humpback whales in the North Pacific. Final report for Contract AB133F-03-RP-00078, US Department of Commerce Western Administrative Center, Seattle, Washington. [Available at: *http://www.cascadiaresearch.org/SPLASH/SPLASH-contract-report-May08.pdf*].

Carlén, I., Nunny, L. and Simmonds, M.P. 2021. Out of sight, out of mind: How conservation is failing European porpoises. *Front. Mar. Sci.* 8: 617478. [Available at: *https://doi.org/10.3389/fmars.2021.617478*].

Carroll, E. and Jackson, J. 2020. New Zealand southern right whale (Tohorā nō Aotearoa) habitat use in Port Ross, Auckland Islands over three decades: 1998-2021. [Available at: *https://doi.org/10.13140/RG.2.2.19440.07687*].

Carroll, E., McGowen, M., McCarthy, M.A., Marx, F., Aguilar, N., Dalebout, M.L., Dreyer, S., Gaggiotti, O., Hansen, S., van Helden, A., Onoufriou, A., Baird, R., Baker, C.S., Berrow, S., Cholewiak, D., Claridge, D., Constantine, R., Davison, N., Catarina Eira, R., Fordyce, E., Gatesy, J., Hofmeyr, G., Martín, V., Mead, J.G., Mignucci-Giannoni, A., Morin, P., Reyes, C., Rogan, E., Rosso, M., Silva, M.A., Springer, M., Steel, D. and Olsen, M.T. 2021. Speciation in the deep: genomics and morphology reveal a new species of beaked whale Mesoplodon eueu. *Proc. Roy. Soc. B* 288(1961). [Available at: *https://doi.org/10.1098/rspb.2021.1213*].

Carroll, E.L., Baker, C.S., Watson, M., Alderman, R., Bannister, J., Gaggiotti, O.E., Grocke, D.R., Patenaude, N. and Harcourt, R. 2015. Cultural traditions across a migratory network shape the genetic structure of southern right whales around Australia and New Zealand. *Sci. Rep.* 5: 16182. [Available at: *https://doi.org/10.1038/srep16182*].

Carroll, E.L., Childerhouse, S.J., Fewster, R.M., Patenaude, N.J., Steel, D., Dunshea, G., Boren, L. and Baker, C.S. 2013. Accounting for female reproductive cycles in a superpopulation capture-recapture framework. *Ecol. Appl.* 23: 1677-90.

Carvalho, S.C., Sampaio, I. and Santos, S. 2020. DNA barcoding reveals mislabeling and commercial fraud in the marketing of fillets of the genus Brachyplatystoma Bleeker, 1862, the Amazonian freshwater catfishes economically important in Brazil. *Heliyon* 6(9): 792-99.

Dolphin, C.f.t.C.o.t.A.H. 2020. Short- and medium-term priority actions to conserve the Atlantic humpback dolphin *Sousa teuszii*. Report of the Consortium for the Conservation of the Atlantic Humpback Dolphin, edited by Minton, G., Weir, C. and Collins, T. [Available from *www.sousateuszii.org*].

Dolphin, C.f.t.C.o.t.A.H. 2021. Consortium for the Conservation of the Atlantic Humpback Dolphin. 2021 Progress report of the Consortium for the Conservation of the Atlantic Humpback Dolphin. [Available at: *https://www.sousateuszii.org/wp-content/uploads/2022/02/2021-Progress-report-of-the-Consortium-for-the-Conservation-of-the-Atlantic-Humpback-Dolphin_Final-English.pdf*].

Cerchio, S., Rasoloarijao, T., Muller-Brennan, B. and Cholewiak, D. 2020. Acoustic monitoring of blue whales (*Balaenoptera musculus*) and fin whales (*Balaenoptera physalus*) in the Mozambique Channel off the northwest coast of Madagascar. Paper SC/68B/SH/08 presented to the IWC Scientific Committee, May 2020, Virtual Meetings (unpublished). 14pp. [Paper available from the Office of this Journal].

Chan, D.K.P., Tsui, C.L. and Kot, B.C.W. 2017. Database documentation of marine mammal stranding and mortality: current status review and future prospect. *Dis. Aquat. Org.* 126: 247-56. [Available at: *https://doi.org/10.3354/dao03179*].

Cheeseman, T., Southerland, K., Park, J., Olio, M., Flynn, K., Calambokidis, J., Jones, L., Garrigue, C., Howard, A., Reade, W., Neilson, J., Gabriele, C. and Clapham, P. 2021. Advanced image recognition: a fully automated, high-accuracy photo-identification matching system for humpback whales. *Mammalian Biology*. [Available at: *https://doi.org/10.1007/s42991-021-00180-9*].

Chen, B., Wang, L., Wang, H., Li, S., Jefferson, T.A., Wang, L., Tang, E.K., Xu, X. and Yang, G. 2017a. Finless porpoises (*Neophocaena asiaeorientalis*) in the East China Sea: insights into feeding habits using morphological, molecular, and stable isotopic techniques. *Can. J. Fish. Aquat. Sci.* . [Available at: *https://doi.org/10.1139/cjfas-2016-0119*].

Chen, C., Kawamura, G., Saeki, T. and Lim, L. 2017b. Heavy metals distribution in cetaceans stranded at west and north coasts of Sabah, Malaysia. *Int. J. Aquat. Biol.* 8(1): 16-25. [Available at: *https://doi.org/10.13140/RG.2.2.29616.00002*].

Cheng, Z., Li, Y., Pine, M.K., Zuo, T., Niu, M. and Wang, J. 2022. Association between porpoise presence and fish choruses: Implications for feeding strategies and ecosystem-based conservation of the East Asian finless porpoise. *Integrative Zoology* 0: 1-14. [Available at: *https://doi.org/10.1111/1749-4877.12639*].

Cheng, Z., Pine, M.K., Li, Y., Zuo, T., Niu, M., Wan, X., Zhao, X., Wang, K. and Wang, J. 2021. Using local ecological knowledge to determine ecological status and threats of the East Asian finless porpoise, Neophocaena asiaeorientalis sunameri, in south Bohai Sea, China. *Ocean and Coastal Management* 203: 105516. [Available at: *https://doi.org/10.1016/j.ocecoaman.2021.105516*].

Choi, S.G., Park, K.J., Kim, H.W., Lee, Y.R., Park, J.E., Moon, D.Y. and An, Y.R. 2010. Finless porpoise, Neophocaena phocaenoides, distribution in the south sea of Korea. *J. Fish. Aquat. Sci.* 43(6): 665-69. [Available at: *https://doi.org/10.5657/kfas.2010.43.6.665*].

Cipriano, F. 2018. Atlantic white-sided dolphin. *In*: Würsig, B., Thewissen, J.G.M. and Kovacs, K.M. (eds). *Encyclopedia of Marine Mammals*. Academic Press.

Clapham, P.J., Wetmore, S.E., Smith, T.D. and Mead, J.G. 1999. Length at birth and at independence in humpback whales. *J. Cetacean Res. Manage.* 1(2): 141-46.

Clarke, J.T., Ferguson, M.C., Okkonen, S.R., Brower, A.A. and Willoughby, A.L. 2022. Bowhead whale calf detections in the western Beaufort sea during the open water season, 2012 2019. *Arct. Sci.* [Available at: *https://doi.org/10.1139/as-2021-0020*].

CMS. 2007. *CMS Family Guide: the encyclopedia of the Convention on the Conservation of Migratory Species of Wild Animals*. CMS, Bonn.

CMS. 2017. Recreational In-Water Interaction with Aquatic Mammals. Prepared by the Aquatic Mammals Working Group of the Scientific Council. UNEP/CMS/COP12/Inf.13, paper presented at the 12th Meeting of the CoP, Manila, Philippines, October 2017.

Constantine, R., Steel, D., Carroll, E., Hamner, R.M., Hansen, C., Hickman, G., Hillock, K., Ogle, M., Tukua, P. and Baker, C.S. 2021. Estimating the abundance and effective population size of Maui dolphins (*Cephalorhynchus hectori maui*) in 2020-2021 using microsatellite genotypes, with retrospective matching to 2021.

Convention on Migratory Species. 2017. *Concerted Action for humpback whales (Megaptera novaeangliae) of the Arabian Sea*. Convention on Migratory Species, Manila. [Available from *https://www.cms.int/en/document/concerted-action-humpback-whales-megaptera-novaeangliae-arabian-sea*].

Cooke, J. and Jackson, J. 2017. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. Appendix 6. Reanalysis of Chiloé Island blue whale mark-recapture data 2006-11. *J. Cetacean Res. Manage. (Suppl.)* 18: 263.

Cooke, J.G. 2018. Abundance estimates for western North Pacific gray whales for use with stock structure hypotheses of the Range-wide Review of the Population Structure and Status of North Pacific gray whales. Paper SC/67b/ASI02 presented to the IWC Scientific Committee, April-May 2018, Bled, Slovenia (unpublished). 15pp. [Paper available from the Office of this Journal].

Corrêa, A.A., Quoos, J.H., Barreto, A.S., Groch, K.R. and Eichler, P.P.B. 2021. Use of satellite imagery to identify southern right whales (*Eubalaena australis*) on a southwest Atlantic Ocean breeding ground. *Mar. Mam. Sci.*38: 87-101. [Available at: *https://doi.org/10.1111/mms.12847*].

Course, G.P. 2021. Monitoring Cetacean Bycatch: An Analysis of Different Methods Aboard Commercial Fishing Vessels. ASCOBANS Secretariat, Bonn, Germany. 74 pages. ASCOBANS Technical Series No.1. [Available at: *https://www.researchgate.net/publication/354920209_MONITORING_CETACEAN_BYCATCH_AN_ANALYSIS_OF_DIFFERENT_METHODS_ABOARD_COMMERCIAL_FISHING_VESSELS*].

Crespo, E.A. and Coscarella, M.A. 2019. The southwestern Atlantic Southern right whale, *Eubalaena australis*: updated population rate of increase. *Mar. Mam. Sci.*35(1): 93-107. Paper SC/68A/CMP/01 presented to the IWC Scientific Committee, May 2019, Nairobi, Kenya (unpublished). 17pp. [Paper available from the Office of this Journal].

Crespo, E.A., Pedraza, S.N., Grandi, M.F., Dans, S.L. and Garaffo, G.V. 2010. Abundance and distribution of endangered franciscana dolphins in Argentine waters and conservation implication. *Mar. Mam. Sci.* 26: 17-35.

Crowe, L.M., Brown, M., Corkeron, P.J., Hamilton, P.K., Ramp, C., Ratelle, S., Vanderlaan, A.S.V. and Cole, T. 2021. In plane sight: a mark recapture analysis of the North Atlantic right whales in the Gulf of St. Lawrence. *Endang. Spec. Res.* 46: 227-51. [Available at: *https://doi.org/10.3354/esr01156*].

Cubaynes, H.C., Fretwell, P.T. and Jackson, J.A. 2017. Whales from space: spectral and visual description of four mysticete species using VHR satellite imagery. Paper SC/67a/NH09 presented to the IWC Scientific Committee, May 2017, Bled, Slovenia (unpublished). 22pp. [Paper available from the Office of this Journal].

Cunha, H.A., Farro, A.P.C. and Caballero, S. 2020. Review of population structure studies for *Sotalia guianensis* and a proposal for Management Units. 9pp. Paper SC/68B/SDDNA/06 presented to the IWC Scientific Committee, May 2020, Virtual Meetings (unpublished). 9pp. [Paper available from the Office of this Journal].

De La Mare, W., Miller, E. and Bell, E. 2016. Updated observations relevant to the Scientific Committee's review of the Southern Ocean Sanctuary. Paper SC/66b/SAN01 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 44pp. [Paper available from the Office of this Journal].

Diallo, S., Staniland, I. and COMHAFAT. 2021. Research plan for a cetacean sighting survey in coastal waters of western North Africa and proposal for capacity building project. 7pp. Paper SC/68C/ASI/09 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 7pp. [Paper available from the Office of this Journal].

Doniol-Valcroze, T., Gosselin, J.-F., Pike, D., Lawson, J., Asselin, N., Hedges, K. and Ferguson, S. 2015. Abundance estimate of the Eastern Canada-West Greenland bowhead whale population based on the 2013 High Arctic Cetacean Survey. Department of Fisheries and Oceans, *Can. Sci. Advis. Sec. Res. Doc.* 2015/058. v + 27pp.

Drinkwater, R.W. and Branch, T.A. 2022. Estimating proportions of identical twins and twin survival rates in cetaceans using fetal data. *Marine Mammal Science*: 1-11. [Available at: *https://doi.org/10.1111/mms.12929*].

Dudhat, S., Pande, A., NAir, A., Mondal, I., Srinivasan, M. and Sivakumar, K. 2022. Spatio-temporal analysis identifies marine mammal stranding hotspots along the Indian coastline. *Sci. Rep.* 12: 4128. [Available at: *https://doi.org/10.1038/s41598-022-06156-0*].

Duengen, D., Burkhardt, E. and El-Gabbas, A. 2019. Fin whale (*Balaenoptera physalus*) distribution modeling on their Nordic and Barents Seas feeding grounds, Carl von Ossietzky Universität, Oldenburg.

Durban, J., Weller, D., Lang, A. and Perryman, W. 2015. Estimating gray whale abundance from shore-based counts using a multilevel Bayesian model. *J. Cetacean Res. Manage.* 15: 61-68.

Durban, J.W., Weller, D.W. and Perryman, W.L. 2017. Gray whale abundance estimates from shore-based counts off California in 2014/15 and 2015/16. Paper SC/A17/GW06 presented to the Fourth Workshop on the Rangewide Review of the Population Structure and Status of North Pacific Gray Whales, April 2017, La Jolla, CA, USA (unpublished). 5pp. [Paper available from the Office of this Journal].

Eisfeld-Pierantonio, S.M., Pierantonio, N. and Simmonds, M.P. 2022. The impact of marine debris on cetaceans with consideration of plastics generated by the COVID-19 pandemic. *Environ. Poll.* 300: 118967. [Available at: *https://doi.org/10.1016/j.envpol.2022.118967*].

Eisfeld, S.M., Simmonds, M.P. and Stansfield, L.R. 2010. Behaviour of a solitary sociable female bottlenose dolphin (*Tursiops truncatus*) off the coast of Kent, Southeast England. *Journal of Applied Animal Welfare Science* 13: 31-45.

El-Gabbas, A., Van Opzeeland, I., Burkhardt, E. and Boebel, O. 2021a. Dynamic Species Distribution Models in the Marine Realm: Predicting Year-Round Habitat Suitability of Baleen Whales in the Southern Ocean. *Front. Mar. Sci.* 8(802276). [Available at: *https://doi.org/10.3389/fmars.2021.802276*].

El-Gabbas, A., Van Opzeeland, I., Burkhardt, E. and Boebel, O. 2021b. Static species distribution models in the marine realm: The case of baleen whales in the Southern Ocean. *Divers. Distrib.* . [Available at: *https://doi.org/10.1111/ddi.13300*].

Eubalaena australis. 2018. The IUCN Red List of Threatened Species 2018: eT8153A50354147 [Downloaded on 25 March 2021]. [Available at: *www.iucnredlist.org*].

Fagan, W.F., Lynch, H.J. and Noon, B.R. 2010. Pitfalls and challenges of estimating population growth rate from empirical data: consequences for allometric scaling relations. *Oikos* 119: 455-64. [Available at: *https://doi.org/10.1111/j.1600-0706.2009.18002.x*].

FAO. 2021. Fishing operations. Guidelines to prevent and reduce bycatch of marine mammals in capture fisheries. *FAO Technical Guidelines for Responsible Fisheries* 1. [Available at: *https://doi.org/10.4060/cb2887en*].

Fauquier, D., Raverty, S., Cottrell, P., MacConnachie, S., Urban R., J., Viloria-Gómora, L., Martínez-Aguilar, S., Swartz, S., Huggins, J., Rice, J., Halaska, B., Flannery, M., Danil, K., Savage, K., Garner, M., Duignan, P., Huntington, K.B., Weller, D., Stewart, J., Gulland, F., Goldstein, T., Calambokidis, J., Moore, S., Baker, J., Wilkinson, K., Viezbicke, J., Greenman, J., Keogh, M., Greig, D., Wilkin, S. and Rowles, T. 2021. Update on the eastern North Pacific gray whale (*Eschrichtius robustus*) Unusual Mortality Event. Paper SC/68C/E/10 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 4pp. [Paper available from the Office of this Journal].

Fazioli, K. and Mintzer, V. 2020. Short-term effects of Hurricane Harvey on bottlenose dolphins (*Tursiops truncatus*) in Upper Galveston Bay, TX. *Estuaries and Coasts* 43: 1013-31. [Available at: *https://doi.org/10.1007/s12237-020-00751-y*].

Felipe-Jiménez, I., Fernández, A., Andrada, M., Arbelo, M., Segura-Göthlin, S., Colom-Rivero, A. and Sierra, E. 2021. Contribution to Herpesvirus surveillance in beaked whales Stranded in the Canary Islands. *Animals* 11(7). [Available at: *https://doi.org/10.3390/ani11071923*].

Félix, F., Acevedo, J., Aguayo-Lobo, A., Ávila, I.C., Botero-Acosta, N., Calderón, A., Cáceres, B., Capella, J., Carnero, R., Castro, C., Cheeseman, T., Dalla Rosa, L., Dellabianca, N., Denkinger, J., Friedlaender, A., Guzmán, H., Haase, B., Haro, D., Hucke-Gaete, R., Llano, M., Oviedo, L., Pacheco, A., Pacheco, J., Palacios, D.M., Palacios-Alfaro, J., Pallin, L., José Pérez, M.J., Rasmussen, K., Sanchez-Godinez, C., Santillán, L., Secchi, E., Torres, M.A. and Vásquez, E. 2021. Humpback whale breeding stock G: updated population estimate based on photo-ID matches between breeding and feeding areas. Paper SC/68C/ASI/02 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 19pp. [Paper available from the Office of this Journal].

Ferguson, S.H., Higdon, J.W., Hall, P.A., Hansen, R. and Doniol-Valcroze, T. 2021. Developing a precautionary management approach for the Eastern Canada–West Greenland population of bowhead whales (Balaena mysticetus). *Front. Mar. Sci.* 8. [Available at: *https://doi.org/10.3389/fmars.2021.709989*].

Fernandez, A., Sierra, E., Arbelo, M., Gago-Martinez, A., Leao Martins, J.M., Garcia-Alvarez, N., Bernaldo de Quiros, Y., Arregui, M., Vela, A.I. and Diaz-Delgado, J. 2022. First case of Brevetoxicosis linked to rough-toothed dolphin (*Steno bredanensis*) mass-mortality event in Eastern Central Atlantic Ocean: A climate change effect? *Front. Mar. Sci.* 9. [Available at: *https://doi.org/10.3389/fmars.2022.834051*].

Flores, P.A.C. and Da Silva, V.M.F. 2009. Tucuxi and Guiana dolphin (*Sotalia fluviatilis and S. guianensis*). pp.1188- 92. *In*: Perrin, W.F., Würsig, B. and Thewissen, J.G.M. (eds). *Encyclopedia of Marine Mammals*. Elsevier, Amsterdam.

Fossi, M.C., Baini, M. and Simmonds, M.P. 2020. Cetaceans as ocean health indicators of marine litter impact at global scale. *Front. Environ. Sci.* 8. [Available at: *https://doi.org/10.3389/fenvs.2020.586627*].

Frasier, T.R., Petersen, S.D., Postma, L., Johnson, L., Heide-Jorgensen, M.P. and Ferguson, S.H. 2020. Abundance estimation from genetic mark-recapture data when not all sites are sampled: An example with the bowhead whale. *Global Ecology and Conservation* 20: e00903. [Available at: *https://doi.org/10.1016/j.gecco.2020.e00903*].

Fretwell, P.T., Staniland, I.J. and Forcada, J. 2014. Whales from space: Counting southern right whales by satellite. *PLoS ONE* 9(2): e88655. [Available at: *https://doi.org/10.1371/journal.pone.0088655*].

Gabriele, C.M., Amundson, C.L., Neilson, J.L., Straley, J.M., Baker, C.S. and Danielson, S.L. 2022. Sharp decline in humpback whale (*Megaptera novaeangliae*) survival and reproductive success in southeastern Alaska during and after the 2014-2016 Northeast Pacific marine heatwave. *Mammalian Biology*. [Available at: *https://doi.org/10.1007/s42991-021-00187-2*].

Galletti Vernazzani, B., Cabrera, E. and Brownell Jr, R.L. 2014. Eastern South Pacific southern right whale photo-identification catalog reveals behavior and habitat use patterns. *Mar. Mam. Sci.* 30(1): 389-98.

Galletti Vernazzani, B., Jackson, J.A., Cabrera, E., Carlson, C.A. and Brownell Jr., R.L. 2017. Estimates of abundance and trend of Chilean blue whales off Isla de Chiloé, Chile. *PLoS One* 12(1): e0168646. [Available at: *https://doi.org/10.1371/journal.pone.0168646*].

Garde, E., Tervo, O.M., Sinding, M.S., Nielsen, N.H., Cornett, C. and Heide-Jorgensen, M.P. 2022. Biological parameters in a declining population of narwhals (*Monodon monoceros*) in Scoresby Sound, Southeast Greenland. *Arctic Science* 8: 329-48. [Available at: *https://doi.org/10.1139/as-2021-0009*].

Garrison, L.P., Ortega-Ortiz, J. and Rappucci, G. 2020. Abundance of marine mammals in waters of the US Gulf of Mexico during the summers of 2017 and 2018. *National Marine Fisheries Service* 56. [Available at: *https://doi.org/10.25923/3px6-9v48*].

George, J.C., Druckenmiller, M., Laidre, K.L., Suydam, R. and Person, B. 2015. Bowhead whale body condition and links to summer sea ice and upwelling in the Beaufort Sea. *Prog. Oceanog.*136: 250-62. [Available at: *https://doi.org/10.1016/j.pocean.2015.05.001*].

George, J.C., Sheffield, G., Reed, D.J., Tudor, B., Stimmelmayr, R., Person, B.T., Sformo, T. and Suydam, R. 2017. Frequency of injuries from line entanglements, killer whales, and ship strikes on Bering-Chukchi-Beaufort seas bowhead whales. *Arctic* 70(1): 37-46.

George, J.C., Suydam, R., Givens, G., Horstmann, L., Stimmelmayr, R. and Sheffield, G. 2018. Length at sexual maturity and pregnancy rates of Bering-Chukchi-Beaufort Seas bowhead whales. Paper SC/67b/AWMP07 presented to the IWC Scientific Committee, April-May 2018, Bled, Slovenia (unpublished). 10pp. [Paper available from the Office of this Journal].

Gillespie, D., Berggren, P., Brown, S., Kuklik, I., Lacey, C., Lewis, T., Matthews, J., McLanaghan, R., Moscrop, A. and Tregenza, N. 2005. Relative abundance of harbour porpoises (*Phocoena phocoena*) from acoustic and visual surveys of the Baltic Sea and adjacent waters during 2001 and 2002. *J. Cetacean Res. Manage.* 7(1): 51-57.

Givens, G.H., Edmondson, S.L., George, J.C., Suydam, R., Charif, R.A., Rahaman, A., Hawthorne, D., Tudor, B., DeLong, R.A. and Clark, C.W. 2016. Horvitz–Thompson whale abundance estimation adjusting for uncertain recapture, temporal availability variation, and intermittent effort. *Environmetrics* 27(3): 134-46. May 2016. [Available at: *https://doi.org/10.1002/env.2379*].

Givens, G.H., George, J.C., Suydam, R., Tudor, B., Von Duyke, A., Person, B. and Scheimreif, K. 2021. Correcting the 2019 survey abundance of Bering-Chukchi-Beaufort Seas bowhead whales for disturbance from powered skiffs. Paper SC/68C/ASI/01 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 18pp. [Paper available from the Office of this Journal].

Gore, M.A., Culloch, R.M., Gray, H.W.I., Hoelzel, R., Lockyer, C., Kiani, M.S., Waqas, U., Hussain, B., Rahim, A., Shah, A. and Ormond, R.F.G. 2017. Assessment of beach-cast cetaceans in Pakistan: implications for conservation and management. *J. Cetacean Res. Manage.* 16: 1-7.

Gore, M.A., Kiani, M.S., Ahmad, E., Hussain, B., Ormond, R.F., Siddiqui, J., Waqas, U. and Culloch, R. 2012. Occurrence of whales and dolphins in Pakistan with reference to fishers' knowledge and impacts. *J. Cetacean Res. Manage.* 12(2): 235-47.

Government of Costa Rica, Government of Guatemala, Government of El Salvador, Government of Mexico, Government of Nicaragua, Government of Panama and Government of the United States of America. 2021. CMP Nomination Template of a Conservation Management Plan for Central America Humpback Whales population. Steering Committee for the proposal's submission: J. Urbán R., J. Casas, M. Iñiguez, L. Rojas-Bracho, L. Trejos, L. Viloria-Gómora, and R.L. Brownell Jr. Paper SC/68C/CMP/15 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 34pp. [Paper available from the Office of this Journal].

Granados-Zapata, A., Robles-Malagamba, M.J., González-Barrientos, R., Kot, B.C.W., Barquero-Calvo, E., Cordero-Chavaría, M., Suárez-Esquivel, M., Guzmán-Verri, C., Palacios-Alfaro, J.D., Tien-Sung, C., Moreno, E. and Hernández-Mora, G. 2022. Pathological studies and postmortem computed tomography of dolphins with Meningoencephalomyelitis and Osteoarthritis caused by *Brucella ceti*. *Oceans* 3(2): 189-203. [Available at: *https://doi.org/10.3390/oceans3020014*].

Guidino, C., Campbell, C., Bielli, A., Pasara-Polack, A., Alfaro-Shigueto, J. and Mangel, J.C. 2022. Pingers reduce small cetacean bycatch in a Peruvian small-scale driftnet fishery, but humpback whale (*Megaptera novaeangliae*) interactions abound. 48(2): 117-25. [Available at: *https://doi.org/10.1578/AM.48.2.2022.117*].

Gushcherov, P.S., Naberezhnykh, I.A., Tiupeleev, P.A., Samonov, V.I. and Miyashita, T. 2021. Research plan of the cetacean sighting survey in the northern Sea of Okhotsk in 2021. Paper SC/68C/ASI/11 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 6pp. [Paper available from the Office of this Journal].

Hakamada, T. and Matsuoka, K. 2016a. The number of the western North Pacific common minke, Bryde's and sei whales distributed in JARPNII Offshore survey area. Paper SC/F16/JR12 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 14pp. [Paper available from the Office of this Journal].

Hakamada, T. and Matsuoka, K. 2016b. The number of western North Pacific common minke, Bryde's and sei whales distributed in JARPNII Offshore survey area. Paper SC/F16/JR12 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). Available from *www.iwc.int*.

Hakamada, T., Matsuoka, K., Katsumata, T., Takahashi, M. and Miyashita, T. 2021. Research plan for Japan's dedicated cetacean sighting surveys in the North Pacific Ocean in summer 2021. Paper SC/68C/ASI/07 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 8pp. [Paper available from the Office of this Journal].

Hakamada, T., Matsuoka, K. and Miyashita, T. 2009. Distribution and the number of western North Pacific common minke, Bryde's, sei and sperm whales distributed in JARPN II offshore component survey area. Paper SC/J09/JR15 presented to the Expert Workshop to Review Results of JARPN II, 26-30 January 2009, Tokyo, Japan (unpublished). 18pp. [Paper available from the Office of this Journal].

Hamer, D. and Minton, G. 2020. Guidelines for the safe and humane handling and release of bycaught small cetaceans from fishing gear. Draft (February 2020) report to WWF, project AK51, for consideration by ACCOBAMS SC, IWC SC and FAO.

Hammond, P.S., Francis, T.B., Heinemann, D., Long, K.J., Moore, J.E., Punt, A.E., Reeves, R.R., Sepúlveda, M., Sigurðsson, G.M., Siple, M.C., Víkingsson, G., Wade, P.R., Williams, R. and Zerbini, A.N. 2021. Estimating the Abundance of Marine Mammal Populations. *Front. Mar. Sci.* 8(1316). [Available at: *https://doi.org/10.3389/fmars.2021.735770*].

Hansen, R.G., Boye, T.K., Larsen, R.S., Nielsen, N.H., Tervo, O., Nielsen, R.D., Rasmussen, M.H., Sinding, M.H.S. and Heide-Jørgensen, M.P. 2018. Abundance of whales in West and East Greenland in summer 2015. *NAMMCO Sci. Pub.* 11: 17. [Available at: *https://doi.org/10.7557/3.4689*].

Heide-Jørgensen, M.P., Borchers, D.L., Witting, L., Laidre, K.L., Simon, M.J., Rosing-Asvid, A. and Pike, D.G. 2008. Estimates of large whale abundance in West Greenland waters from an aerial survey in 2005. *J. Cetacean Res. Manage.* 10(2): 119-30.

Heide-Jørgensen, M.P., Laidre, K., Borchers, D., Samarra, F. and Stern, H. 2007. Increasing abundance of bowhead whales in West Greenland. *Biol. Lett.* 3: 577-80. [Available at: *https://doi.org/10.1098/rsbl.2007.0310*].

Hines, E., Ponnampalam, L., Junchompoo, C., Peter, C., Vu, L., Huynh, T., Caillat, M., Johnson, A.F., Minton, G., Lewison, R.L. and Verutes, G. 2020. Getting to the bottom of bycatch: a GIS-based toolbox to assess the risk of marine mammal bycatch. *Endang. Spec. Res.* 42: 37-57. [Available at: *https://doi.org/10.3354/esr01037*].

Hoffman, E., Biddle, L., de Bruin, T., Brooks, C., Corney, S., Haumann, A., Johnston, N., Mazloff, M., Murphy, E., Reiss, C., Russell, J., Rosenthal, H. and Sikes, E. 2022. Report of the 1st Southern Ocean regional workshop, 16 February 2020, San Diego, CA. UN Decade of Ocean Science for Sustainable Development (2021-2030).

Houegnigan, L., Merino, E.R., Vermeulen, E., Block, J., Safari, P., Moreno-Noguer, F. and Nadeu, C. In review. Wildlife and Marine Mammal Spatial Observatory: Observation and automated detection of Southern Right Whales in multispectral satellite imagery. *bioRxiv - Pathology Early View*. [Available at: *https://doi.org/10.1101/2022.01.20.477141*].

Htay, Y.Y., Hte, W., Soe, A.N., MAw, S.S., Htay, W.N., Pan, M.T., Min, P., Paing, M.T., Htet, N.L., Oo, Z.P., Lwin, P.P.P., San, H.N., Htet, H.L., Hein, M.K.K., Hmone, S.W., Htun, Z.M., Aung, C.N., Oo, H.K., Lwin, T.M. and Whitty, T.S. 2019. It Started With A Fisher's Tale: Interdisciplinary Research on Marine Mammals, Their History, and Treats in the Gulf of Mottama, Myanmar. Poster. World Marine Mammal Conference, 9-12 December, Barcelona, Spain. [Available at: *https://www.iucn.org/sites/dev/files/content/documents/2020/gomp_wmmc_poster_december_2019.pdf*].

Hucke-Gaete, R., Bedriñana-Romano, L., Viddi, F.A., Ruiz, J.E., Torres-Florez, J.P. and Zerbini, A.N. 2018. From Chilean Patagonia to Galapagos, Ecuador: novel insights on blue whale migratory pathways along the Eastern South Pacific. *PeerJ* 6: e4695. [Available at: *https://dx.doi.org/10.7717/peerj.4695*].

Ibrahim, A., Chen, B., Ali, I., Ali, H., Qadir, A. and Yang, G. 2021. Diversity and Conservation of Cetaceans in Pakistan. ARPHA Preprints. [Available at: *https://doi.org/10.3897/arphapreprints.e75384*].

International Council for the Exploration of the Sea. 2020. Workshop on fisheries Emergency Measures to minimize Bycatch of short-beaked common dolphins in the Bay of Biscay and harbour porpoise in the Baltic Sea (WKEMBYC). *ICES Sci. Rep.* 2(43):354. [Available at: *http://doi.org/10.17895/ices.pub.7472*].

International Council for the Exploration of the Sea. 2021. Workshop on estimation of MOrtality of Marine MAmmals due to Bycatch (WKMOMA). *ICES Sci. Rep.* 3(106):97. [Available at: *https://doi.org/10.17895/ices.pub.9710*].

Ijsseldijk, L.L., van Schalkwijk, L., van den Berg, A., Doeschate, M.T.I., Everaarts, E., Keijl, G.O., Kuijpers, N., Rebolledo, E.L.B., Veraa, S., Kik, M.J.K. and Leopold, M.F. 2020. Fatal attraction: The death of a solitary-sociable bottlenose dolphin due to anthropogenic trauma in the Netherlands. *Lutra* 63(1-2): 17-32.

IMO. 2021. Identification of Western Mediterranean Sea as PSSA to minimize the risk of ship strikes with cetaceans. MEPC 77/.inf27.

Ingram, D., Prideaux, M., Hodgins, N., Frisch-Nwakanma, H., Avila, I., Collins, T., Cosentino, M., Keith-Diagne, L., Marsh, H., Shirley, M., Van Waerebeek, K., Djondo, M., Fukuda, Y., Glaus, K., Jabado, R.W., Lang, J., Lüber, S., Manolis, C., Webb, G. and Porter, L. 2022. Widespread use of migratory megafauna for aquatic wild meat in the tropics and subtropics. *Front. Mar. Sci.* 9(837447). [Available at: *https://doi.org/10.3389/fmars.2022.837447*].

Ivashchenko, Y.V. and Clapham, P.J. 2021. An updated humpback whale catch series for the North Pacific. Paper SC/68C/IA/04 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 18pp. [Paper available from the Office of this Journal].

International Whaling Commission. 1990. Report of the Scientific Committee. *Rep. Int. Whal. Comm.* 40:39-79.

International Whaling Commission. 1993. Report of the Scientific Committee. *Rep. Int. Whal. Comm.* 43:55-92.

International Whaling Commission. 2001. Report of the Workshop on the Comprehensive Assessment of Right Whales: A worldwide comparison. *J. Cetacean Res. Manage. (special issue)* 2:1-60.

International Whaling Commission. 2002a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 4:1-78.

International Whaling Commission. 2002b. Report of the Scientific Committee. Annex E. Report of the Standing Working Group (SWG) on the Development of an Aboriginal Subsistence Whaling Management Procedure (AWMP). *J. Cetacean Res. Manage. (Suppl.)* 4:148-77.

International Whaling Commission. 2003a. Chair's Report of the Fifty-Fourth Annual Meeting. Annex F. Resolution adopted during the 54th meeting. Resolution 2002-1. Guidance to the Scientific Committee on the Sanctuary review process. *Ann. Rep. Int. Whal. Comm.* 2002:89.

International Whaling Commission. 2003b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 5:1-92.

International Whaling Commission. 2004. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 6:1-60.

International Whaling Commission. 2008a. Report of the Intersessional Workshop to Review Data and Results from Special Permit Research on Minke Whales in the Antarctic, Tokyo, 4-8 December 2006. *J. Cetacean Res. Manage. (Suppl.)* 10:411-45.

International Whaling Commission. 2008b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 10:1-74.

International Whaling Commission. 2008c. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on the Development of an Aboriginal Subsistence Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 10:121-49.

International Whaling Commission. 2009a. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure (RMP). *J. Cetacean Res. Manage. (Suppl.)* 11:91-144.

International Whaling Commission. 2009b. Report of the Scientific Committee. Annex H. Report of the sub-committee on other Southern Hemisphere whale stocks. *J. Cetacean Res. Manage. (Suppl.)* 11:220-47.

International Whaling Commission. 2010a. Chairman's Report of the Sixty-First Annual Meeting, Annex F. IWC Resolution 2009-1. Consensus Resolution on Climate and Other Environmental Changes and Cetaceans. *Ann. Rep. Int. Whal. Comm.* 2009:95.

International Whaling Commission. 2010b. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 11(2):218-51.

International Whaling Commission. 2011a. Chair's Report of the Sixty-Second Annual Meeting. *Ann. Rep. Int. Whal. Comm.* 2010:5-39.

International Whaling Commission. 2011b. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 12:89-116.

International Whaling Commission. 2011c. Report of the Third Intersessional Workshop on the Review of MSYR for Baleen Whales, Seattle, 20-24 April 2010. *J. Cetacean Res. Manage. (Suppl.)* 12:399-411.

International Whaling Commission. 2012a. Chair's Report of the 63rd Annual Meeting. *Ann. Rep. Int. Whal. Comm.* 2011:5-44.

International Whaling Commission. 2012b. Report of the Scientific Committee. Annex G. Report of the Sub-Committee on In-Depth Assessments. Appendix 4. Report of the Small Group planning for the 2012 IWC Pacific Ocean Whales and Research (POWER). *J. Cetacean Res. Manage. (Suppl.)* 13:189-90.

International Whaling Commission. 2012c. Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme. *J. Cetacean Res. Manage. (Suppl.)* 13:509-17.

International Whaling Commission. 2012d. Requirements and Guidelines for *Implementations* under the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 13:495-506.

International Whaling Commission. 2013a. Report of the IWC Workshop on the Assessment of Southern Right Whales. *J. Cetacean Res. Manage. (Suppl.)* 14:437-62.

International Whaling Commission. 2013b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 14:1-86.

International Whaling Commission. 2013c. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 5. Abundance estimates agreed by the Scientific Committee for use in the *CLA*. *J. Cetacean Res. Manage. (Suppl.)* 14:115-16.

International Whaling Commission. 2014a. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 15:87-111.

International Whaling Commission. 2014b. Report of the Scientific Committee. Annex I. Report of the Working Group on Stock Definition. Appendix 5. Key stock definition terms for the IWC Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 15:287-88.

International Whaling Commission. 2014c. Report of the Scientific Committee. Annex Q. Report of the *adhoc* group to develop a list of 'accepted' abundance estimates. *J. Cetacean Res. Manage. (Suppl.)* 15:416-17.

International Whaling Commission. 2015a. Report of the AWMP Intersessional Workshop on Developing SLAs for the Greenland hunts, 8-11 January 2014, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 16:433-58.

International Whaling Commission. 2015b. Report of the AWMP/RMP Joint Workshop on the Stock Structure of North Atlantic Common Minke Whales, 14-17 April 2014, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 16:543-58.

International Whaling Commission. 2015c. Report of the Expert Workshop to Review the Japanese JARPA II Special Permit Research Programme, 24-28 February 2014, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 16:369-409.

International Whaling Commission. 2015d. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure (RMP). Appendix 5. *Implementation Review* for North Atlantic common minke whales. *J. Cetacean Res. Manage. (Suppl.)* 16:112-36.

International Whaling Commission. 2015e. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on the Aboriginal Whaling Management Procedure (AWMP). *J. Cetacean Res. Manage. (Suppl.)* 16:144-57.

International Whaling Commission. 2015f. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 16:196-221.

International Whaling Commission. 2015g. Report of the Workshop on the Rangewide Review of the Population Structure and Status of North Pacific Gray Whales, 8-11 April 2014, La Jolla, California, USA. *J. Cetacean Res. Manage. (Suppl.)* 16:487-528.

International Whaling Commission. 2016a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 17:1-92.

International Whaling Commission. 2016b. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 17:106-84.

International Whaling Commission. 2016c. Report of the Scientific Committee. Annex F. Report of the Sub-Committee on Bowhead, Right and Gray Whales. *J. Cetacean Res. Manage. (Suppl.)* 17:204-23.

International Whaling Commission. 2016d. Report of the Scientific Committee. Annex O. Report of the Working Group to Review Sanctuaries and Sanctuary Proposals. *J. Cetacean Res. Manage. (Suppl.)* 17:404-08.

International Whaling Commission. 2016e. Report of the Scientific Committee. Annex O. Report of the Working Group to Review Sanctuaries and Sanctuary Proposals. Appendix 3. Terms of Reference for the review of the Southern Ocean Whale Sanctuary. *J. Cetacean Res. Manage. (Suppl.)* 17:406-07.

International Whaling Commission. 2017a. Chair's Report of the 66th Meeting. Annex E. Resolutions Adopted at the 66th Meeting. Resolution 2016-3. Resolution on Cetaceans and their Contribution to Ecosystem Functioning. *Rep. 65 Mtg Int. Whaling Commn* 2016:50.

International Whaling Commission. 2017b. Chair's Report of the 66th Meeting. Annex K. Report of the Finance and Administration Committee. Appendix 10. IWC/66/Rep01(2016) Table 26 as revised by the F&A Committee. *Rep. 65 Mtg Int. Whaling Commn* 2016:135.

International Whaling Commission. 2017c. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 18:1-109.

International Whaling Commission. 2017d. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 18:123-73.

International Whaling Commission. 2017e. Report of the Scientific Committee. Annex F. Report of the Sub-Committee on Bowhead, Right and Gray Whales. *J. Cetacean Res. Manage. (Suppl.)* 18:185-202.

International Whaling Commission. 2017f. Report of the Scientific Committee. Annex G. Report of the Sub-Committee on In-Depth Assessments. *J. Cetacean Res. Manage. (Suppl.)* 18:203-29.

International Whaling Commission. 2017g. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 18:230-63.

International Whaling Commission. 2017h. Report of the Scientific Committee. Annex M. Report of the Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 18:340-86.

International Whaling Commission. 2017i. Report of the Scientific Committee. Annex Q. Report of the Working Group to Review Sanctuaries and Sanctuary Proposals. *J. Cetacean Res. Manage. (Suppl.)* 18:410-33.

International Whaling Commission. 2018a. Chair's Summary Report of the First IWC Workshop on the Comprehensive Assessment of North Pacific Humpback Whales, 19-21 April 2017, Seattle, USA. *J. Cetacean Res. Manage. (Suppl.)* 19:595-601.

International Whaling Commission. 2018b. Report of the Fourth Rangewide Workshop on the Status of North Pacific Gray Whales, 27-29 April 2017, La Jolla, CA, USA. *J. Cetacean Res. Manage. (Suppl.)* 19:519-36.

International Whaling Commission. 2018c. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 19:193-221.

International Whaling Commission. 2018d. Report of the Scientific Committee. Annex Q. *Ad hoc* Working Group on Abundance Estimates, Status and International Cruises. *J. Cetacean Res. Manage. (Suppl.)* 19:376-98.

International Whaling Commission. 2018e. Report of the Third RMP Intersessional Workshop on the *Implementation Review* for North Atlantic Common Minke Whales, 16-18 December 2016, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 19:537-46.

International Whaling Commission. 2019a. Report of the 2017 AWMP Workshops on the Development of *SLA*s for the Greenlandic Hunts, 18-21 October 2017, Copenhagen, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 20:499-520.

International Whaling Commission. 2019b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 20:1-78.

International Whaling Commission. 2019c. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on Aboriginal Subsistence Whaling Management Procedures. *J. Cetacean Res. Manage. (Suppl.)* 20:120-82.

International Whaling Commission. 2019d. Report of the Scientific Committee. Annex E. Report of the Standing Working Group on Aboriginal Subsistence Whaling Management Procedures. Appendix 9. Scientific aspects of an aboriginal whaling scheme. *J. Cetacean Res. Manage. (Suppl.)* 20:179-82.

International Whaling Commission. 2019e. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 20:211-38.

International Whaling Commission. 2019f. Report of the Scientific Committee. Annex I. Report of the Working Group on Stock Definition and DNA Testing. *J. Cetacean Res. Manage. (Suppl.)* 20:239-56.

International Whaling Commission. 2019g. Report of the Scientific Committee. Annex Q. Report of the Standing Working Group on Abundance Estimates, Status of Stocks and International Cruises. *J. Cetacean Res. Manage. (Suppl.)* 20:394-412.

International Whaling Commission. 2019h. Report of the Scientific Committee. Annex Q. Report of the Standing Working Group on Abundance Estimates, Status of Stocks and International Cruises. Appendix 3. Table of accepted abundance estimates (2017-18) *J. Cetacean Res. Manage. (Suppl.)* 20:410-12.

International Whaling Commission. 2019i. Report of the Scientific Committee. Annex W. Draft Amendments to Scientific Committee Rules of Procedure. *J. Cetacean Res. Manage. (Suppl.)* 20:454-58.

International Whaling Commission. 2020a. Report of the 2018 Meeting of the IWC-POWER Technical Advisory Group (TAG), 12-14 October 2018, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 21:311-32.

International Whaling Commission. 2020b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 21:1-65.

International Whaling Commission. 2020c. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on *Implementation Reviews* and *Simulation Trials*. *J. Cetacean Res. Manage. (Suppl.)* 21:77-106.

International Whaling Commission. 2020d. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on the Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 21:128-56.

International Whaling Commission. 2020e. Report of the Scientific Committee. Annex O. Report of the Sub-Committee on Cetacean Stocks That Are or Might Be the Subject of Conservation Management Plans (CMPs). *J. Cetacean Res. Manage. (Suppl.)* 21:260-72.

International Whaling Commission. 2020f. Report of the Scientific Committee. Annex P. Scientific Committee Procedures for Submission, Review and Validation of Abundance Estimates. *J. Cetacean Res. Manage. (Suppl.)* 21:273-76.

International Whaling Commission. 2020g. Report of the Scientific Committee. Annex Q. Report of the Standing Working Group on Abundance Estimates, Stock Status and International Cruise (ASI). *J. Cetacean Res. Manage. (Suppl.)* 21:277-99.

International Whaling Commission. 2021a. Report of the IWC-CMS Workshop on the Cetacean Ecosystem Functioning, virtual meeting, 19-21 April 2021. *J. Cetacean Res. Manage. (Suppl.)* 23: 39pp.

International Whaling Commission. 2021b. Report of the IWC Workshop on Marine Debris: The Way Forward. 3-5 December 2019, La Garriga, Catalonia, Spain. *J. Cetacean Res. Manage. (Suppl.)* 22:273-310.

International Whaling Commission. 2021c. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 22:1-122.

International Whaling Commission. 2022a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 23:1-171.

International Whaling Commission. 2022b. Report of the Workshop on the Review of the Status of the Franciscana, virtual meeting, 7-9 April 2021. *J. Cetacean Res. Manage. (Suppl.)* 23: 23pp.

IWC Review Team. 2018. IWC Review, Final Report 8 April 2018. Paper IWC/67/18 presented to the 67th Meeting of the International Whaling Commission, Florianopolis, Brazil, September 2018. 172pp. [Paper available *https://archive.iwc.int/?r=7225*].

Jefferson, T.A. and Moore, J.E. 2020. Abundance and trends of Indo-Pacific finless porpoises (*Neophocaena phocaenoides*) in Hong Kong waters, 1996-2019. *Frontiers in Marine Science*. [Available at: *https://doi.org/10.3389/fmars.2020.574381*].

Jefferson, T.A., Robertson, K. and Wang, J.Y. 2002. Growth and reproduction of the finless porpoise in southern China. *Raffles Bull. Zool.* Supplement 10: 105-13.

Jefferson, T.A. and Wang, J.Y. 2011. Revision of the taxonomy of finless porpoises (*genus Neophocaena*): the existence of two species. *Journal of Marine Animals and their Ecology* 4(1): 3-16.

Jepson, P.D., Deaville, R., Barber, J., Aguilar, A., Borrell, A., Murphy, S., Barry, J., Brownlow, B., Barnett, J., Berrow, S., Cunningham, A., Davison, N., Esteban, R., Ferreira, M., Foote, A., Genov, T., Gimenez, J., Loveridge, J., Llavona, A., Martin, V., Maxwell, D., Papachlimitzou, A., Penrose, R., Perkins, M., Smith, B., de Stephanis, R., Tregenza, N., Verborgh, P., Fernandez, A. and Law, R.J. 2016. PCB pollution continues to impact populations of orcas and other dolphins in European waters. *Sci. Rep.* 6: Article number: 18573. [Available at: *https://doi.org/10.1038/srep18573*].

Jia, K., Lin, W., Gui, D., Karczzmarski, L. and Wu, Y. 2014. Molecular evidence reveals the distinctiveness of Indo-Pacific finless porpoises (*Neophocaena phocaenoides*) in the Pearl River Estuary and insights into genus Neophocaena's origin. *Mar. Biol.* 161(8). [Available at: *https://doi.org/10.1007/s00227-014-2474-y*].

Johnson, C., Reisinger, R., Palacios, D., Friedlaender, A., Zerbini, A., Willson, A., Lancaster, M., Battle, J., Graham, A., Cosandey-Godin, A., T., J., Felix, F., Grilly, E., Shahid, U., Houtman, N., Alberini, A., Montecinos, Y., Najera, E. and Kelez, S. 2022. Protecting Blue Corridors, Challenges and Solutions for Migratory Whales Navigating International and National Seas. WWF, Oregon State University, University of California, Santa Cruz, Publisher: WWF International, Switzerland. [Available at: *https://doi.org/10.5281/zenodo.6196131*].

Khalaf, N. 2020. The Chilean Blue Whale (*Balaenoptera musculus chilensis*): A New Subspecies from Chile. *The Palestinian Biological Bulletin* 38: 40-63.

Khalaf, N. 2021. The Arabian Sea Blue Whale (*Balaenoptera musculus arabica*): A New Subspecies from the Arabian Sea and Western Indian Ocean. *The Palestinian Biological Bulletin* 39(193): 17-46.

Kiszka, J.J., Moazzam, M., Boussarie, G., Shahid, U., Khan, B. and Nawaz, R. 2021. Setting the net lower: A potential low-cost mitigation method to reduce cetacean bycatch in drift gillnet fisheries. *Aquatic Conservation: Marine and Freshwater Ecosystems* 31(11): 3111-19. [Available at: *https://doi.org/10.1002/aqc.3706*].

Kot, B., W., Tsui, H.C.L., Chung, T.Y.T., Ho, H.H.N., Malagamba, M.J.R., Kwok, J.Y.C., Leung, E.K.C., Ho, G.Y.H., Kwan, A.S.Y. and Yeong, J.W.Y. 2021. Virtopsy investigations of stranded cetaceans in Hong Kong waters (2017-2020). Paper SC/68C/SM/09rev01 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 14pp. [Paper available from the Office of this Journal].

Krafft, B.A., Macaulay, G.J., Skaret, G., Knutsen, T., Bergstad, O.A., Lowther, A., Huse, G., Fielding, S., Trathan, P., Murphy, E., Choi, S., Chung, S., Han, I., Lee, K., Zhao, X., Wang, X., Ying, Y., Yu, X., Demianenko, K. and Hoem, N. 2021. Standing stock of 289 Antarctic krill (*Euphausia superba Dana,* 1850) (*Euphausiacea*) in the Southwest Atlantic sector of the Southern Ocean, 290 2018-19. *Journal of Crustacean Biology* 41(3). [Available at: *https://doi.org/10.1093/jcbiol/ruab046*].

Krishnan, A.A., Yousuf, K.S., Kumaran, P.L., Harish, N., Anoop, B., Afsal, V.V., Rajagopalan, M., Vivekanandan, E., Krishnakumar, P.K. and Jayasankar, P. 2008. Stomach contents of cetaceans incidentally caught along Mangalore and Chennai coasts of India. *Eastuarine Coastal and Shelf Science* 76: 909-13. [Available at: *https://doi.org/10.1016/j.ecss.2007.08.004*].

Kuit, S.H., Ponnampalam, L.S., Hammond, P.S., Chong, V.C. and Then, A.Y.H. 2021. Abundance estimates of three cetacean species in the coastal waters of Matang, Perak, Peninsular Malaysia. *Aquatic Conservation: Marine and Freshwater Ecosystems* 31(11): 3120-32. [Available at: *https://doi.org/10.1002/aqc.3699*].

Laake, J.L., Punt, A.E., Hobbs, R., Ferguson, M., Rugh, D. and Breiwick, J. 2012. Gray whale southbound migration surveys 1967-2006: an integrated re-analysis. *J. Cetacean Res. Manage.* 12(3): 287-306.

Lang, A.R., Archer, E.I., Attard, C., Baker, C.S., Branch, T.A., Brownell, R.L., Jr., Buss, D., Jackson, J., Kelly, N., Möller, L., Olson, P., Sirovic, A. and Sremba, A.L. 2020. Evaluating the evidence for population structure within Antarctic blue whales. Paper SC/68B/SH/03 presented to the IWC Scientific Committee, May 2020, Virtual Meetings (unpublished). 23pp. [Paper available from the Office of this Journal].

Larsen, F. 1995. Abundance of minke and fin whales off West Greenland, 1993. *Rep. Int. Whal. Comm.* 45: 365-70.

Lawson, J. and Gosselin, J.-F. 2018. Estimates of cetacean abundance from the 2016 NAISS aerial surveys of eastern Canadian waters, with a comparison to estimates from the 2007 TNASS. [Paper SC/25/AE/09 available from NAMMCO].

Lawson, J.W. and Gosselin, J.-F. 2009. Distribution and preliminary abundance estimates for cetaceans seen during Canada's Marine Megafauna Survey - a component of the 2007 TNASS. *Can. Sci. Advisory Sec. Res. Doc.* 2009/031: 33pp.

LeDuc, R.G., Archer, F.I., Lang, A.R., Martien, K.K., Hancock-Hanser, B., Torres-Florez, J.P., Hucke-Gaete, R., Rosenbaum, H.C., van Waerebeek, K., Brownell, R.L. and Taylor, B.L. 2017. Genetic variation in blue whales in the eastern pacific: implication for taxonomy and use of common wintering grounds. *Mol. Ecol.* 26: 740-51. [Available at: *https://doi.org/10.1111/mec.13940*].

LeDuc, R.G., Dizon, A.E., Goto, M., Pastene, L.A., Kato, H., Nishiwaki, S., LeDuc, C.A. and Brownell, R.L. 2007. Patterns of genetic variation in Southern Hemisphere blue whales, and the use of assignment test to detect mixing on the feeding grounds. *J. Cetacean Res. Manage.* 9(1): 73-80.

Leonard, D.M. and Øien, N.I. 2020a. Estimated abundances of cetacean species in the northeast Atlantic from Norwegian shipboard surveys in 2014-2018. *NAMMCO Sci. Pub.* 11. [Available at: *https://doi.org/10.7557/3.4694*].

Leonard, D.M. and Øien, N.I. 2020b. Estimated abundances of cetacean species in the northeast Atlantic from two multiyear surveys conducted by Norwegian vessels between 2002-2013. *NAMMCO Sci. Pub.* 11. [Available at: *https://doi.org/10.7557/3.4695*].

Leslie, M., Kant, L., Perkins-Taylor, C., Van Bressem, M., Minton, G., MacDonald, D., Christiansen, F., Sarrouf Willson, M., Collins, T., Baldwin, R., Al Harthi, S. and Willson, A. In Prep. Remote and non-invasive quantification of Tattoo-like Skin Disease in Endangered Arabian Sea humpback whales using drone photography. 6pp.

Li, S., Wang, D., Wang, K., Akamatsu, T., Ma, Z. and Han, J. 2007. Echolocation click sounds from wild inshore finless porpoise (*Neophocaena phocaenoides sunameri*) with comparisons to the sonar of riverine *N. p. asiaeorientalis*. *J. Acoust. Soc. Am.* 121(6): 3938-46. [Available at: https://doi.org/10.1121/1.2721658].

Lin, W., Frere, C.H., Karczmarski, L., Xia, J., Gui, D. and Wu, Y. 2014. Phylogeography of the finless porpoise (genus Neophocaena): testing the stepwise divergence hypothesis in the northwestern Pacific. *Sci. Rep.* 4(6572). [Available at: *https://doi.org/10.1038/srep06572*].

Lin, W., Karczmarski, L., Li, J., Chan, S.C., Guo, L. and Wu, Y. 2019. Differential population dynamics of a coastal porpoise correspond to the fishing effort in a large estuarine system. *Aquatic Conservation: Marine and Freshwater Ecosystems* 29(2): 223-34. [Available at: *https://doi.org/10.1002/aqc.2998*].

Lin, W., Karczmarski, L. and Wu, Y. 2017. Phylogeography of the finless porpoise and potential implications for the taxonomy of Neophocaena spp. *Mammalian Biology* 86: 92-101. [Available at: *https://doi.org/10.1016/j.mambio.2017.07.002*].

Liu, M., Lin, M. and Li, S. 2022. Species diversity and spatiotemporal patterns based on cetacean stranding records in China, 1950-2018. *Science of the Total Environment* 822: 153651. [Available at: *https://doi.org/10.1016/j.scitotenv.2022.153651*].

Liu, X., Mei, Z., Zheng, J., Hao, Y., Wang, K. and Wang, D. 2021. Media used as an information source to solve baseline gaps in marine megafauna conservation: Recommendations to standardize reports on cetacean stranding events. *Aquatic Conservation: Marine and Freshwater Ecosystems* 32(4): 658-70. [Available at: *https://doi.org/10.1002/aqc.3784*].

Lizewski, K., Steel, D., Lohman, K., Albertson, G.R., Peral, U.G., Urbán R., J., Calambokidis, J. and Baker, C.S. 2021a. Mixed-stock apportionment of humpback whales from feeding grounds to breeding grounds in the North Pacific based on mtDNA. Paper SC/68C/IA/01rev01 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 13pp. [Paper available from the Office of this Journal].

Lizewski, K., Steel, D., Lohman, K., Albertson, G.R., Peral, U.G., Urbán R., J., Calambokidis, J. and Baker, C.S. 2021b. Mixed-stock apportionment of humpback whales from feeding grounds to breeding grounds in the North Pacific based on mtDNA. Paper SC/68C/IA/01 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 12pp. [Paper available from the Office of this Journal].

Lu, Z., Xu, S., Song, N., Gao, T., Tian, J. and Han, J. 2016. Analysis of the diet of finless porpoise (*Neophocaena asiaeorientalis sunameri*) based on prey morphological characters and DNA barcoding. *Conservation Genetics Resources* 8(4). [Available at: *https://doi.org/10.1007/s12686-016-0575-2*].

Macaulay, J., Kingston, A., Coram, A., Oswald, M., Swift, R., Gillespie, D. and Northridge, S. 2022. Passive acoustic tracking of the three-dimensional movements and acoustic behaviour of toothed whales in close proximity to static nets. *Methods in Ecology and Evolution*. [Available at: *https://doi.org/10.1111/2041-210X.13828*].

Marcondes, M.C.C., Colósio, A.C., Ramos, H.G.C. and Coelho, I.P. 2017. Krill decreasing in South Georgia could explain humpback whale strandings in Brazil? VIII ENCOPEMAQ Book of Abstracts, Natal-RN, 22-25 August 2017.

Martin, M.J., Gridley, T., Roux, J. and Elwen, S.H. 2020. First abundance estimates of Heaviside's (*Cephalorhynchus heavisidii*) and dusky (*Lagenorhynchus obscurus*) dolphins off Namibia using a novel visual and acoustic line transect survey. *Front. Mar. Sci.*7: 555659. [Available at: *https://doi.org/10.3389/fmars.2020.555659*].

Mate, B.R., Ilyashenko, V.Y., Bradford, A.L., Vertyankin, V.V., Tsidulko, G.A., Rozhnov, V.V. and Irvine, L.M. 2015. Critically endangered western gray whalesmigrate to the eastern North Pacific. *Biol. Lett.* 11: 20150071. 4pp. [Available at: *https://doi.org/10.1098/rsbl.2015.0071*].

Matsuoka, K. and Hakamada, T. 2014. Estimates of abundance and abundance trend of the blue, fin and southern right whales in Areas IIIE-VIW, south of 60°S, based on JARPA and JARPAII sighting data (1989/90-2008/09). Paper SC/F14/J05 presented to the JARPA II Special Permit Expert Panel Review Workshop, 24-28 February 2014, Tokyo, Japan (unpublished). 27pp. [Paper available from the Office of this Journal].

Matsuoka, K., Hakamada, T., Kiwada, H., Murase, H. and Nishiwaki, S. 2006. Distribution and standardized abundance estimates of humpback, fin and blue whales in the Antarctic Areas IIIE, IV, V and VIW (35°E-145°W) south of 60°S. Paper SC/D06/J7 presented to the Intersessional Workshop to Review Data and Results from Special Permit Research on Minke Whales in the Antarctic, Tokyo, 4-8 December 2006 (unpublished). 37pp. [Paper available from the Office of this Journal].

Matsuoka, K., Katsumata, T., Yoshimura, I., Yamaguchi, F., Ohmukai, R., Konishi, K., Takahashi, M. and Hakamada, T. 2021. Results of the Japanese dedicated cetacean sighting survey in the western North Pacific in autumn and winter season 2020/21. Paper SC/68C/ASI/10 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 15pp. [Paper available from the Office of this Journal].

Mattmüller, R.M., Thomisch, K., Opzeeland, I.V., Laidre, K.L. and Simon, M. 2022. Passive acoustic monitoring reveals year-round marine mammal community composition off Tasiilaq, Southeast Greenland. *J. Acoust. Soc. Am.* 151: 1380-92. [Available at: *https://doi.org/10.1121/10.0009429*].

McDonald, M.A., Mesnick, S.L. and Hildebrand, J.A. 2006. Biogeographic characterisation of blue whale song worldwide: using song to identify populations. *J. Cetacean Res. Manage.* 8(1): 55-65.

Ministerio de la Presidencia. 2008. Real Decreto 1727/2007. *Bol. Of. del Estado* 11: 2292-96.

Minton, A.G., Folegot, T., Cosandy-Godin, A., Jacob, T., Lancaster, M. and Ushio, M. 2021. Shipping and cetaceans: A review of impacts and mitigation options for policy makers and other stakeholders *WWF Report* 72. [Available at: *https://www.wwf.nl/globalassets/pdf/nieuws/wwf-shipping-and-cetaceans-report-2021.pdf*].

Minton, G., Collins, T., Findlay, K., Baldwin, R., Ersts, P.J., Rosenbaum, H., Berggren, P. and Baldwin, R.M. 2011a. Seasonal distribution, abundance, habitat use and population identity of humpback whales in Oman. *J. Cetacean Res. Manage.* 12: 183-98.

Minton, G., Collins, T., Pomilla, C., Findlay, K., Rosenbaum, H., Baldwin, R. and Brownell, R.L., Jr. 2008. *Megaptera novaeangliae* (Arabian Sea sub-population). pp.e.T132835A3464679. *IUCN Red List of Threatened Species*. [https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T132835A3464679.en. Downloaded on 21 February 2021].

Minton, G., Peter, C., Poh, A.N.Z., Ngeian, J., Braulik, G.T., Hammond, P.S. and Tuen, A.A. 2013. Population estimates and distribution patterns of Irrawaddy dolphins (*Orcaella Brevirostris*) and Indo-Pacific finless porpoises (*Neophocaena phocaenoides*) in the Kuching Bay, Sarawak. *Raffles Bull. Zool.* 61(2): 877-88.

Minton, G., Peter, C. and Tuen, A.A. 2011b. Distribution of small cetaceans in the nearshore waters of Sarawak, East Malaysia. *Raffles Bull. Zool.* 59: 91-100.

Minton, G., Van Bressem, M., Willson, A., Collins, T., Al Harthi, S., Sarrouf Willson, M., Baldwin, R., Leslie, M. and Van Waerebeek, K. 2022. Visual Health Assessment and Evaluation of Anthropogenic Threats to Arabian Sea Humpback Whales in Oman. *J. Cetacean Res. Manage.* 23: 59-79.

Moore, J.E. 2021. Estimating Bycatch Mortality for Marine Mammals: Concepts and Best Practices. *Front. Mar. Sci.* 8: 752356. [Available at: *https://doi.org/10.3389/fmars.2021.752356*].

Moosa, N. 2017. An updated model of the krill-predator dynamics of the Antarctic ecosystem, University of Cape Town, Cape Town. 251pp. [Available at: *http://hdl.handle.net/11427/25490*].

Moosa, N. and Butterworth, D.S. 2017. Summary of an update of the Mori-Butterworth (2006) model of the krill-predator dynamics of the Antarctic ecosystem. Paper SC/67a/EM14 presented to the IWC Scientific Committee, May 2017, Bled, Slovenia (unpublished). 31pp. [Paper available from the Office of this Journal].

Morimura, N. and Mori, Y. 2019. Social responses of travelling finless porpoises to boat traffic risk in Misumi West Port, Ariake Sound, Japan. *PLoS ONE* 14(1). [Available at: *https://doi.org/10.1371/journal.pone.0208754*].

Mosquera-Guerra, F., Trujillo, F., Pérez-Torres, J., Mantilla-Meluk, H., Franco-León, N., Paschoalini, M., Valderrama, M., Oviedo, J., Campbell, E., Alfaro-Shigueto, J., Mena, J.L., Mangel, J., Gilleman, C., Zumba, M., Briceño, Y., Valencia, K., Torres-Forero, P., Sánchez, L., Ferrer, A., Barreto, S., van Damme, P. and Armenteras-Pascual, D. 2022. Strategy to Identify Areas of Use of Amazon River dolphins. *Front. Mar. Sci.* 9: 838988. [Available at: *https://doi.org/10.3389/fmars.2022.838988*].

Murase, H., Katsumata, T., Yoshimura, I., Fujii, S., Abe, N. and Matsuoka, K. 2021. Cruise report of the 2020 IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER). Paper SC/68C/ASI/05 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 38pp. [Paper available from the Office of this Journal].

Myers, H.J. and Moore, M.J. 2020. Reducing effort in the U.S. American lobster (*Homarus americanus*) fishery to prevent North Atlantic right whale (*Eubalaena glacialis*) entanglements may support higher profits and long-term sustainability. *Marine Policy* 118(1). [Available at: *https://10.1016/j.marpol.2020.104017*].

NAMMCO. 2018. Report of the Working Group on Abundance Estimates. [Available at: *https://nammco.no/wp-content/uploads/2019/02/12-sc-25_report_aewg_may-rev-october-2018_rev.pdf*].

NAMMCO. 2019. Report of the 26th Meeting of the NAMMCO Scientific Committee. 2019. [Available at: *https://nammco.no/wp-content/uploads/2017/01/final-report_sc26-2019_rev230120.pdf*.]

NAMMCO. 2021. Report of the 27th Meeting of the NAMMCO Scientific Committee. 2021. [Available at: *https://nammco.no/wp-content/uploads/2017/01/final_report_sc27_2021.pdf*.]

NAMMCO. 2022. NAMMCO-North Atlantic Marine Mammal Commission (2022). Report of the 28th meeting of the NAMMCO Scientific Committee. 24-28 January 2022, online. [Available at: *https://nammco.no/topics/scientific-committee-reports/*].

Natoli, A., Moura, A.E. and Sillero, N. 2021. Citizen science data of cetaceans in the Arabian/Persian Gulf: Occurrence and habitat preferences of the three most reported species. *Mar. Mam. Sci.* 38(1): 235-555. [Available at: *https://doi.org/10.1111/mms.12865*].

Nithyanandan, M. and Bohadi, Y. 2021. Incidental mortality events of the Indo-Pacific finless porpoise, *Neophocaena phocaenoides* in Kuwait, Northwestern Arabian Gulf. *Zoology in the Middle East*: 373-76. [Available at: *https://doi.org/10.1080/09397140.2021.1992838*].

NOAA. 2016. Fish and Fish Product Import Provisions of the Marine Mammal Protection Act. *Final Rule Federal Register* 81(157). Docket No. 0907301201–6406–03. p 1-31, United States of America.

Notarbartolo di Sciara, G. and Frisch-Nwakanma, H. 2018. Work on recreational in-water interactions with aquatic mammals under the Convention on Migratory Species (CMS). Paper SC/67b/WW03 presented to the IWC Scientific Committee, May 2018, Bled, Slovenia (unpublished). 2pp. [Paper available from the Office of this Journal].

Nunny, L. and Simmonds, M.P. 2019. A Global Reassessment of Solitary-Sociable Dolphins. *Front. Vet. Sci.* 5: 331. [Available at: *https://doi.org/10.3389/fvets.2018.00331*].

OceanMind, WWF, IUCN and IWC. 2020. A geospatial analysis of vessel traffic in Important Marine Mammal Areas. Paper SC/68B/HIM/03 presented to the IWC Scientific Committee, May 2020, Virtual Meetings (unpublished). 410pp. [Paper available from the Office of this Journal].

Øien, N. 2021. Report of the Norwegian 2020 survey for minke whales in the Small Management Area EW – Norwegian Sea. Paper SC/68C/ASI/06 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 10pp. [Paper available from the Office of this Journal].

Olsen, M.T., Nielsen, N.H., Board, V., Teilmann, J., Ngo, M.C., Vikingsson, G., Gunnlaugsson, T., Stenson, G., Lawson, J., Lah, L., Tiedemann, R. and Heide-Jorgensen, M.P. 2022. Genetic and behavioural data confirm the existence of a distinct harbour porpoise ecotype in West Greenland. *Ecological Genetics and Genomics* 22: 100108. [Available at: *https://doi.org/10.1016/j.egg.2021.100108*].

Olson, P., Jackson, J. and Donovan, G. 2017. IWC photo-identification catalogues: draft guidelines. Paper SC/67a/PH05 presented to the IWC Scientific Committee, May 2017, Bled, Slovenia (unpublished). 6pp. [Paper available from the Office of this Journal].

Olson, P.A., Kinzey, D., Double, M.C., Matsuoka, K. and Findlay, K. 2021. Capture-recapture estimates of abundance of Antarctic blue whales. Paper SC/68C/ASI/15 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 15pp. [Paper available from the Office of this Journal].

Oremus, M., Garrigue, C., Tezanos-Pinto, G. and Baker, C.S. 2015a. Phylogenetic identification and population differentiation of bottlenose dolphins (*Tursiops* spp.) in Melanesia, as revealed by mitochondrial DNA. *Mar. Mam. Sci.* 31(3): 1035-56. [Available at: *https://doi.org/10.1111/mms.12210*].

Oremus, M., Leqata, J. and Baker, S.C. 2015b. Resumption of traditional drive hunting of dolphins in the Solomon Islands in 2013. *Royal Society Open Science* 2(5): 140524. [Available at: *https://doi.org/10.1098/rsos.140524*].

Oremus, M., Poole, M.M., Albertson, G.R. and Baker, C.S. 2012. Pelagic or insular? Genetic differentiation of rough-toothed dolphins in the Society Islands, French Polynesia. *Journal of Experimental Marine Biology and Ecology* 432/433: 37-46. [Available at: *https://doi.org/10.1016/j.jembe.2012.06.027*].

Oremus, M., Poole, M.M., Steel, D. and Baker, C.S. 2007. Isolation and interchange among insular spinner dolphin communities in the South Pacific revealed by individual identification and genetic diversity. *Mar. Ecol. Prog. Ser.* 336: 275-89. [Available at: *https://doi.org/10.3354/meps336275*].

Pace, R.M. 2021. Revisions and further evaluations of the right whale abundance model: improvements for hypothesis testing. *NOAA Tech. Mem.* NMFS-NE-269: 54. [Available at: [http://catalog.gpo.gov/F/?func=direct&doc_number=001151826&format=999].

Pace, R.M., Corkeron, P.J. and Kraus, S.D. 2017. State-space mark-recapture estimates reveal a recent decline in abundance of North Atlantic right whales. *Ecol. Evol.* 7: 8730-41. [Available at: *https://doi.org/10.1002/ece3.3406*].

Pace, R.M., Williams, R., Kraus, S.D., Knowlton, A.R. and Pettis, H.M. 2021. Cryptic mortality of North Atlantic right whales. *Conservation Science and Practice* 3(2): e346. [Available at: *https://doi.org/10.1111/csp2.346*].

Palka, D. 2020. Cetacean abundance estimates in US northwestern Atlantic Ocean waters from summer 2016 line transect surveys conducted by the Northeast Fisheries Science Center. Northeast Fish. Sci. Cent. Ref. Doc. 20-05

Park, K.J., Zhang, C.I., Sohn, H. and Kim, Z.G. 2005. Feeding habits of finless porpoise (*Neophocaena phocaenoides*) in the west coast of Korea. Paper SC/57/SM17 presented to the IWC Scientific Committee, June 2005, Ulsan, Korea (unpublished). 9pp. [Paper available from the Office of this Journal].

Pastene, L.A., Goto, M., Taguchi, M. and Matsuoka, K. 2021. Genetic matches of southern right whales in the Indian sector of the Antarctic: a contribution towards understanding their movement and site-fidelity. *Cetacean Popul. Stud.* 3: 129-38. [Available at: *https://doi.org/10.34331/cpops.2020F002*].

Pastene, L.A., Hakamada, T., Acuña, P., Taguchi, M., Goto, M., Matsuoka, K. and Nishiwaki, S. 2018. Site-fidelity and movement ranges of southern right whales in Antarctic Area IV inferred from genetic tagging. Paper SC/67b/SH06 presented to the IWC Scientific Committee, April-May 2018, Bled, Slovenia (unpublished). 11pp. [Paper available from the Office of this Journal].

Peel, D., Smith, J. and Childerhouse, S. 2018. Vessel strike of whales in Australia: The challenges of analysis of historical incident data. *Front. Mar. Sci.* 5(69). [Available at: *https://doi.org/10.3389/fmars.2018.00069*].

Peltier, H., Authier, M., Caurant, F., Dabin, W., Daniel, P., Dars, C., Demaret, F., Meheust, E., Van Canneyt, O., Spitz, J. and Ridoux, V. 2021. In the wrong place at the wrong time: Identifying spatiotemporal co-occurrence of bycaught common dolphins and fisheries in the Bay of Biscay (NE Atlantic) from 2010 to 2019. *Front. Mar. Sci.* 8(359). [Available at: *https://doi.org/10.3389/fmars.2021.617342*].

Pike, D., Paxton, C.G.M., Gunlaugsson, T. and Víkingsson, G. 2009. Estimates of the abundance of minke whales (*Balaenoptera acutorostrata*) from Faroese and Icelandic NASS shipboard surveys. *NAMMCO Sci. Publ.* 7: 81-93. [Available at: *https://doi.org/10.7557/3.2707*].

Pike, D.G., Gunlaugsson, T., Elvarsson, B. and Víkingsson, G. 2011. Correcting perception bias for Icelandic aerial surveys, 2007 and 2009. Paper SC/18/AESP/08, presented to the NAMMCO Scientific Committee. 12pp. [Available from the author].

Pike, D.G., Gunnlaugsson, T., Mikkelsen, B., Halldórsson, S.D. and Víkingsson, G.A. 2019. Estimates of the abundance of cetaceans in the central North Atlantic based on the NASS Icelandic and Faroese shipboard surveys conducted in 2015. *NAMMCO Sci. Pub.* 11. [Available at: *https://doi.org/10.7557/3.4941*].

Pike, D.G., Gunnlaugsson, T., Mikkelsen, B. and Víkingsson, G.A. 2016. Estimates of the abundance of common minke whales (*Balaenoptera acutorostrata*) from the NASS Icelandic and Faroese ship surveys conducted in 2015. *NAMMCO Sci. Pub. s* 7. [Available at: *https://doi.org/10.7557/3.2707*].

Pike, D.G., Gunnlaugsson, T. and Víkingsson, G. 2002. A reanalysis of minke whale (*Balaenoptera acutorostrata*) abundance from Icelandic NASS-95 shipboard data. NAMMCO document SC/10/AE/6. 9pp.

Pike, D.G., Gunnlaugsson, T., Víkingsson, G.A. and Mikkelsen, B. 2010. Estimates of the abundance of minke whales (*Balaenoptera acutorostrata*) from the T-NASS Icelandic and Faroese ship surveys conducted in 2007. Paper SC/62/RMP5 presented to the IWC Scientific Committee, June 2010, Agadir, Morocco (unpublished). 12pp. [Paper available from the Office of this Journal].

Plön, S., Roussouw, N., Uren, R., Naidoo, K., Siebert, U. and Bouwman, H. 2022. Metal concentrations of three dolphin species incidentally caught in bather protection nets off KwaZulu-Natal, South Africa. Paper SC/68D/E/01 presented to the IWC Scientific Committee (unpublished). [Paper available from the Office of this Journal].

Ponnampalam, L.S. 2012. Opportunistic observations on the distribution of cetaceans in the Malaysian South China, Sulu and Sulawesi Seas and an updated checklist of marine mammals in Malaysia. *Raffles Bull. Zool.* 60(1): 221-31.

Porter, L. and Lai, H.Y. 2017. Marine mammals in Asian societies: trends in consumption, bait and traditional use. *Front. Mar. Sci.* 4. [Available at: *https://doi.org/10.3389/fmars.2017.00047*].

Quintana-Rizzo, E., Leiter, S., Cole, T.V., Hagbloom, M.N., Knowlton, A.R., Nagelkirk, P., Brien, O.O., Khan, C.B., Henry, A.G., P.A., D. and Crowe, L.M. 2021. Residency, demographics, and movement patterns of North Atlantic right whales *Eubalaena glacialis* in an offshore wind energy development in southern New England, USA. *Endang. Spec. Res.* 45: 251-68. [Available at: *https://doi.org/10.3354/esr01137*].

Quintela, M., Skaug, H.J., Øien, N., Haug, T., Bjørghild, B., Seliussen, B.B., Solvang, H.K., Pampoulie, C., Kanda, N., Pastene, L. and Glover, K.A. 2014. Investigating population genetic structure in a highly mobile marine organism: the minke whale *Balaenoptera acutorostrata acutorostrata* in the North East Atlantic. *PLoS ONE* 9(9). [Available at: *http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0108640*].

Rabaoui, L., Roa-Ureta, R.H., Yacoubi, L., Lin, Y.J., Maneja, R., Joydas, T.V., Panickan, P., Gopalan, J., Loughland, R., Prihartato, P.K., Qassem, A., Hikmawan, T.I., B., D.L. and Qurban, M.A. 2021. Diversity, distribution, and density of marine mammals along the Saudi waters of the Arabian Gulf: Update from a multi-method approach. *Front. Mar. Sci.* 8: 687445. [Available at: *https://doi.org/10.3389/fmars.2021.687445*].

Ramp, C., Gaspard, D., Gavrilchuk, K., Unger, M., Schleimer, A., Delarue, J., Landry, S. and Sears, R. 2021. Up in the air: drone images reveal underestimation of entanglement rates in large rorqual whales. *Endang. Spec. Res.* 44: 33-44. [Available at: *https://doi.org/10.3354/esr01084*].

Rankin, S., Ljungblad, D., Clark, C. and Kato, H. 2005. Vocalizations of Antarctic blue whales, *Balaenoptera intermedia*, recorded during the 2001-2002 and 2002-2003 IWC-SOWER circumpolar cruises, Area V, Antarctica. *J. Cetacean Res. Manage.* 7(1): 13-20.

Read, F.L. 2021. Cost-Benefit Analysis for Mitigation Measures in Fisheries with High Bycatch. ASCOBANS 15. [Available at: *https://www.ascobans.org/sites/default/files/document/accobams-ascobans_jbwg1_pres5.2g_analysis-mitigation-measures-fisheries-high-by-catch_read.pdf*].

Reeves, R., Weller, D., Cooke, J., Shpak, O. and New, L. 2021. Report on IUCN Western Gray Whale Advisory Panel (WGWAP) work from June 2020 to May 2021. Paper SC/68C/CMP/19 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 6pp. [Paper available from the Office of this Journal].

Reeves, R.R. and Brownell, R.L. 2009. Indo-Pacific bottlenose dolphin assessment workshop report: Solomon Islands case study of *Tursiops aduncus*. *Occasional Papers of the Species Survival Commission* 40 (IUCN, Gland, Switzerland): 53pp.

Rekdal, S.L., Hansen, R.G., Borchers, D., Bachmann, L., Laidre, K.L., Wiig, Ø., Nielsen, N.H., Fossette, S., Tervo, O. and Heide-Jørgensen, M.P. 2015. Trends in bowhead whales in West Greenland: Aerial surveys vs. genetic capture-recapture analyses. *Mar. Mam. Sci.* 31: 133-54. [Article first published online: 24 July 2014, available at: *https://doi.org/10.1111/mms.12150*].

Renault-Braga, E.P., Groch, K.R. and Simoes-Lopes, P.C. 2021. Numerical population estimates update for Southern right whales in Brazil. Paper SC/68C/CMP/10 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 8pp. [Paper available from the Office of this Journal].

Robbins, J., Zerbini, A.N., Gales, N., Gulland, F.M.D., Double, M., Clapham, P.J., Andrews-Goff, V., Kennedy, A.S., Landry, S., Mattila, D.K. and Tackaberry, J. 2013. Satellite tag effectiveness and impacts on large whales: preliminary results of a case study with Gulf of Maine humpback whales. Paper SC/65a/SH05 presented to the IWC Scientific Committee, June 2013, Jeju Island, Republic of Korea (unpublished). 10pp. [Paper available from the Office of this Journal].

Roberts, J.O., Webber, D.N., Goetz, K.T., Edwards, C.T.T., Roe, W.D. and Doonan, I.J. 2019. Spatial risk assessment of threats to Hector's and Maui dolphins (*Cephalorhynchus hectori*). New Zealand Aquatic Environment and Biodiversity Report.: 169.

Rodrigues, A.S.L., Monsarrat, S., Charpentier, A., Brooks, T.M., Hoffmann, M., Reeves, R., Palomares, M.L.D. and Turvey, S.T. 2019. Unshifting the baseline: a framework for documenting historical population changes and assessing long-term anthropogenic impacts. *Philosophical Transactions of the Royal Society B: Biological Sciences* 374(1788): 20190220. [Available at: *https://doi.org/10.1098/rstb.2019.0220*].

Rodríguez-Vargas, L.H. and Yobe, M. 2018. Marine Mammals of Coastal Penang Island, Malaysia. *Aquat. Mamm.* 44(3): 319-27. [Available at: *https://doi.org/10.1578/AM.44.3.2018.319*].

Rojas-Bracho, L., Jaramillo-Legorreta, A., García, E.N., Hinojosa, G.C., Hidalgo, E., Vázquez, E., Hoefer, C. and Taylor, B. 2021. Vaquita update during the pandemic. Paper SC/68C/SM/20 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 6pp. [Paper available from the Office of this Journal].

Rojas-Bracho, L., Taylor, B.L., Jaramillo-Legorreta, A., Olson, P., Ruiz, D., Hidalgo, E., Gerrodette, T. and Henry, A. 2020. Survey report for vaquita photographic identification research, 2019. Paper SC/68B/SM/08 presented to the IWC Scientific Committee, May 2020, Virtual Meetings (unpublished). 31pp. [Paper available from the Office of this Journal].

Romero, M.A., Coscarella, M.A., Adams, G.D., Pedraza, J.C., Gonzalez, R.A. and Crespo, E.A. 2022. Historical reconstruction of the population dynamics of southern right whales in the southwestern Atlantic Ocean. *Sci. Rep.* 12. [Available at: [https://doi.org/10.1038/s41598-022-07370-6].

Rosel, P.E., Wilcox, L.A., Yamada, T.K. and Mullin, K.D. 2021. A new species of baleen whale (*Balaenoptera*) from the Gulf of Mexico, with a review of its geographic distribution. *Mar. Mam. Sci.* 37(2): 1-34. [Available at: *https://doi.org/10.1111/mms.12776*].

Rouby, E., Authier, M. and Ridoux, V. North-East Atlantic Common dolphin population viablity. Life History traits variations due to Bycatch.

Rouby, E., Dubroca, L., Cloatre, T., Demaneche, S., Genu, M., Macleod, K., Peltier, H., Ridoux, V. and Authier, M. 2022. Estimating bycatch from non-representative samples (II): A case study of pair trawlers and common dolphins in the Bay of Biscay. *Front. Mar. Sci.* 8: 795942. [Available at: *https://doi.org/10.3389/fmars.2021.795942*].

Saez, L., Lawson, D. and Deangelis, M. 2020. Large whale entanglements off the U.S. West Coast, from 1982-2017. *NOAA Tech. Mem.* NMFS-OPR-63 [Available at: *https://www.fisheries.noaa.gov/resource/document/large-whale-entanglements-us-west-coast-1982-2017*].

Samaran, F., Berne, A., Leroy, E.C., Moreira, S., Stafford, K.M., Maia, M. and Royer, J.-Y. 2019. Antarctic blue whales (*Balaenoptera musculus intermedia*) recorded at the Equator in the Atlantic Ocean. *Mar. Mam. Sci.* 35(2): 641-48. [Available at: *https://doi.org/10.1111/mms.12559*].

Sarrouf Willson, M., Turley, C., Daar, L.A., Al Masroori, H., Al Muscati, H., Al Aufi, M., Al Bulushi, A., Al Harthi, S. and Willson, A. 2021. Addressing marine wildlife entanglement in derelict fishing nets using community-based social marketing: Case study and lessons learnt. *Social Marketing Quarterly* 27(4): 284-301. [Available at: *https://doi.org/10.1177/15245004211053841*].

Secchi, E., Santos, M. and Reeves, R. 2018. *Sotalia guianensis* (errata version published in 2019). The IUCN Red List of Threatened Species 2018: e.T181359A144232542. [Available at: *https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T181359A50386256.en*]. [Downloaded on 22 June 2020].

Segre, P.S., di Clemente, J., Kahane-Rapport, S.R., Gough, W.T., Meyer, M.A., Lombard, A.T., Goldbogen, J.A. and Penry, G.S. 2022. High-speed chases along the seafloor put Bryde's whales at risk of entanglement. *Conservation Science and Practice* 4(5): e12646. [Available at: *https://doi.org/10.1111/csp2.12646*].

Selling, J., Herr, H., Heyer, K., Siebert, U. and Burkhardt-Holm, P. 2016. Epidermal conditions, lesions and malformations in cetaceans of the Strait of Gibraltar. Paper SC/66b/E13 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 21pp. [Paper available from the Office of this Journal].

Shirakihara, K., Shirakihara, M. and Yamamoto, Y. 2007. Distribution and abundance of finless porpoise in the Inland Sea of Japan. *Mar. Biol.* 150: 1025-32. [Available at: *https://doi.org/10.1007/s00227-006-0363-8*].

Širović, A., Oleson, E.M., Stafford, K.M. and McDonald, M.A. 2017. Blue whale song occurrence in the North Pacific. Paper SC/67a/NH02 presented to the IWC Scientific Committee, May 2017, Bled, Slovenia (unpublished). 6pp. [Paper available from the Office of this Journal].

Skaug, H.J., Øien, N., Schweder, T. and Bothun, G. 2004. Abundance of minke whales (*Balaenoptera acutorostrata*) in the northeastern Atlantic; variability in time and space. *Can. J. Fish. Aquat. Sci.* 61(6): 870-86. [Available at: *https://doi.org/10.1139/f04-020*].

Skaug, H.J. and Solvang, H.K. 2015. A new variance estimator for Northeast Atlantic minke whales applied to survey data from 1996-2001. Paper SC/66a/RMP05rev1 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 8pp. [Paper available from the Office of this Journal].

Smith, B.D., Ahmed, B., Mowgli, R.M. and Strindberg, S. 2008. Species occurrence and distributional ecology of nearshore cetaceans in the Bay of Bengal, Bangladesh, with abundance estimates for Irrawaddy dolphins *Orcaella brevisrostris* and finless porpoise *Neophocaena phocaenoides*. *J. Cetacean Res. Manage.* 10(1): 45-58.

Smith, D.W. and Palka, D. 2021. Update on modernization of visual survey simulation programs. Paper SC/68C/ASI/13 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 23pp. [Paper available from the Office of this Journal].

Smith, J.N., Kelly, N., Double, M.C. and Bannister, J.L. 2021. Population trend in right whales off southern Australia 1993-2020. Paper SC/68C/SH/18 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 15pp. [Paper available from the Office of this Journal].

Solvang, H.K., Skaug, H.J. and Øien, N.I. 2015. Abundance estimates of common minke whales in the Northeast Atlantic based on survey data collected over the period 2008-2013. Paper SC/66a/RMP08 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 11pp. [Paper available from the Office of this Journal].

Solvang, H.K., Skaug, H.J. and Øien, N.I. 2021. Abundance of common minke whales in the Northeast Atlantic based on survey data collected over the period 2014-2019. Paper SC/68C/ASI/04 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 12pp. [Paper available from the Office of this Journal].

Song, Z., Zhang, Y., Wang, X. and Wei, C. 2017. Vocalizations of a wild finless porpoise (*Neophocaena asiaeorientalis sunmeri*) in the western coast of the Taiwan Strait, China. *Journal of Biobased Materials and Bioenergy* 11(1): 45-52. [Available at: *https://doi.org/10.1166/jbmb.2017.1642*].

Stewart, J.D. and Weller, D.W. 2021a. Abundance of eastern North Pacific gray whales 2019/2020. U.S. Department of Commerce. *NOAA Tech. Mem.* NMFS-SWFSC-639. [Available at: *https://doi.org/10.25923/bmam-pe91*].

Stewart, J.D. and Weller, D.W. 2021b. Estimates of eastern North Pacific gray whale calf production 1994-2021. U.S. Department of Commerce. *NOAA Tech. Mem*. NMFS-SWFSC-653.

Stimmelmayr, R., George, J.C., Clarke, J., Ferguson, M., Willoughby, A., Brower, A., Sheffield, G., Stafford, K., Givens, G.H., Von Duyke, A., Sformo, T., Person, B., de Sousa, L. and Suydam, R. 2020. 2018-2019 health report for the Bering-Chukchi-Beaufort Seas bowhead whales – preliminary findings. Paper SC/68b/ASW/03 presented to the Scientific Committee of the International Whaling Commission, May 2020 (unpublished). [Paper available from the Office of this Journal].

Stimmelmayr, R., Rotstein, D., Seguel, M. and Gottdenker, N. 2017. Hepatic Lipomas and Myelolipomas in subsistence harvested bowhead whales (*Balaena mysticetus*), Barrow, Alaska: A case review 1980-2016. *Dis. Aquat. Org.* 127(1): 71-74. [Available at: *https://doi.org/10.3354/dao03186*].

Stimmelmayr, R. and Sheffield, G. 2021. Arctic Risk Monitoring and Real Time Emerging Cumulative Issues: Bering-Chukchi-Beaufort Sea Perspective in RS19418 Climate Change Workshop report. [Available at: *www.iwc.int*].

Stockin, K.A., Pantos, O., Betty, E.L., Pawley, M.D., Doake, F., Masterton, H., Palmera, E., Perrott, M., Nelms, S.E. and Machovsky-Capuska, G.E. 2021. Fourier transform infrared (FTIR) analysis identifies microplastics in stranded common dolphins (Delphinus delphis) from New Zealand waters. *Mar. Poll. Bull.* 173: 113084. [Available at: *https://doi.org/10.1016/j.marpolbul.2021.113084*].

Taylor, B., Rojas-Bracho, L., Moore, A.M., Jaramillo-Legorreta, A., Ver Hoef, J., Cardenas-Hinojosa, G., Nieto-Garcia, E., Barlow, J., Gerrodette, T., Tregenza, N., Thomas, L. and Hammond, P. 2016. Extinction is imminent for Mexico's endemic porpoise unless fishery bycatch is eliminated. *Cons. Lett.* 10(5): 588-95. [Available at: *https://doi.org/10.1111/conl.12331*].

Tetley, M.J., Braulik, G.T., Lanfredi, C., Minton, G., Panigada, S., Politi, E., Zanardelli, M., Notarbartolo di Sciara, G. and Hoyt, E. 2022. The Important Marine Mammal Area network: A tool for systematic spatial planning in response to the marine mammal habitat conservation crisis. *Front. Mar. Sci.* 9: 841789. [Available at: *https://doi.org/10.3389/fmars.2022.841789*].

Thums, M., Ferreira, L.C., Jenner, C., Kenner, M., Harris, D., Davenport, A., Andrews-Goff, V., Double, M., Moller, L., Attard, C.R.M., Bilgmann, K., Thomson, P.G. and McCauley, R. 2022. Pygmy blue whale movement, distribution and important areas in the Eastern Indian Ocean. *Global Ecology and Conservation* 35(e02054). [Available at: *https://doi.org/10.1016/j.gecco.2022.e02054*].

Tiedemann, R., Ernst, A. and Autenrieth, M. 2018. Interpreting currently available NA minke whale genotype data in the context of current stock structure hypothesis, with an attempt to estimate mixing proportions among putative stocks. Paper SC/M18/AWMP05 presented to the AWMP Workshop, 20-24 March 2018, Copenhagen, Denmark (unpublished). 12pp. [Paper available from the Office of this Journal].

Torres-Florez, J.P., Hucke-Gaete, R., LeDuc, R., Lang, A., Taylor, B., Pimper, L.E., Bedriñana-Romano, L. and Rosenbaum, H.C. 2014a. Blue whale population structure along the eastern South Pacific Ocean: evidence of more than one population. *Mol. Ecol.* 23(24): 5998-6010.

Torres-Florez, J.P., Hucke-Gaete, R., Rosenbaum, H. and Figueroa, C.C. 2014b. High genetic diversity in a small population: the case of Chilean blue whales. *Ecol. Evol.* 4(8): 1398-412. [Available at: *https://doi.org/1002/Ece3.998*].

Torres-Florez, J.P., Olson, P.A., Bedriñana-Romano, L., Rosenbaum, H.C., Ruiz, J., LeDuc, R. and Hucke-Gaete, R. 2015. First documented migratory destination for eastern South Pacific blue whales. *Mar. Mam. Sci.* 31(4): 1580-86.

Torres-Florez, J.P., Ruiz, J. and Hucke-Gaete, R. 2021. Reconciling a long-term photo-id database for blue whales in Chilean Patagonia. Paper SC/68C/PH/05 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 4pp. [Paper available from the Office of this Journal].

Townhill, B.L., Tinker, J., Jones, M., Pitois, S., Creach, V., Simpson, S.D., Dye, S., Bear, E. and Pinnegar, J.K. 2018. Harmful algal blooms and climate change: exploring future distribution changes. *ICES J. Mar. Sci.* 75(6): 1882-93. [Available at: *https://doi.org/10.1093/icesjms/fsy113*].

Tulloch, V.J.D., Plagányi, E.E., Matear, R., Brown, C. and Richardson, A.J. 2017. Ecosystem modelling of baleen whale predators and their prey: consequences of historic whaling in the Southern Hemisphere. Paper SC/67a/EM12 presented to the IWC Scientific Committee, May 2017, Bled, Slovenia (unpublished). 25pp. [Paper available from the Office of this Journal].

van den Heuvel-Greve, M.J., van den Brink, A.M., Kotterman, M.J., Kwadijk, C.J., Geelhoed, S.C., Murphy, S., van den Broek, J., Heesterbeek, H., Gröne, A. and IJsseldijk, L.L. 2021. Polluted porpoises: Generational transfer of organic contaminants in harbour porpoises from the southern North Sea. *Science of the Total Environment* 796(148936). [Available at: *https://doi.org/10.1016/j.scitotenv.2021.148936*].

Vermeulen, E., Wilkinson, C., van den Berg, G. and Paarman, S. 2021. Report of the southern right whale aerial surveys 2020. Paper SC/68C/SH/04 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 25pp. [Paper available from the Office of this Journal].

Verutes, G.M., Johnson, A.F., Caillat, M., Ponnampalam, L.S., Peter, C., Vu, L., Junchompoo, C., Lewison, R.L. and Hines, E. 2020. Using GIS and stakeholder involvement to innovate marine mammal bycatch risk assessment in data-limited fisheries. *PLoS ONE* 15(8). [Available at: *https://doi.org/10.1371/journal.pone.0237835*].

Vrooman, J., Geelhoed, S.C.V. and Scheidat, M. 2022. Current status of tagging harbour porpoises - application to the Dutch North Sea. Wageningen Marine Research report; No. C017/22 [Available at: *https://doi.org/10.18174/567532*].

Vu, L. and Ponnampalam, L. 2018. Stranded online: Utilizing social media to monitor marine mammal strandings in Vietnam. Poster. 5th International Marine Conservation Congress (IMCC), 24-29 June, Kuching, Sarawak, Malaysia.

Wade, P.R., Long, K.J., Francis, T.B., Punt, A.E., Hammond, P.S., Heinemann, D., Moore, J.E., Reeves, R.R., Sepúlveda, M., Sullaway, G., Sigurðsson, G.M., Siple, M.C., Víkingsson, G.A., Williams, R. and Zerbini, A.N. 2021. Best practices for assessing and managing bycatch of marine mammals. *Front. Mar. Sci.* 8. [Available at: *https://doi.org/10.3389/fmars.2021.757330*].

Wang, J.Y., Frasier, T.R., Yang, S.C. and White, B.N. 2008. Detecting recent speciation events: the case of the finless porpoise (genus *Neophocaena*). *Heredity* 101: 145-55. [Available at: *https://doi.org/10.1038/hdy.2008.40*].

Wang, J.Y. and Reeves, R. 2017. *Neophocaena asiaeorientalis*. The IUCN Red List of Threatened Species 2017: e.T41754A50381766. [Available at: *http://dx.doi.org/10.2305/IUCN.UK.2017- 3.RLTS.T41754A50381766.en*].

Wang, Y., Li, W. and Van Waerebeek, K. 2015. Strandings, bycatches and injuries of aquatic mammals in China, 2000-2006, as reviewed from official documents: A compelling argument for a nationwide strandings programme. *Mar. Policy* 51: 242-50. [Available at: *https://doi.org/10.1016/j.marpol.2014.07.016*].

Waples, R.S. and Gaggiotti, O. 2006. What is a population? An empirical evaluation of some genetic methods for identifying the number of gene pools and their degree of connectivity. *Mol. Ecol.* 15(6): 1419-39.

Waples, R.S., Hoelzel, A.R., Gaggiotti, O., Tiedemann, R., Palsbøll, P.J., Cipriano, F., Jackson, J., Bickham, J.W. and Lang, A.R. 2018. Guidelines for genetic data analysis. *J. Cetacean Res. Manage. (Suppl.)* 18: 33-80.

Weir, C.R. 2016. Atlantic humpback dolphins Sousa teuszii in the Saloum Delta (Senegal): distribution, relative abundance and photo-identification. *African J. Mar. Sci.* 38(3): 385-94. [Available at: *https://doi.org/10.2989/1814232X.2016.1216893*].

Wenzel, F.W., Broms, F., Lopez-Suarez, P., Lopes, K., Veiga, N., Yeoman, K., Rodrigues, M.S.D., Allen, J., Fernald, T.W., Stevick, P.T., Jones, L., Jann, B., Bouveret, L., Ryan, C., Berrow, S. and Corkeron, P. 2020. Humpback whales (M*egaptera novaeangliae)* in the Cape Verde Islands: Migratory patterns, resightings, and abundance. *Aquat. Mamm.* 46: 21-31. [Available at: *https://doi.org/10.1578/AM.46.1.2020.21*].

Williams, R., Hedley, S.L., Branch, T.A., Bravington, M.V., Zerbini, A.N. and Findlay, K.P. 2011. Chilean blue whales as a case study to illustrate methods to estimate abundance and evaluate conservation status of rare species. *Cons. Biol.* 25(3): 526-35.

Williams, R., Lacy, R.C., Ashe, E., Hall, A., Plourde, S., McQuinn, I. and Lesage, V. 2021. Climate change complicates efforts to ensure survival and recovery of St. Lawrence Estuary beluga. *Mar. Poll. Bull.* 173(B): 113096. [Available at: *https://doi.org/10.1016/j.marpolbul.2021.113096*].

Willoughby, A.L., Ferguson, M.C., Stimmelmayr, R., Clarke, J.T. and Brower, A.A. 2020. Bowhead whale (*Balaena mysticetus*) and killer whale (*Orcinus orca*) co-occurrence in the U.S. Pacific Arctic, 2009-2018: evidence from bowhead whale carcasses. *Polar Biol.* 43: 1669-79. [Available at: *https://doi.org/10.1007/s00300-020-02734-y*].

Willson, A., Baldwin, R., Cerchio, S., Collins, T., Findlay, K., Gray, H., Godley, B.J., Al-Harthi, S., Kennedy, A., Minton, G., Zerbini, A. and Witt, M. 2015. Research update of satellite tracking studies of male Arabian Sea humpback whales: Oman. Paper SC/66a/SH22rev1 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 13pp. [Paper available from the Office of this Journal].

Willson, A.J. 2021. A geospatial analysis of Arabian Sea humpback whale ecology (*Megaptera novaeangliae*, Borowski 1781) and shipping traffic movements; charting a route towards seascape management in the north Indian Ocean. Thesis, University of Exeter, Exeter.

Wilson, K. 2022. The whale watching handbook: sustainable and educational whale watching. *Eco Magazine Marine Mammals* 167(57). [Available at: *http://digital.ecomagazine.com/publication/frame.php?i=745267&p=1&pn=&ver=html5&view=issueViewer*].

Witting, L. 2003. Reconstructing the population dynamics of eastern Pacific gray whales over the past 150 to 400 years. *J. Cetacean Res. Manage.* 5(1): 45-54.

Witting, L. 2013. Selection-delayed population dynamics in baleen whales and beyond. *Population Ecology* 55: 377-401.

Wong, M.I. 2021. Impact of Vessel Traffic on Underwater Soundscape and marine mammals in the Pearl River Delta. Thesis, The University of St. Joseph, Macau SAR, China.

Wood, M. and Sirovic, A. 2022. Characterization of fin whale song off the Western Antarctic Peninsula. *PLoS One* 17(3). [Available at: *https://doi.org/10.1371/journal.pone.0264214*].

Zerbini, A., Baumgartner, M., Kennedy, A., Rone, B., Wade, P. and Clapham, P. 2015. Space use patterns of the Endangered North Pacific right whale *Eubalaena japonica* in the Bering Sea. *Mar. Ecol. Prog. Ser.* 532: 269-81. [Available at: *https://doi.org/10.3354/meps11366*].

Zerbini, A.N., Secchi, E., Crespo, E., Danilewicz, D. and Reeves, R. 2017. *Pontoporia blainvillei*. The IUCN Red List of Threatened Species 2017. [Available at: *http://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T17978A50371075.en*] Downloaded on 27 April 2018.

Zhang, C.I., Park, K.J., Kim, Z.G. and Sohn, H. 2004. Distribution and abundance of finless porpoise (*Neophocaena phocaenoides*) in the West Coast of Korea. *Korean J. Fish. Aquat. Sci.* 37(2): 129-36. [Available at: *https://doi.org/10.5657/kfas.2004.37.2.129*].

Zhang, W., Bravington, M.V. and Fewster, R.M. 2019. Fast likelihood-based inference for latent count models using the saddlepoint approximation. *Biometrics* 75: 723-33. [Available at: *https://doi.org/10.1111/biom.13030*].

Annex A

List of Participants

ARGENTINA

Miguel Iñíguez (H)

AUSTRALIA

Michael Double (H)
Elanor Bell (AH)
Virginia Andrews-Goff
Brian Miller
Natalie Kelly
Annie Robinson
Adam Clark

AUSTRIA

Michael Stachowitsch (H)

BELGIUM

Jan Haelters (H)
Stephanie Langerock (AH)
Jens Warrie

BRAZIL

Marco Farani (H)
Ricardo José Lustova Leal (AH)
Alexandre Zerbini
Alexandra Gurgel Valente da Costa
André Silva Barreto
Artur Andriolo
Camila Domit
Carlos Hugo Suarez Sampaio
Fábia de Oliveira Luna
João Luis Fernandino Ferreira
Juliana Couto Di Tullio
Julio Ernesto Baumgarten
Karine Rejane Groch
Leandro Cortese Aranha
Milton Marcondes
Pedro Fruet
Renata Santoro de Sousa Lima
Salvatore Siciliano
Thais Coutinho
Verônica Alberto Barros
Wagner Augusto Fischer

CHILE

Barbara Galletti Vernazzani (H)

COLOMBIA

Ana María González (H)

COSTA RICA

Eugenia Arguedas Montezuma (H)
Javier Rodriguez
Frank Garita
José David Palacios
Marisol Amador

CROATIA

Katja Jelic (H)
Srdana Rozic
Martina Marić

CZECH REPUBLIC

Jiri Mach (H)
Barbora Krizova (AH)
Jan Plesnik
Petra Neveceralova
Pavel Hulva
Dagmar Svobodova
Martina Janu Mrnkova
Barbora Chmelova
Eliska Rolfova

DENMARK

Lars Witting (H)

ECUADOR

Victor Chocho (H)
Marco Herrera
Leonardo Alvardo
Nelson Pazmino
Karla Bravo
Fernando Félix
Daniela Alarcon

FRANCE

Vincent Ridoux (H)
Hélène Peltier
Etienne Rouby
Michel Vély

GERMANY

Nicole Hielscher (H)
Daniel Stepputtis
Elke Burkhardt
Ahmed El-Gabbas

ICELAND

Gísli Víkingsson (H)
Christophe Pampoulie
Guðjón Sigurðsson

ITALY

Giancarlo Lauriano (H)
Caterina Maria Fortuna (AH)
Simone Panigada
Maria Cristina Fossi
Ada Natoli
Sandro Mazzariol

KOREA, REPUBLIC OF

Seok-Gwan Choi (H)
Joon Taek Yoo
Jong Hee Lee
Kyung Lee Lee
Eun Ho Kim
Jeong Eun Ku
In Woo Han
Bong Jin Cha
Hyun-Young Kim
Da Young Kang
Sanggyu Shin
Zang Geun Kim

LUXEMBOURG

Pierre Gallego (H)
Elizabeth Slooten
Mel Cosentino

MEXICO

Armando Jaramillo-Legorreta (H)
Gustavo Cardenas Hinojosa

NETHERLANDS

Anne-Marie Svoboda (H)
Meike Scheidat (AH)
Jip Vrooman
Lonneke IJsseldijk

NEW ZEALAND

Dave Lundquist (H)
Tom Butler
Kristina Hillock
Anton van Helden
Hannah Hendriks
Mike Ogle

NORWAY

Nils Øien (H)
Martin Biuw
Arne Bjørge
Tore Haug
Ulf Lindstrøm
Kathrine Ryeng
Hiroko Kato Solvang
Andre Moan
Maria Quintela Sanchez
Hans Julius Skaug

PANAMA

Lissette Trejos-Lasso (H)
Karly Urriola (AH)
Betzi Perez
Adriana Ng

PERU

Sofía Rivadeneyra Villafuerte (H)
José Pacheco De Freitas (AH)
Alejandra Paz Ramos
Ana Daniela Fernández Vidarte
Arturo González Araujo
Cinthia Magaly Rojo López
Cristian Miguel Condori Tito
Edson Apaza Mamani
Elisa Goya Sueyoshi
Ever Arboleda Ludeña
Fabiola Nunez Neira
Frida Rodríguez Pacheco
Giancarlo Leon Collazos
Hugo Alonso Díaz Díaz
Javier Quiñones Dávila
Jennifer Chauca Huánuco
Joaquin Correa Muniz
Juan Carlos Moreno Echandía
Lincol Roller Polo Bordonabe
Manuel Ochoa Madrid
María Andrea Meza Torres
Regina Aguilar Arakaki
Romero Moreno
Rosa Ñahui Saccaco
Santos Eladio Saavedra Moncada
Sharon Dale Gonzales

PORTUGAL

Marina Sequeira (H)
Luis Freitas (AH)
Ana Rita Amaral
Ana Mafalda Correia
Ana Marçalo
Andreia Torres Pereira
Andreia Sofia da Silva Pereira
Catarina Eira
Cláudia Oliveira
David Jacinto
Francisco Neves
Helder Araújo
Inês Carvalho
Joana Castro
João J. Castro
Margarida Rolim
Marisa Ferreira
Miguel Grilo
Pauline Gauffier
Ruth Esteban
Sara Magalhães
Sergi Pérez-Jorge

RUSSIAN FEDERATION

Viacheslav Bizikov (H)
Lev Sidorov
Pavel Gusherov
Dennis Litovka

SOLOMON ISLANDS

Rosalie Masu (H)

SOUTH AFRICA

Mduduzi Seakamela (H)
Matshidisho Malatji

SPAIN

Elvira García-Bellido (H)
Antonio Fernandez
Natalia de la Carrera
Graham Pierce
Diego Fernández Fernández
Marie Petitguyot
Paula Gutierrez
Andrea Fariñas
Carolina Fernández-Maldonado

ST. LUCIA

Horace Walters (H)
Thomas Nelson
Monique Calderon
Makeba Felix

SWITZERLAND

Patricia Holm (H)

UK

Stuart Reeves (H)
Lindsay Porter
Catherine Bell
Emma Day
Murray Fyfe
Lara Turtle
Marta Soeffker
Mark Simmonds
Russell Leaper

USA

Debra Palka (H)
Aimee Lang
Amy Baird
Charles Scott Baker
Danielle Cholewiak
David Weller
Dawn Noren
Dennis Heinemann
Douglas DeMaster
Frederick (Eric) Archer
Geof Givens
John Bickham
John Citta
Jonathan Scordino
Kayla Scheimreif
Kimberly Goetz
Kristy Long
Megan Ferguson
Paul Wade
Peter Thomas
Phillip Clapham
Raphaela Stimmelmayr
Robert Brownell
Robin Waples
Sarah Mallette
Teresa (Teri) Rowles
Yulia Ivashchenko

INVITED PARTICIPANTS

Aderson Nascimento
Adrianne Akmajian
Ailsa Hall
Alex Aguilar
Amy Van Cise
Ana Cañadas
Ana Širovic
Anabela Brandão
André Punt
Andrea Ross-Gillespie
Andrew Brownlow
Andrew Willson
Andy Rogan
Angie Sremba
Anissa Lawrence
Anna Brüniche-Olsen
Anna Guasco
Asha de Vos
Astrid Frisch-Jordan
Barbara Taylor
Bjørn Krafft
Brian Kot
Brianna Elliott
Cara Miller
Carla Freitas-Brandt
Carlos Sacristan

Caroline Hoeschle
Carryn de Moor
Catherine Marzin
Cherry Allison
Chris Parsons
Claire Charlton
Claire Garrigue
Constanza Rojas
Courtney Smith
Craig Hayslip
Daniel Palacios
Daniel Stepputtis
Danielle Buss
Danielle Kreb
Deb Fauquier
Debbie Steel
Diego Rodriguez
Ding Wang
Dipani Sutaria
Doug Butterworth
Elisa Seyboth
Elizabeth Allyn
Elizabeth Mueni
Ellen Hines
Ellie McLennan
Els Vermeulen
Emma Carroll
Enrique Crespo
Eva Hanninger
Eva Hidalgo Pla
Eva Sierra
Fabian Ritter
Fannie Shabangu
Federico Sucunza
Fernando Trujillo
Fiona Read
Frances Gulland
Frank Cipriano
Gaby Hernandez
Gerladine Busquets-Vass
Gianna Minton
Gill Braulik
Gin Swen Ham
Greg Donovan
Hannah Cubaynes
Hannah Myers
Helena Herr
Hidehiro Kato
Hon Ip
Howard Rosenbaum
Husain Al Sayegh
Ida Carlen
Isabel Avila
Isabel Beasley
J. Andrew DeWoody
Jamie Macaulay
Jeffrey Mangel
Jennifer Jackson
Jens Currie
Joanna Kershaw
John 'Craig' George
Jooke Robbins
Jorge Urbán
Juan Pablo Torres-Flórez
Karen Martien
Karen Stockin
Kathi George
Kathleen Colegrove
Keith Hamilton
Kim Parsons
Koji Matsuoka
Kristin Privitera-Johnson
Lance Garrison
Lars Walløe
Lauren Nelson
Leslie New
Liam Mueller-Brennan
Lindsey Jones
Lisa Kettemer
Lorena Viloria
Lorenzo Rojas Bracho
Lotte Kindt-Larsen
Luciano Dalla-Rosa
Lucy Keith Diagne
Macarena Agrelo
Magdalena Arias
Marc Oremus
Marcello Hernandez-Blanco
Marcy Uhart
Margi Prideaux
María Alejandra Romero
Maria Clara Jimenez Assmus
Mariana Paschoalini Frias
Mariano Coscarella
Mariano Sironi
Martha Delaney
Mason Weinrich
Matthew Leslie
Michael Donoghue
Michael Meyer
Michael Poole
Michael Wilberg
Michaela Kratofil
Miriam Marmontel
Muhammad Moazzam Khan
Nantarika Chansue
Naomi Brannan
Naomi Rose
Naruki Morimura
Naseera Moosa
Nicola Hodgins
Nithyanandan Manickam
Pamela Martinez-Loustalot
Patricia Rosel
Paul de Bruyn
Paula Olson
Penny Clarke
Per Palsboll
Pingguo He
Pooja Balaji
Rachel Fewster
Rachel Cavanagh
Ralph Tiedemann
Randall Reeves
Rob Enever
Rob Williams
Robert Baldwin
Robert Suydam
Robin Baird
Rochelle Constantine
Rus Hoelzel
Sabre Mahaffy
Sarah Mesnick
Sally Mizroch
Salvatore Cerchio
Sara Konigson
Sarah Wilkin
Samantha Simmons
Scott Landry
Sharon Livermore
Silvia Frey
Simon Allen
Simon Childerhouse
Simon Elwen
Sivakumar Kuppusamy
Sonja Pine Eisfeld-Pierantonio
Soojin Jang
Stephanie Plön
Stephanie Stack
Steven Ferguson
Susanna Buchan
Sverrir Halldorsson
Thomas Doniol-Valcroze
Tilen Genov
Tim Collins
Toshihide Kitakado
Trevor Branch
Valerie Chosson
Vanesa Reyes Reyes
Vivitskaia Tulloch
Yolarnie Amepou
Yousef Buhadi
Yujiang Hao
Zoe Rand

OBSERVERS

Non-Member Countries

Japan

Institute of Cetacean Research (ICR)
Kenji Konishi
Luis A. Pastene
Megumi Takahashi
Mioko Taguchi
Mutsuo Goto
Taiki Katsumata
Takashi Hakamada
Tatsuya Isoda
Tsutomu Tamura
Yoshihiro Fujise

Fisheries Resources Institute (FRI)
Hideyoshi Yoshida
Hikari Maeda
Tomio Miyashita
Toshiya Kishiro
Shingo Minamikawa

Tokyo University of Marine Science and Technology (TUMSAT)
Gen Nakamura
Hiroto Murase
Joji Morishita

Fisheries Agency of Japan (FAJ)
Shingo Fukui
Masaki Kadota
Takeru Iida
Mitsuki Azeyanagi

Ministry of Foreign Affairs (MOFA)
KImihiko Okano
Yasushi Nakamura
Akihiro Tonai
Takayuki Hirashima

Ministry of Justice (MOJ)
Fumihiko Yanaka
Yohei Sakakibara
Natsuko Matsuyama

Interpreters
Hiroko Yasokawa
Saemi Baba

Inter-Governmental Organisations

ASCOBANS
Jenny Renell

CCAMLR
Steve Parker
Dirk Welsford
Nathan Walker
Marco Favero

CMS
Heidrun Frisch-Nwakanma

PICES
Tsutomu Tamura

SPAW-RAC
Claire Pusineri

SPREP
Karen Baird

Non-Governmental Organisations

Animal Welfare Institute
DJ Schubert
Sue Fisher

Associação R3 Animal
Cristiane Kolesnikovas
Emanuel Ferreira

Center for Biological Diversity
Dianne DuBois
Sarah Uhlemann

Centro de Conservación Cetacea
Elsa Cabrera

Comarino Mexico
Yolanda Alaniz

Environmental Investigation Agency
Clare Perry

Instituto Baleia Jubarte - Brazilian Humpback Whale Institute
Jose Palazzo
Luena Fernandes
Sergio Cipolotti

Instituto de Conservación de Ballenas
Roxana Schteinbarg
Camila Muñoz Moreda

ORCA
Lucy Babey

Paso Pacífico
Osmar Sandino
Sarah Otterstrom

WDC
Sarah Dolman

WWF
Chris Johnson
Colman O Criodain
Doris Woo
Leigh Henry
Nathalie Houtman
Umair Shahid
Stina Nyström
Uzma Khan

IWC Secretariat

Rebecca Lent
David Mattila
Elizabeth Campbell
Elsie Whittle
Emma Neave-Webb
Harriet Pinder
Iain Staniland
Imogen Webster
Isidora Katara
Jemma Jones
Jessica Rowley
Julie Creek
Kate Wilson
Lydia O'Loughlan
Marion Hughes
Mark Tandy
Moussa Sow
Nikki Bartmeier
Shanmugakani Ramachandran
Stella Duff
Stewart Thomas
Sue Burkett
Vanessa Steen

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 schedule
   - 1.5 Establishment of sub-committees

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 the Recommendations Database
   - 3.5 Review of Commission Resolutions from 2018

4. Cooperation with other organisations
   - 4.1 Summary of Secretariat co-operation with other organisations
   - 4.2 African States Bordering the Atlantic Ocean (ATLAFCO)
   - 4.3 Arctic Council
   - 4.4 Convention on Biological Diversity (CBD) [Secretariat]
   - 4.5 Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) [Secretariat]
   - 4.6 Convention on the Conservation of Migratory Species (CMS) [Secretariat]
     - 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) [Secretariat]
   - 4.9 Regional Fisheries Management Organizations (RFMOs)
     - 4.9.1 Inter American Tropical Tuna Commission (IATTC)
     - 4.9.2 Indian Ocean Tuna Commission (IOTC)
   - 4.10 International Council for the Exploration of the Sea (ICES) [Haug]
   - 4.11 International Maritime Organisation (IMO) [Leaper and Secretariat]
   - 4.12 International Union for the Conservation of Nature (IUCN) [Cooke, Reeves]
     - 4.12.1 IUCN Red List status of cetaceans [Braulik]
     - 4.12.2 Integrated Conservation Planning for Cetaceans [Abel/Taylor]
     - 4.12.3 IUCN Task Force on Marine Mammal Protected Areas (formerly ICMMPA) [Panigada and Mattila]
   - 4.13 North Atlantic Marine Mammal Commission (NAMMCO) [Secretariat, Moronuki]
   - 4.14 North Pacific Marine Science Organisation (PICES) [Tamara]
   - 4.15 Protocol on Specially Protected Areas and Wildlife (SPAW) of the Cartagena Convention for the Wider Caribbean [Nelson]
   - 4.16 Secretariat of the Pacific Regional Environmental Programme (SPREP) [Secretariat]
   - 4.17 Marine Traffic [Secretariat and Leaper]
   - 4.18 Other

5. General Assessment and Modelling Issues
   - 5.1 Use of ISTs for consideration of species' and populations' status
   - 5.2 Progress on previous recommendations
   - 5.3 Biennial workplan

6. AWMP and RMP *Implementation* related matters
   - 6.1 *Implementation Review* of West Greenland bowhead whales
   - 6.2 Plan for *Implementation Review* of West Greenland common minke whales
   - 6.3 *Implementation Review* of North Atlantic common minke whales
   - 6.4 Plan for *Implementation Review* of North Atlantic fin whales
   - 6.5 Progress on previous recommendations
   - 6.6 Biennial workplan

7. Stocks subject to Aboriginal Subsistence Whaling
   - 7.1 New information and progress on recommendations
     - 7.1.1 Eastern Canada/West Greenland bowhead whales
     - 7.1.2 Bering Chukchi Beaufort Seas bowhead whales
     - 7.1.3 North Pacific gray whales
     - 7.1.4 Common minke whale stocks off East Greenland
     - 7.1.5 Common minke whale stocks off West Greenland
     - 7.1.6 Fin whales off West Greenland
     - 7.1.7 Humpback whales off West Greenland (see Item 8.2.7)
     - 7.1.8 Humpback whales off St. Vincent and The Grenadines (see Item 8.2.7)
   - 7.2 Biennial workplan

8. Whale stocks not subject to directed takes by Contracting Governments
   - 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 Biennial workplan
   - 8.2 Potential new assessments: progress on previous recommendations and prioritised workplan
     - 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 North Atlantic humpback whales (see Items 6.1, 7.1.7 and 7.1.8)
     - 8.2.8 Rice's whales
     - 8.2.9 Biennial workplans
   - 8.3 New information (if provided) for other northern stocks
     - 8.3.1 North Atlantic blue whales
     - 8.3.2 North Atlantic common minke whales
     - 8.3.3 East Greenland Svalbard Barents Sea (Spitsbergen) bowhead whales
     - 8.3.4 Unusual mortality events affecting northern stocks (see Item 14.3.2)
     - 8.3.5 Biennial workplan
   - 8.4 New information (if provided) for other Southern stocks
     - 8.4.1 Southern Hemisphere humpback whales (if new information from Australia provided for estimating abundance of breeding stock D)
     - 8.4.2 Southern Hemisphere fin whales
     - 8.4.3 Biennial workplan
   - 8.5 Progress on previous recommendations
   - 8.6 Biennial workplan

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 SE Pacific southern right whales
     - 9.1.2 SW Atlantic southern right whales
     - 9.1.3 North Pacific gray whales
     - 9.1.4 Franciscana
     - 9.1.5 South American river dolphins
   - 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
9.3 Progress on previous recommendations
9.4 Biennial workplan

10. Stock definition and DNA testing
10.1 Provide advice to other sub-groups on population structure for requested stocks
10.1.1 North Pacific gray whales
10.1.2 Franciscana
10.1.3 *Sotalia guianensis*
10.2 DNA data quality
10.3 DNA guidelines checklist
10.4 Recommendations on the avoidance of sample depletion
10.5 Review terminology used for stock structure related terms used within the IWC
10.6 New genetic approaches (if submitted) for use by the Scientific Committee in addition to stock structure issues
10.7 Progress on previous recommendations
10.8 Biennial workplan

11. Cetacean abundance estimates and stock status
11.1 Review of abundance estimates
11.1.1 Bering Chukchi Beaufort bowhead whales
11.1.2 North Atlantic common minke whales
11.1.3 North Atlantic humpback whales
11.1.4 North Atlantic right whales
11.1.5 Eastern North Pacific gray whales
11.1.6 North Pacific sei whales
11.1.7 North Pacific blue whales
11.1.8 North Pacific humpback whales
11.1.9 Southern Hemisphere non-Antarctic blue whales
11.1.10 Antarctic blue whales
11.1.11 Southern Hemisphere right whales
11.1.12 Southern Hemisphere humpback whales
11.1.13 Franciscana
11.1.14 Finless porpoise
11.1.15 Other species/stocks identified intersessionally by SC Convenors
11.2 Update and review abundance table maintained by the IWC
11.3 Review and refine the abundance review process
11.4 Methodological issues
11.4.1 Amendments to RMP guidelines to consider model-based abundance estimates
11.4.2 Progress on simulation software to evaluate methods for abundance estimates
11.4.3 Consider diagnostic methods for mark recapture models
11.5 Provide advice to the Commission on the status of stocks
11.6 Review and provide advice on surveys (past and future)
11.7 Progress on previous recommendations
11.8 Biennial workplan

12. Bycatch and entanglements
12.1 IWC's Bycatch Mitigation Initiative
12.2 Collaboration on bycatch mitigation with IGOs (including FAO, Regional Fisheries Management Organisations and others)
12.3 Review new methods and estimates of bycatch and entanglement rates, risks and mortality
12.4 Reporting of bycatch and entanglements (both small and large cetaceans) including National Progress Reports
12.5 Review mitigation measures for preventing bycatch and entanglement
12.6 Review studies examining the implications of effort reductions on cetacean bycatch, fisheries economics and yields
12.7 Review of topics related to Hectors and Māui dolphins in New Zealand (with SM)
12.8 Consider definition of r_{max} for small cetaceans for use by the Scientific Committee
12.9 Progress on previous recommendations
12.10 Biennial workplan

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
    - 13.3 Co-operation with IMO Secretariat and relevant IMO committees
    - 13.4 Review progress for obtaining Automated Information System (AIS) data
    - 13.5 Progress on previous recommendations
    - 13.6 Biennial workplan

14. Environmental concerns
    - 14.1 Chemical pollution
        - 14.1.1 Review intersessional work on Pollution 2025 (Report on Workshop on Cumulative Effects)
        - 14.1.2 New information on pollution
    - 14.2 Diseases of concern
        - 14.2.1 Review progress in intersessional work on emerging diseases
        - 14.2.2 Special primer on coronavirus surveillance in aquatic wildlife
        - 14.2.3 Review new information on Diseases of Concern
    - 14.3 Strandings and mortality events
        - 14.3.1 Review progress of steering committee for IWC Strandings Initiative
        - 14.3.2 New information on unusual mortality events
        - 14.3.3 Other information
    - 14.4 Climate change
        - 14.4.1 Review report from intersessional workshop on climate change
        - 14.4.2 Review new information
    - 14.5 Underwater noise
        - 14.5.1 Review progress from intersessional work on impacts to cetaceans from underwater noise
        - 14.5.2 Review new information
    - 14.6 Marine debris
        - 14.6.1 Review progress on recommendations on marine debris
        - 14.6.2 Review new information
    - 14.7 Habitat alteration as anthropogenic impact on cetaceans
    - 14.8 SOCER report (Polar regions)
    - 14.9 Review strategy to better integrate E workplan with other Committee sub-groups
    - 14.10 Review strategy on developing and using a 'One Health' approach
    - 14.11 Progress on previous recommendations
    - 14.12 Biennial workplan

15. Ecosystem modelling
    - 15.1 Workshop on the Role of Cetaceans in Ecosystem Functioning: Gap Analysis
        - 15.1.1 Review outcomes and recommendations
    - 15.2 Review results of ecosystem modelling in the Antarctic Ocean and northeast Atlantic Ocean
    - 15.3 Review progress on estimating pre- exploitation and current abundance of large whale populations
    - 15.4 Progress on multi- species distribution models (MSDMs)
    - 15.5 Progress with development of individual- based energetic models (IBEMs)
    - 15.6 Modelling of competition among whales and relationships between whales and prey
    - 15.7 Standing topics
        - 15.7.1 Progress on considering effects of long- term environmental variability on whale populations
        - 15.7.2 Review progress on evaluation of krill distribution and abundance
    - 15.8 Progress on previous recommendations
    - 15.9 Biennial workplan

16. Small cetaceans
    - 16.1 Small cetacean use as aquatic wildmeat
        - 16.1.1 Discuss framework for progressing on identified issues/areas
        - 16.1.2 Review of other information
    - 16.2 Potential CMP for small cetaceans
        - 16.2.1 Asian river dolphins
    - 16.3 Progress on previous recommendations
        - 16.3.1 Finless porpoise

16.3.2 Atlantic humpback dolphin
16.3.3 Vaquita
16.3.4 Strait of Gibraltar killer whales
16.3.5 Management of the solitary sociable dolphin in northwest Spain
16.3.6 Lahille's dolphin
16.3.7 Review of previous recommendations
16.3.8 Other
16.4 South Pacific island small cetaceans
16.4.1 Review of SPREP work on small cetaceans
16.4.2 Threats to small cetaceans of the South Pacific islands
16.4.3 Workplan for future review of the small cetaceans of the South Pacific islands
16.5 Review direct takes and live captures of small cetaceans
16.5.1 Direct takes
16.5.2 Live captures
16.6 Status of the voluntary fund for small cetacean conservation research
16.7 Biennial workplan

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 issues of concern; and (v) emerging technologies
17.1.2 Review responses to MAWI questionnaire
17.2 Finalise IWC's General Principles for Whale Watching after intersessional discussion with the Conservation Committee and Secretariat
17.3 Progress with regional reviews of whale watching
17.3.1 Sri Lanka
17.3.2 Latin America
17.3.3 Timor-Leste
17.3.4 Indian Ocean Sanctuary
17.4 Collaborative work within the IWC
17.4.1 Update on IWC's Whale Watching Handbook
17.4.2 Communication with Conservation Committee's Standing Working Group on Whale Watching
17.4.3 Collaboration with other SC sub groups on platforms of opportunity and citizen science
17.5 Progress on previous recommendations
17.6 Biennial workplan

18. Whale sanctuaries
18.1 Updates from relevant sub committees on new information relevant to the Southern Ocean Sanctuary management plan
18.2 New information for Indian Ocean Sanctuary
18.3 Progress on previous recommendations
18.4 Biennial workplan

19. Extinction initiative

20. IWC List of Recognised Species

21. IWC databases and catalogues
21.1 Guidelines for IWC catalogues and photo ID databases
21.2 Progress with existing or proposed new catalogues
21.2.1 Right whale photo catalogues
21.2.2 Happywhale database
21.2.3 Flukebook
21.2.4 Southern Hemisphere Blue Whale Catalogue (SHBWC)
21.2.5 Antarctic Blue Whale Catalogue (ABWC)
21.2.6 Fin whale photo catalogues
21.2.7 Humpback whale photo catalogues
21.2.8 Other photo identification catalogues

21.3 Progress with existing IWC databases
- 21.3.1 Summary of IWC databases and current priorities
- 21.3.2 IWC National Progress Reports
- 21.3.3 Review database procedures, evaluate possible integration and consolidation of existing databases, and define rules for accessing data

21.4 Potential future IWC databases
- 21.4.1 IWC database proposal pro forma
- 21.4.2 New proposals for IWC databases

21.5 Biennial workplan

22. Multinational research programmes and national research cruises that require IWC endorsement
- 22.1 IWC-POWER and co-operation with Japan
- 22.2 Southern Ocean Research Partnership (IWC-SORP)
- 22.3 IWC-ATLAFCO collaboration for capacity building and cetacean surveys
- 22.4 National cruises that require IWC oversight
- 22.5 Review and provide advice on plans for future surveys
- 22.6 Biennial workplan

23. Scientific Committee budget for the current and next biennium

23.1 Status of funded research, workshop proposals, data processing and computing needs
- 23.1.1 Funded proposals for 2022
- 23.1.2 Funded proposals in previous years still ongoing
- 23.1.3 Report on fund reallocations and contingencies for the Research Fund, Voluntary Fund for Small Cetaceans and SORP Voluntary Fund

23.2 Proposed budget for 2023-2024 developed under the Committee's guidelines

24. Committee priorities for the biennium 2023-24 and initial agenda for 2023

25. Working methods of the Committee
- 25.1 Updates on Rules of Procedure and Handbook of the Scientific Committee
- 25.2 Reporting to the Commission and related matters
- 25.3 Capacity building and succession plan for Scientific Committee
- 25.4 Update on Data Availability requests and consideration of potential updates/clarifications
- 25.5 Committee involvement in the IWC recommendations database
- 25.6 Governance review
- 25.7 Joint Conservation Committee-Scientific Committee Working Group
- 25.8 Any other matters
- 25.9 Biennial workplan

26. Publications

27. Adoption of Report

Annex C

List of Documents

SC/68D/ASI/

01. Ferguson, M.C., Miller, D.L., Clarke, J.T., Brower, A.A., Willoughby, A.L. and Rotrock, A.D. Spatial modeling, parameter uncertainty, and precision of density estimates from line-transect surveys: a case study with Western Arctic bowhead whales. 53pp.
02. Hakamada, T., Takahashi, M., Katsumata, T. and Matsuoka, K. Research plan for Japan's dedicated cetacean sighting surveys in the North Pacific Ocean in summer 2022. 9pp.
03. Murase, H., Gilpatrick, J.W., Yoshimura, I. and Eguchi, H. Cruise report of the 2021 IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER) 35pp.
04. Matsuoka, K., Isoda, T., Katsumata, T., Takahashi, M., Hakamada, T. and Pastene, L.A. Outline of the research plan for the 2022/2023 JASS-A survey in Area VIE 10pp.
05. Katsumata, T., Yamaguchi, F., Yoshimura, I., Nagata, R., Teruya, S., Maehashi, K., Sawada, N., Ohmukai, R., Kawabe, S. and Matsuoka, K. Results of the Japanese dedicated cetacean sighting surveys in the North Pacific in 2021/2022 spring, autumn, and winter seasons. 13pp.
06. Katsumata, T., Takahashi, M., Teruya, S., Watanabe, R. and Matsuoka, K. Results of the Japanese dedicated cetacean sighting surveys in the North Pacific in 2021 summer season. 19pp.
07. Øien, N. and Leonard, D. Report of the Norwegian 2021 survey for minke whales in the Small Management Area CM-the Jan Mayen area. 9pp.
08. NO PAPER.
09. Lee, J.H., Kim, E.H., Yoo, J.T., Lee, K.L., Ku, J.E., Han, I.W. and Choi, S.G. Plan for the Korean Sighting Survey in Korean waters in 2022-2023. 7pp.
10. Isoda, T., Katsumata, T., Ueta, E., Kasai, H. and Matsuoka, K. Results of the Japanese Abundance and Stock structure Survey in the Antarctic (JASS-A) during the 2021/2022 austral summer season. 29pp.
11. Gushcherov, P.S., Naberezhnykh, I.A., Bashtovoy, A.N., Kenin, M.D., Katugin, O.N., Belokobylskiy, I.F. and Miyashita, T. Cruise report of the cetacean sighting survey in the northern part of the Sea of Okhotsk in 2021. 25pp.
12. Gushcherov, P.S., Naberezhnykh, I.A., Katugin, O.N. and Miyashita, T. Research plan of the cetacean sighting survey in the southwestern Sea of Okhotsk in 2022. 6pp.

SC/68D/ASW/

01. Scheimreif, K., Citta, J., Stimmelmayr, R., Sformo, T.L., Olemaun, F., Anashugak, P., VonDuyke, A.L., Acker, R., Person, B.T., Sousa, L., Agnasagga, L., SimsKayotuk, C., Kanayurak, N., George, C. and Suydam, R. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Natives during 2021. 10pp.
02. Sidorov, L.K., Litovka, D.I. and Vereshagin, E.V. Aboriginal subsistence whaling in the Russian Federation during 2021. 3pp.
03. Stimmelmayr, R., Citta, J., Scheimreif, K., Ferguson, M., Givens, G.H., Willoughby, A., Brower, A., Von Duyke, A., Sheffield, G., Person, B., Sformo, T., de Sousa, L. and Suydam, R. 2020-2021 health report for the Bering-Chukchi-Beaufort Seas bowhead whales. 38pp.

SC/68D/CMP/

01. Rojas-Cerda, C., Buchan, S., Galletti Vernazzani, B., Vega, M. and Perez-Santos, I. Assessment of Southern right whale (*Eubalaena australis*) acoustic presence off northwestern Chiloé Island and Arauco Gulf, Chile. 12pp.
02. Crespo, E.A., Coscarella, M.A., Arias, M., Sueyro, N. and González, R.C. Population dynamics of southern right whales at Península Valdés and Golfo San Matías, Argentina: rates of increase and changes in distribution. 17pp.
03. Moazzam, M. and Nawaz, R. Sightings of whales in the Northern Arabian Sea along the coast of Pakistan in 2021. 8pp.
04. Minton, G., Anderson, R.C., Baldwin, R., Bohadi, Y., Cerchio, S., Collins, T., al Lawati, R., Kiani, M.S., Manickam, N., Moazzam, M., Mohsenian, N., Moshiri, H., Nanayakkara, R., Natoli, A., Razzaque, S.A., Rosenbaum, H., al Sayegh, H., Sutaria, D., de Vos, A., Willson, M.S. and Willson, A. Progress Report from the Arabian Sea Network. 14pp.

04rev1. Minton, G., Anderson, R.C., Baldwin, R., Bohadi, Y., Cerchio, S., Collins, T., al Lawati, R., Kiani, M.S., Manickam, N., Moazzam, M., Mohsenian, N., Moshiri, H., Nanayakkara, R., Natoli, A., Razzaque, S.A., Rosenbaum, H., al Sayegh, H., Sutaria, D., de Vos, A., Willson, M.S. and Willson, A. Progress Report from the Arabian Sea Network. 14pp.

05. Baird, R.W., James, J., Mata, C.C. and Hughes, M. Two gray whale sightings off Hawai'i Island: the first records for the central tropical Pacific. 6pp.

06. Galletti Vernazzani, B. IWC Eastern South Pacific Southern Right Whale Conservation Management Plan – Progress Report April 2022. 5pp.
07. Nakamura, G., Iida, T., Yoshida, H., Katsumata, T., Matsuoka, K., Bando, T. and Kato, H. Status Report of Conservation and Research on the western North Pacific Gray Whales in Japan, May 2021 - April 2022. 6pp.
08. Valerio-Conchas, M., Martínez-Aguilar, S., Swartz, S.L. and Urbán R., J. Gray whale's body condition in Laguna San Ignacio, BCS, México for winter breeding season 2022. 8pp.
09. Martínez-Aguilar, S., Urbán R., J., Weller, D., Tyurneva, O., Bradford, A., Burdin, A., Lang, A., Swartz, S., Sychenko, O., Viloria-Gómora, L., Hernández, E. and Yakovlev, Y. Gray whale (*Eschrichtius robustus*) migratory movements between the western North Pacific and the Mexican breeding grounds: 2022 update. 10pp.
10. Martínez-Aguilar, S., González-Cisneros, A., Valerio-Conchas, M., Rodríguez González, F.M., Lobo-Barrera, R., Zamora-Zavala, L.A., Olguín-Hernández, J.A., Castillo Romero, F., Zaragoza-Aguilar, G.A., Rivera-Rodríguez, J., Mariano-Meléndez, E., López-Paz, N., Swartz, S., Viloria-Gómora, L. and Urbán R., J. Gray whale stranding records in Mexico, during the 2022 winter breeding season. 12pp.
11. Willson, A., Ashok, K., Baldwin, R., Cerchio, S., Christensen, F., Collins, T., al Jabri, A., al Lawati, R., Leslie, M., Minton, G., Van Bressem, M.F., al Riyami, S. and Willson, M.S. Oman cetacean research and conservation activities status update 2022. 13pp.
12. Urbán R., J., Martínez-Aguilar, S., Viloria-Gómora, L. and Swartz, S. Gray whale abundance in Laguna San Ignacio and Bahía Magdalena lagoon complex, B.C.S., México for 2022 breeding season. 15pp.
13. Reeves, R., Donovan, G. and Weller, D. Western Gray Whale Advisory Panel: Closing Statement. 5pp.
14. Fauquier, D., Raverty, S., Cottrell, P., MacConnachie, S., Urbán R., J., Viloria-Gómora, L., Martínez-Aguilar, S., Swartz, S., Huggins, J.L., Rice, J., Halaska, B., Flannery, M., Danil, K., Savage, K., Garner, M., Duignan, P., Burek Huntington, K.B., Weller, D., Stewart, J., Lefebvre, K., Gulland, F., Goldstein, T., Calambokidis, J., Moore, S., Goley, D., Lui, A., Baker, J., Wilkinson, K., Viezbicke, J., Greenman, J., Keogh, M., Greig, D., Wilkin, S. and Rowles, T. Update on the Eastern North Pacific gray whale (*Eschrichtius robustus*) 2019-2022 Unusual Mortality Event. 7pp.
15. Burdin, A., Sychenko, O. and Kunitsa, A. Gray whale research in 2021 off northeastern Sakhalin Island and Eastern Kamchatka, Russia. 14pp.
16. Burdin, A. and Weller, D. Photo-identification catalogue of western gray whales 1994-2001. 3pp.
17. Crespo, E.A., Arias, M., Sueyro, N., Grandi, M.F. and Coscarella, M.A. Abundance estimation of franciscana dolphins by means of aerial surveys in Buenos Aires Province, Argentina. 11pp.

SC/68D/E/

01. Plön, S., Roussouw, N., Uren, R., Naidoo, K., Siebert, U. and Bouwman, H. Report to IWC Annual Scientific Committee Meeting: Metal concentrations of three dolphin species incidentally caught in bather protection nets off KwaZulu-Natal, South Africa. 14pp.
02. Plön, S., Norman, S., Adam, P.A., Andrianarivelo, N., Bachoo, S., Braulik, G., Collins, T., Estrade, V., Griffiths, O., Inteca, G., Khan, N., Marinesque, S., Mederic, E., Mwang'ombe, M., Olbers, J., Ramoelintsalama, L., Reeve-Arnold, K., Rocha, D., Gullan, A.D., Saloma, A., Vermuelen, E., Vitry, H., Wilkinson, C. and Dulau, V. Spatio-temporal trends in cetacean strandings and response in the southwestern Indian Ocean region - 2000 to 2020. 27pp.
03. Ferguson, S.H., Young, B.G., Thiemann, G.W., Higdon, J.W., Raverty, S. and Houde, M. Unusual mortality of bowhead whales of the Eastern Canada-West Greenland population in Nunavut, Canada in autumn 2020. 38pp.
04. Marcondes, M.C.C., Barreto, A.S., Colosio, A.C., Kolesniskovas, C.K.M., Ramos, H.G.C., Secchi, E., Seyboth, E. and Wedekin, L.L. Spatial and long-term trends in the strandings of humpback whales in Brazil breeding ground. 11pp.
05. Hanniger, E.M., Selling, J., Heyer, K. and Burkhardt-Holm, P. Injuries, emaciation and skin conditions in cetaceans of the Strait of Gibraltar. 29pp.

05rev1. Hanniger, E.M., Selling, J., Heyer, K. and Burkhardt-Holm, P. Injuries, emaciation and skin conditions in cetaceans of the Strait of Gibraltar. 29pp.

06. NO PAPER.
07. NO PAPER.
08. IJsseldijk, L.L. Summary: unusual mortality event of harbour porpoises in the Netherlands. 3pp.

08rev1. IJsseldijk, L.L. Summary: unusual mortality event of harbour porpoises in the Netherlands. 3pp.

09. Leaper, R., Iñiguez, M. and Webster, I. Collaboration with IMO on reducing underwater noise from shipping. 7pp.
10. Simmonds, M.P. and Nunny, L. The less expected consequences of climate change for cetaceans. 8pp.
11. Litovka, D.I., Naidenko, S.V., Mamaev, M.S., Klyuchnikova, P.S., Kovekovdova, L.T., Blokhin, S.A., Voronin, V.P., Murzina, S.A. and Semenikhin, A.V. Toxicology researches and monitoring of gray whales off Chukotka Peninsula (Russia), 2008-2021. 4pp.
12. Stachowitsch, M., Rose, N.A. and Parsons, E.C.M. State of the Cetacean Environment Report (SOCER) 2022. 24pp.
13. Mazzariol, S. Update on progress of the IWC Strandings Initiative May 2021-April 2022. 4pp.

14. Galletti, B., Uhart, M., Fisher, S., Burkhardt-Holm, P., Alaniz, Y., Avila, I.C., Cabrera, E., Fernandez, A., Rodríguez Fonesca, J., Gulland, F., Mazzariol, S., Pulpillo, E.M.S., Rowles, T. and Stimmelmayr, R. Advances on Intersessional Correspondence Group (ICG) on One Health Approach. 5pp.

SC/68D/EM/

01. Freitas, C., Gundersen, K., Lindblom, L., Biuw, M. and Haug, T. Nutrient concentrations in minke whale faeces and the potential impact on dissolved nutrient pools off Svalbard, Norway. 24pp.

SC/68D/GDR/

01. Staniland, I.J., Tandy, M., Webster, I., Sow, M.K., Katara, I. and O'Loughlin, L. Databases and data holdings in the IWC: A review of the current status, issues and future plans. 11pp.

SC/68D/HIM/

01. Svoboda, A.M. and Pierce, G. Coordinated Development and Implementation of Best Practice in Bycatch Reduction in the North Atlantic Region (CIBBRiNA) – project update 3pp.
02. Dolman, S.J., Carlen, I., Adams, C., del Castillo, C., Condon, J. and Pierce, G. Cetacean bycatch efforts in European waters. 9pp.
03. IWC. Draft Strategic Plan to Mitigate the Impacts of Ship Strikes on Cetacean Populations: 2022-2032. 23pp.
04. Welsford, D., Walker, N., Favero, M., Krafft, B., Darby, C. and Parker, S. CCAMLR – IWC coordination: Incidents of whale bycatch in the Antarctic krill fishery. 49pp.
05. Carlén, I., Berggren, P., Cosentino, M., Dolman, S.J., Leaper, R., Parsons, E.C.M., Plön, S. and Simmonds, M.P. Additional measures are needed to minimise bycatch of the critically endangered Baltic Sea subpopulation of harbour porpoise *Phocoena phocoena*. 5pp.
06. Livermore, S., Leaper, R., Webster, I. and O'Loughlin, L. Progress of IWC work on ship strikes. 12pp.
07. Gahm, M., Long, K., Good, C., Matzen, E., Milliken, H. and Hayes, S. U.S. efforts to develop ropeless fishing gear technology 8pp.
08. Peltier, H., Authier, M., Dabin, W., Dars, C., Demarte, F., Doremus, G., Laran, S., Mendez-Fernandez, P., Meheust, E., Ridoux, V., Spitz, J. and Van Canneyt, O. Common dolphin mortalities in fisheries off the French Atlantic coast in the winter 2021: combining stranding and aerial survey data. 7pp.
09. IWC Secretariat. Bycatch Mitigation Initiative - 2022 update on progress. 7pp.
10. Pierce, G.J., Petitguyot, M.A.C., Gutiérrez-Muñoz, P., Fernández-Fernández, D., Fariñas-Bermejo, A., Read, F.L., Saavedra, C., López, A. and Martínez-Cedeira, J. Iberian harbour porpoise - an update on fishery bycatch mortality. 15pp.
11. Cha, B.J., Kim, H.Y. and Kang, D. Research plan to mitigation bycatch. 2pp.
12. Kim, H.Y., Lee, G.H. and Kim, S. Monitoring of bycatch mitigation items for finless porpoise 4pp.
13. Johnson, C., Reisinger, R., Palacios, D., Friedlaender, A., Willson, A., Zerbini, A., Lancaster, M., Battle, J., Graham, A., Cosandey-Godin, A., Jacob, T., Felix, F., Grilly, E., Shahid, U., Houtman, N., Alberini, A., Montecinos, Y., Najera, E. and Kelez, S. Protecting Blue Corridors – a collaborative international report highlighting the challenges and solutions for migratory whales navigating national and international seas. 7pp.
14. Torres-Pereira, A., Araújo, H., Bastos-Santos, J., Sá, S., Lídia Nicolau, L., Marçalo, A., Marques, C., Ferreira, M., Covelo, P., Martínez-Cedeira, J., López, A., Sequeira, M., Vingada, J. and Eira, C. Assessment of harbour porpoise bycatch along the Portuguese and Galician coast: insights from strandings over two decades. 23pp.

14rev1. Torres-Pereira, A., Araújo, H., Bastos-Santos, J., Sá, S., Lídia Nicolau, L., Marçalo, A., Marques, C., Ferreira, M., Covelo, P., Martínez-Cedeira, J., López, A., Sequeira, M., Vingada, J. and Eira, C. Assessment of harbour porpoise bycatch along the Portuguese and Galician coast: insights from strandings over two decades. 23pp.

15. Panigada, S. Extract from the final report of the project: "Develop and evaluate mitigation strategies to reduce the risk of ship strikes to fin and sperm whales in the Pelagos Sanctuary". 8pp.
16. Panigada, S. Steps towards the designation of a Particularly Sensitive Sea Area (PSSA) in the North-Western Mediterranean Sea. 4pp.
17. Torres-Pereira, A., Araújo, H., Matos, F.L., Bastos-Santos, J., Sá, S., Ferreira, M., Martínez-Cedeira, J., Lopez, A., Sequeira, M., Vingada, J. and Eira, C. Harbour porpoise abundance in Portugal over a 5-year period and estimates of potential distribution. 38pp.

SC/68D/IA/

01. Mueller-Brennan, L.E., Busquets-Vass, G., Newsome, S. and Palacios, D.M. A preliminary analysis of stable isotope data from satellite tagged humpback whales in the North Pacific. 17pp.
02. Cheeseman, T., Baker, C.S., Calambokidis, J., Clapham, P., Steel, D., Lizewski, K., Ivashchenko, Y., Palacios, D.M., Palka, D., Privitera-Johnon, K., Punt, A.E., Wade, P.R. and Weinrich, M. Summary of data currently available for an assessment of North Pacific humpback whales. 18pp.

03. Wade, P.R., Quinn, T.J., Barlow, J., Baker, C.S., Burdin, A.M., Calambokidis, J., Clapham, P.J., Falcone, E.A., Ford, J.K.B., Gabriele, C.M., LeDuc, R., Mattila, D.K., Rojas-Bracho, L., Straley, J.M., Taylor, B.L., Urbán R., J., Weller, D., Witteveen, B.H. and Yamaguchi, M. Revised estimates of abundance and migratory destination for North Pacific humpback whales in both summer feeding areas and winter areas. 25pp.

03rev1. Wade, P.R., Quinn, T.J., Barlow, J., Baker, C.S., Burdin, A.M., Calambokidis, J., Clapham, P.J., Falcone, E.A., Ford, J.K.B., Gabriele, C.M., LeDuc, R., Mattila, D.K., Rojas-Bracho, L., Straley, J.M., Taylor, B.L., Urbán R., J., Weller, D., Witteveen, B.H. and Yamaguchi, M. Revised estimates of abundance and migratory destination for North Pacific humpback whales in both summer feeding areas and winter areas. 25pp.

04. Doniol-Valcroze, T. Sightings of sei whales (*Balaenoptera borealis*) in Pacific Canadian waters from systematic surveys conducted in 2018-2021. 4pp.

05. Lizewski, K., Steel, D., Urbán R., J., Calambokidis, J. and Baker, C.S. Mixed-stock apportionment of humpback whales in the North Pacific based on mtDNA haplotypes and microsatellite genotypes. 12pp.

06. Punt, A.E. and Privitera-Johnon, K. A very preliminary set of results for the B1F2 hypotheses. 13pp.

07. Allison, C., de Moor, C.L., Katara, I. and Punt, A.E. Ongoing work towards an In-Depth Assessment of western North Pacific Minke whales. 68pp.

SC/68D/NH/

01. Cholewiak, D., Linden, D. and Pace, R.M., III. Population status updare for North Atlantic right whales: 2021-2022. 7pp.

02. Lisi, N.E., Bettridge, S., Borggaard, D., Coogan, C., Daly, J., Fauquier, D., Good, C., Grewal, C., Harrison, J., Long, K.J., Patterson, E.M., Sisson, N.B., Spradlin, T.R., Trego, M.L., Wilkin, S. and Zoodsma, B. U.S. management efforts to recover North Atlantic right whales: 2021-2022 updates. 12pp.

03. Soldevilla, M., Garrison, L., Engleby, L. and Zoodsma, B. Update on the Gulf of Mexico Bryde's whale/Rice's Whale Research and Conservation - 2021-2022. 4pp.

SC/68D/O/

01. Braulik, G., Taylor, B., Minton, G., Cooke, J., Notarbartolo di Sciara, G. and Reeves, R. Red List status of cetaceans - March 2022. 8pp.

02. Japan. Japan's Scientific Progress Reports on large cetaceans. 2pp.

03. IWC Secretariat. Update on cooperation with other organisations. 8pp.

04. IWC Secretariat. Report on the Research Fund financial position. 8pp.

04rev1. IWC Secretariat. Report on the Research Fund financial position. 8pp.

05. IWC Secretariat. Cooperation with other organisations. 18pp.

05rev1. IWC Secretariat. Cooperation with other organisations. 18pp.

06. Burkett, S., Whittle, E., Katara, I. and Allison, C. Catches reported for the 2021 season. 2pp.

06rev1. Burkett, S., Whittle, E., Katara, I. and Allison, C. Catches reported for the 2021 season. 2pp.

06rev2. Burkett, S., Whittle, E., Katara, I. and Allison, C. Catches reported for the 2021 season. 2pp.

SC/68D/SDDNA/

01. Goto, M. and Taguchi, M. An update of the Japanese DNA register for large whales. 4pp.

02. Martien, K.K., Taylor, B.L., Lang, A.R., Clapham, P.J., Weller, D.W., Archer, F.I. and Calambokidis, J. The migratory whale herd concept: A novel unit to conserve under the ecological paradigm. 44pp.

03. Van Cise, A.M., Switzer, A.D., Apprill, A., Champagne, C.D., Chittaro, P.M., Dudek, N.K., Gavery, M.R., Hancock-Hanser, B.L., Harmon, A.C., Kellar, N.M., Miller, C.A., Morin, P.A., Nelms, S.E., Robertson, K.M., Schultz, I.R., Timmins-Schiffman, E., Unal, E. and Parsons, K.M. Best practices for collecting and preserving marine mammal biological samples in the 'omics era. 39pp.

04. Sanchez, M.Q. and Skaug, H.J. Population genetic structure in the minke whale, *Balaenoptera acutorostrata acutorostrata* in the North East Atlantic: Fifteen years of data. 16pp.

SC/68D/SH/

01. Field, V.R., Burkhardt, E. and Van Opzeeland, I. Geographic variation in fin whale (*Balaenoptera physalus*) calls in the Weddell Sea, Antarctica. 15pp.

02. Vermeulen, E., Wilkinson, C. and Germishuizen, M. Report of the southern right whale aerial surveys - 2021. 24pp.

03. Vermeulen, E., van Jaarsveld, C. and Carroll, E. Desktop review of southern right whale (*Eubalaena australis*) off-shore sightings south of 40°S (1980-2020). 36pp.

04. Galletti Vernazzani, B., Olson, P.A. and Salgado-Kent, C. Progress report on Southern Hemisphere Blue Whale Catalogue: Period April 2021-March 2022. 13pp.

05. NO PAPER.

06. Butterworth, D., Cooke, J., Charlton, C., Vermeulen, E., Ross-Gillespie, A., Brandão, A., Groch, K., Leaper, R., Rayment, W., Rowntree, V., Sironi, M., Agrelo, M., Watson, M., Carroll, E.L., Carlyon, K., Burnell, S., Double, M. and Jackson, J. Intersessional working group report: Multi-ocean assessment of southern right whale demographic parameters and environmental correlates. 11pp.

07. Bell, E.M. Annual Report of the Southern Ocean Research Partnership (IWC-SORP) 2021/22. 120pp.
07rev1. Bell, E.M. Annual Report of the Southern Ocean Research Partnership (IWC-SORP) 2021/22. 120pp.
08. Bell, E.M. IWC-SORP Research Fund: 2022 progress reports from funded projects. 115pp.
08rev1. Bell, E.M. IWC-SORP Research Fund: 2022 progress reports from funded projects. 115pp.
09. Olson, P.A., Andrews-Goff, V., Double, M.C., Matsuoka, K. and Pastene, L.A. Movements of Antarctic blue whales derived from Discovery tag, photo-ID, and satellite tag data. 11pp.
10. Galletti Vernazzani, B., Cabrera, E., Olson, P., Español-Jimenez, S., Toro, F., Perez-Alvarez, M.J., Pavez, G., Moraga, R., Cortés-Peña, D., Clegg, I.L.K., Häussermann, V., Findlay, K., Wright, S. and Brownell, R.L., Jr. Blue whale photo-identifications reveal strong site fidelity to feeding areas from the Southeast Pacific and connectivity between southern Chile and Eastern Tropical Pacific. 12pp.
11. Busquets-Vass, G., Carroll, E.L., Lubcker, N., Constantine, R., Childerhouse, S., Baker, S., Dunshea, G., Hindell, M. and Newsome, S. A promising tool to infer the protein balance and reproductive status of the capital breeding southern right whale. 12pp.
12. Hoschle, C., MacLeod, K., Mahjoub, B., Kosarev, V., Humphries, G., Voss, J., Carroll, E.L., Constantine, R., Childerhouse, S., Lundquist, D., Riekkola, L. and Nehls, G. Satellite surveys prove a reliable monitoring method for high latitude southern right whale habitat. 11pp.
13. Rand, Z.R., Branch, T.A. and Jackson, J.A. Movement rates of Antarctic blue whales from Discovery marks. 16pp.

SC/68D/SM/

01. Al Sayegh, H. Kuwait marine mammal strandings for 2014. 9pp.
02. NO PAPER.
03. Esteban, R., López, A., de los Rios, G., Ferreira, M., Martinho., F., Méndez-Fernandez, P., Andréu, E., García-Gómez, J.C., Olaya-Ponzone, L., Espada-Ruiz, R., Gil-Vera, F.J., Martín Bernal, C., Garcia-Bellido Capdevila, E., Sequeira, M., Marçalo, A. and Martínez-Cedeira, J.A. Update on the interactions between killer whales and vessel along the Iberian Peninsula. 7pp.
04. Kratofil, M.A., Mahaffy, S.D. and Baird, R.W. Photo-identification-based age estimation of false killer whales utilizing information on sex, relative size, markings, and morphology. 12pp.
05. Gushcherov, P.S., Tiupeleev, P.A., Naberezhnykh, I.A. and Katugin, O.N. White whale (*Delphinapterus leucas,* Pallas 1776) migration travel pattern during readaptation to the natural environment. 11pp.
05rev1. Gushcherov, P.S., Tiupeleev, P.A., Naberezhnykh, I.A. and Katugin, O.N. White whale (*Delphinapterus leucas,* Pallas 1776) migration travel pattern during readaptation to the natural environment. 11pp.
06. Rojas-Bracho, L., Taylor, B.L., Jaramillo-Legorreta, A., Barlow, J., Gerrodette, T. and Henry, A. Survey report for vaquita research 2021. 15pp.
07. Rojas-Bracho, L., Booth, C., Taylor, B., Thomas, L., Jaramillo-Legorreta, A., Mesnick, S., Gerrodette, T. and Henry, A. Report using expert elicitation to estimate total unique vaquitas and calves seen in the Zero Tolerance Area during the 2021 survey. 35pp.
08. Fruet, P.F., Daura-Jorge, F., Laporta, P., Coscarella, M.A., Vermeulen, E., Ott, P.H., Berninsone, L., Genoves, R.C., Moreno, I.B., Failla, M., Flores, P.A.C., Iñíguez, M., Pretto, D.J., Machado, R., Perez, M.S., Bezamat, C., Secchi, E.R., Volkmer de Castilho, P., Barreto, A.S., Carrion, M., Frainer, G. and Di Tullio, J.C. Progress report on the research and conservation of Lahille's bottlenose dolphins - 2021. 10pp.
09. Taylor, B.L., Barlow, J., Breese, D., Gerrodette, T., Henry, A., Hoefer, C., Jefferson, T., Mesnick, S.L., Olson, P., Payne, A., Pitman, R., Triana, F., Vázquez, E., Ü, A., Weber, M. and Yin, S. Illegal gillnetting remains a serious threat to vaquitas. 10pp.
09rev1. Taylor, B.L., Barlow, J., Breese, D., Gerrodette, T., Henry, A., Hoefer, C., Jefferson, T., Mesnick, S.L., Olson, P., Payne, A., Pitman, R., Triana, F., Vázquez, E., Ü, A., Weber, M. and Yin, S. Illegal gillnetting remains a serious threat to vaquitas. 10pp.
10. Jaramillo-Legorreta, A., Nieto-García, E., Cárdenas-Hinojosa, G., Arellano, D., Rojas-Bracho, L. and de la Cueva, H. Vaquita population acoustic monitoring season 2021. 9pp.
11. Taylor, B.L., Abel, G., Bader, D., Barlow, J., Braulik, G., Cipriano, F., Collins, T., DeMaster, D., von Fersen, L., Gomez, F., Hao, Y., Miller, P.S., Minton, G., Reeves, R.R., Rojas-Bracho, L., Secchi, E., Smith, C.R., Wang, D. and Wells, R.S. Integrated Conservation Planning for Cetaceans: 2022 Update. 7pp.
12. Minton, G., Keith-Diagne, L., Seck, D., Cerchio, S., Tregenza, N., Kamla, A.T., Eniang, E., Senhoury, C., Sallah-Muhammed, Y., Lene, A. and Cristiano, N. Preliminary results of 2021 and 2022 *Sousa teuszii* surveys in the Saloum Delta, Senegal. 17pp.
13. da Silva, H.F.G., da Silva, V.M.F., de Souza, I.S., Picaluga, A.S., Valdevino, G.C.M., Bisi, T., Lailson-Brito, J. and Cunha, H.A.C. Genetic and toxicological analyses show that the Brazilian moratorium on the catfish piracatinga (*Calophysus macropterus*) has been ineffective and its consumption can pose a health risk. 27pp.
14. Khan, U., Khan, A.H., Mogha, Z., Malik, M.I. and Akram, U. First successful satellite tagging of a river dolphin in Asia: movements of Indus River dolphin *Platanista minor* in the Indus River, Sindh Province, Pakistan. 10pp.

14rev1. Khan, U., Khan, A.H., Mogha, Z., Malik, M.I. and Akram, U. First successful satellite tagging of a river dolphin in Asia: movements of Indus River dolphin *Platanista minor* in the Indus River, Sindh Province, Pakistan. 10pp.
15. Brum, S., Gil, N. and da Silva, F.V.M. One trip, too many threats: evidence of interactions with fisheries threatening river dolphins in central Amazon. 10pp.
16. Beasley, I., Amepou, Y. and Mavea, W. Unsustainable inshore dolphin by-catch in gillnet fisheries in the Kikori Delta, Papua New Guinea: a lucrative swim-bladder fishery causing marine megafauna population declines. 7pp.

SC/68D/WW/

01. Wulff, R. and Webster, I. Update from the Whale Watching Standing Working Group. 12pp.
02. Arias, M., González, R.A.C., Crespo, E.A. and Sapriza, F.G.R. E-Whale: intergrating citizen-science and mobile web app as a tool for the conservation of cetaceans in San Matias Gulf, Rio Negro Province, Argentina. 15pp.
03. NO PAPER.
04. Coscarella, M.A. and Riera, M.G. Prospective new whale watching site based on sei (*Balaenoptera borealis*) and other whale species in Punta Marqués (Chubut Province, Argentina). 8pp.

REPORTS FROM INTERSESSIONAL WORKSHOPS

SC/68D/REP/

01. Report of the IWC Climate Change Workshop, 30 November-3 December 2021, virtual meeting. 50pp.
02. Report of the Pollution 2025 IWC Intersessional Workshop, 1-4 November 2021, virtual meeting. 38pp.
03. Report of the IWC-POWER Planning Meeting, 9-10 December 2021, virtual meeting. 23pp.

RESEARCH PROPOSALS

SC/68D/RP/

01. ASI: IWC-POWER cruise in 2023 and 2024 including associated workshop/meetings and processing. 10pp.
02. ASI: Annual Meeting of the Abundance Steering Group: Review of Estimates and Status of Stocks Website. 8pp.
03. WW: Communicating the science of sustainable, responsible whale watching. 5pp.
04. SH: Assessing movement rates of Southwest Atlantic southern right whales between Argentina and Brazil. 6pp.
05. SH: Assessment of Antarctic blue whales. 9pp.
06. SH: Mark recapture analysis of Southern Hemisphere blue whale photo-ID datasets to estimate regional abundance. 7pp.
07. SH: Southern right whale catch series, stock structure and catch allocation review workshops. 10pp.
08. SH: Southern Hemisphere Blue Whale Catalogue 2023-2024. 8pp.
09. SH: Passive acoustic monitoring of cetaceans from the former Durban whaling ground, western Indian Ocean. 7pp.
10. SH: Rock ‘n Whales: can we detect blue and fin whale acoustic presence from a land-based seismic station in the equatorial Atlantic Ocean? 9pp.
11. IA/IST: Essential computing support to the Secretariat for IA and IST for assessments of several species. 6pp.
12. IA/NP: Assessment modelling for in-depth assessments of North Pacific sei and humpback whales – 2022 to 2024. 6pp.
13. HIM: Progressing the development and use of the IWC Ship Strikes Database. 9pp.
14. GDR: Ongoing SC database hosting and server management by IWC Secretariat. 6pp.
15. SM: Assessment of the traditional drive-hunt in the Solomon Islands: Collaborating with Indigenous communities and updating the IWC Direct Take Database 9pp.
16. CMP: Passive Acoustic Monitoring of the Eastern South Pacific Southern Right Whale CMP - Outputs 2023/2024 9pp.
17. CMP: Development of a GIS (meta) database on information on human activities that might have an adverse impact on Southern right whales. 11pp.
18. CMP: Assessment of spatio-temporal distribution of humpback whale and blue whale song along the Arabian Sea coast of Oman. 12pp.
19. CMP: Continuation of field deployments in 2023-2024 for Passive Acoustic Monitoring for humpback, blue and other baleen whales off Oman. 13pp.
20. E: Compilation of the State of the Cetacean Environment Report (SOCER) for 2023-2024 including the 2nd 5-year global compendium. 5pp.
21. E: Climate Change Workshop part II. 10pp.
22. E: Contaminant Mapping in Cetaceans: Review of spatial and temporal trends in POPs and heavy metals. 5pp.
23. NH: Review of the Spanish statistics in the IWC catch database. 5pp.
24. NH: Assessing endangered baleen whales in the eastern North Atlantic through Passive Acoustic Monitoring off Senegal, West Africa. 10pp.
25. SAN: Southern Ocean Sanctuary Review. 7pp.
26. SEC: Scientific Committee Communications Initiative. 6pp.

Annex D

An Update on the 2023-24 IWC Budget and Implications for the Scientific Committee

Alexandre Zerbini, Lindsay Porter and Iain Staniland

BACKGROUND

The Commission is facing a financial deficit of at least £497,000 in the next biennium (i.e. 2023-24). If the Commission does not balance its biennial budget, it will become insolvent in 2025. The Commission is in this position due to consistently adopting deficit budgets (i.e. the Commission agreeing that expenditure should exceed income), freezing member contributions and increased operating costs due to inflation (Fig. 1). Consequently, the Commission's General Fund and reserves have now been depleted.

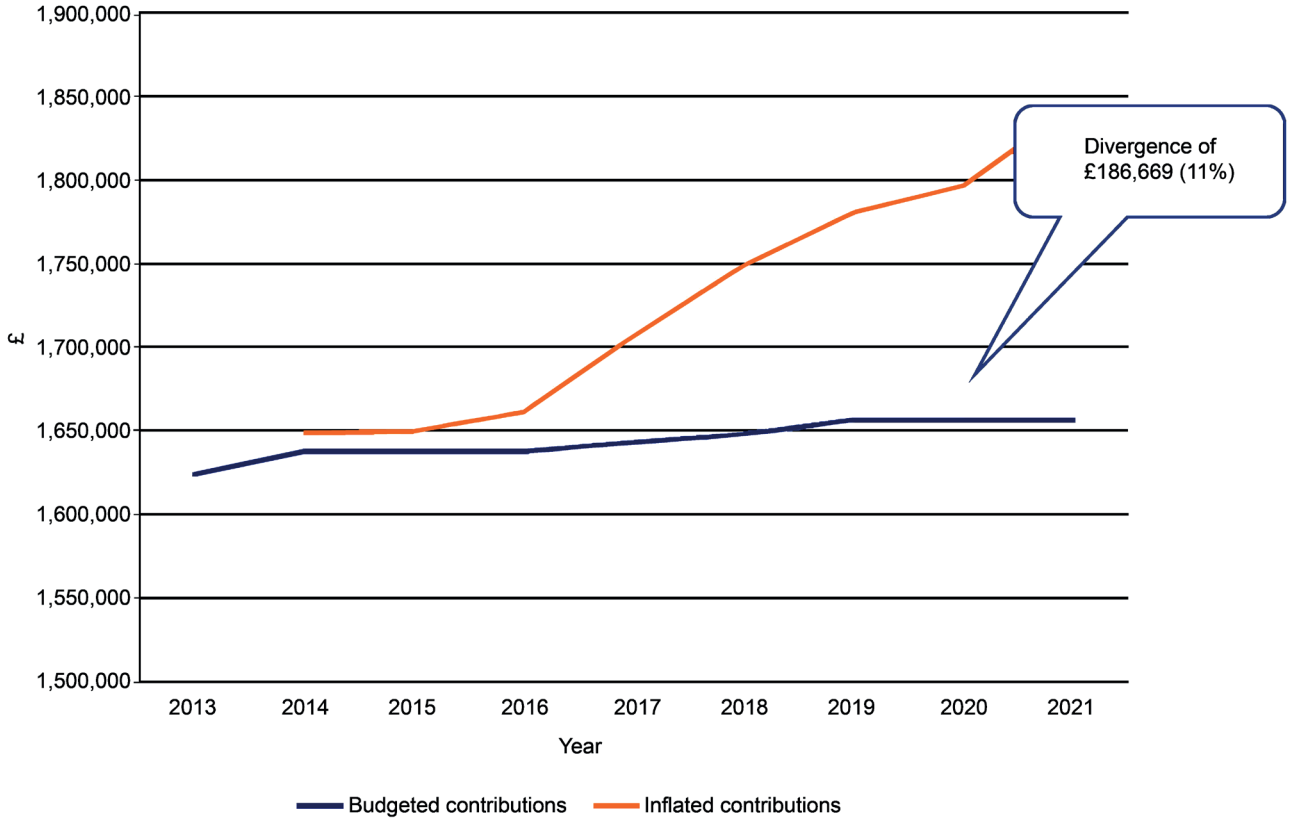


Fig. 1. The graph above shows that budgeted contributions (blue) from 2013 to 2021 (8 years) have only increased by 2%. By applying annual inflation in the UK to the 2013 budgeted contribution (£1,623,972), the 2021 contribution budget would have been £1,843,269, which represents a divergence of £186,669 or 11%, (orange).

To address this, in 2019 the IWC Bureau directed the Commission's Budgetary Sub-Committee (BSC) to only submit balanced budget proposals (where expenditure equals income) to the Commission. The BSC established two groups to propose changes to the usual business of the IWC to mitigate the budget crisis. One group focused on the Commission meeting and the Secretariat budgets, and the other group focused on the SC research and meeting budgets. The summary of the discussions of these two groups is included at Appendix 1.

The BSC has developed a draft budget proposal for IWC68 based on the predicted deficit, advice from the discussion groups, detailed review of the Commission's finances and cashflow, advice from the Scientific Committee and Secretariat, and consideration of the Commission's broader operating context (current global circumstances and position of member countries, etc.).

Table 1

BSC proposed options to balance the 2023-24 IWC budget.

Option 1: Reduce Expenditure	Option 2: Increase Income	Option 3: Reduce Expenditure/Increase Income
This option includes permanently reducing expenditure by 8% in 2023, 17% in 2024. In practice, it includes: • Moving to biennial SC meetings after an in- person meeting in 2023. • No IP budget in non-meeting years. • An additional 1% reduction to the research budget. • Significant reduction to Secretariat running costs • Bureau meetings virtual except at Commission meetings. • Virtual pre-meets for Commission meetings. • Reduction of Commission meetings by 1 day. • Bad debt provision reduction. Depending on the SC's preference, an in-person meeting could be held in 2023 or 2024 (aligned with Commission years, or in 'off' years). This option does NOT include budget for full virtual meetings in 'off years'. However, in renewal years for ASW quotas (e.g. 2024), funds will be provided for an SC workshop as needed.	Raise annual contributions by 15% in 2023 (establishing a new baseline income). • Expenditure will remain at current levels. • Future deficits will be avoided through the use of zero-based budgeting. (The total cost of all activities is first calculated to determine the budget. The contributions formula is then applied to this agreed budget, giving zero deficit.	Raise annual contributions by 2% in 2023, 13% in 2024. Permanently reduce expenditure by 7% in 2023, 6% in 2024. This includes: • Moving to biennial SC meetings after a transitional period (e.g. after in-person or virtual annual meetings in 23-24), with some intersessional workshops supported. • Reduced IP budget. • Moderate reduction to Secretariat running costs • Bureau meetings virtual except at Commission meetings. • Virtual pre-meets for Commission meetings • Reduction of Commission meetings by 1 day. • Bad debt provision reduction. Depending on the increases to contribution supported, this option could include a budget for full virtual SC meetings in 'off years', and/or intersessional workshops. However, this is not guaranteed.

PROPOSED OPTIONS TO BALANCE THE BUDGET

There are three possible options to balance the 2023-24 budget that the Commission will consider at IWC68. All options are intended to establish a new status quo, that is, the Commission will not return to previous patterns of expenditure. These three options are summarised in Table 1 above, and the breakdown of proposed savings for Options 1 and 3 is presented in Table 2[1].

The options described above, or the financial figures provided in Table 2, are not yet finalised, but do provide sufficient detail to inform the SC. The BSC will present this revised draft budget to the Bureau in June 2022 and will circulate a proposal to the Commission in July, 90 days prior to IWC68. Over the next few months, the BSC will also approach Contracting Governments directly to discuss the budget and invite discussion. The Commission will then discuss the proposal at IWC68 in October 2022. The Commission may opt for a variation of one of the options proposed but must agree a balanced 2023-24 budget.

IMPACT OF THE BUDGET REFORM ON THE WORK OF THE SC

Here only the budget impact on the SC research and meeting budgets is considered, however the proposed reductions are balanced across the other components of the Commission's budget (i.e. Secretariat running costs and Bureau and Commission meeting costs). For more information of the impacts to these budget streams, please contact the BSC directly (*whales@awe.gov.au*).

It is unclear what will happen to the budget after 2024 as the Commission will review the Budget Reform Strategy, to be presented at IWC68, to agree the future of budgeting.

Proposed Options 1 and 3 for balancing the IWC budget will have a substantial impact on the work of the SC. Option 1 represents a cut of 48% in the SC meeting budget, reflecting the proposal to shift the SC meeting to a biennial schedule. A reduction of 21% in the research budget reflects a reduction in IP expenditure, given that there will be biennial meetings, plus a small reduction in funds available for research. Option 1 does include the provision of funds for an ASW workshop, as 2024 is a renewal year for quotas. Option 1 *does not* include funds for the Secretariat to support a virtual meeting, meaning that if the SC chooses to host a virtual meeting, funds to support this (approximately £10-15K) would need to be allocated from the SC research budget or found from external sources.

Option 3 represents a smaller cut of 3% in the SC meeting budget in the next biennium, which is sufficient to fund full in-person annual meetings of the SC while it transitions to biennial meetings. Smaller in-person and/or virtual meetings during the interim years may be supported depending on the level of contribution increases agreed. ASW workshops will be funded in renewal years of the ASW quotas. The SC research budget is reduced by 11%, reflecting reduced IP expenditure during interim years.

[1]Breakdown for Option 2 is not shown because no savings are required under this option; the SC would operate under the current budget.

Table 2

Breakdown of proposed budget savings in the IWC under Options 1 (left) and 3 (right).

Option 1	2023-24 status quo Budget £	2023-24 proposed savings £	2023-24 proposed budget £	Option 3	2023-24 status quo Budget £	2023-24 proposed savings £	2023-24 proposed budget £
Income				**Income**			
All income				*All income*			
Financial contributions	(3,313,200)	0	(3,313,200)	Financial contributions	(3,313,200)	(248,499)	(3,561,699)
Interest on Financial Contributions	(12,300)	0	(12,300)	Interest on Financial Contributions	(12,300)	0	(12,300)
Interest Receivable on Cash Balances	(800)	0	(800)	Interest Receivable on Cash Balances	(800)	0	(800)
Meeting Fund reserves transfers	(125,000)	0	(125,000)	Meeting Fund reserves transfers	(125,000)	0	(125,000)
Total income	**(3,451,300)**	**0**	**(3,451,300)**	**Total income**	**(3,451,300)**	**(248,499)**	**(3,699,800)**
Expenditure				**Expenditure**			
Secretariat running costs	2,885,474	(159,927)	2,725,547	Secretariat running costs	2,885,474	(86,525)	2,798,948
Bureau meeting costs	24,725	(24,000)	725	Bureau meeting costs	24,725	(24,000)	725
Commission meeting costs	290,700	(78,000)	212,700	Commission meeting costs	290,700	(78,000)	212,700
Scientific Committee meeting costs	271,941	(130,941)	141,000	Scientific Committee meeting costs	271,941	(9,041)	262,900
Scientific Committee – research budget costs	475,746	(104,418)	371,328	Scientific Committee – research budget costs	475,746	(51,220)	424,526
Total expenditure	**3,948,586**	**(497,286)**	**3,451,300**	**Total expenditure**	**3,948,586**	**(248,786)**	**3,699,799**
Total (surplus)/deficit	**497,286**	**(497,286)**	**(0)**	**Total (surplus)/deficit**	**497,286**	**(497,286)**	**(0)**

At last year's meeting, the Committee discussed the consequences of a reduction in the meeting and research budget and a change of meeting structure (Appendices 3 and 4). These discussions highlighted that a reduction to the meeting fund will reduce the SC's ability to consider important conservation and management problems in a timely fashion and, therefore, may not be able to provide the same level of advice to the Commission. This would mean that the SC would need to reduce and prioritise its agenda, which will require guidance from the Commission. Further, the Commission will need to reduce its expectations of the SC.

EXTERNAL FUNDING FOR IWC SCIENTIFIC RESEARCH

There have previously been suggestions to explore external funding for IWC scientific research. The IWC Research Fund comes from 'core' funding but within the current Rules of Procedure (see Financial RoP C.1 and C.1.a) this can be supplemented by fundraising. Whilst there are no specific guidelines on voluntary funding for the Research Fund (unlike the Commission's five other voluntary funds) the IWC Commissioners have agreed generic guidelines and a code of ethical fund raising (see *https://iwc.int/commission/iwcfinancing*, Guidelines on Acceptance of Funds and Code of Ethical Fundraising). However, it would be prudent to discuss any plans for funding raising with the Chair of the Finance and Administration Committee (F&A) and the Bureau.

The IWC Secretariat has recently hired a half-time Projects Coordinator, Harriet Pinder, whose responsibilities include fundraising. Pinder is drafting a Strategic Plan for Fundraising which is under internal review. This Strategic Plan includes a preliminary list of potential funding sources for medium and long-term funding.

NEXT STEPS

Under a scenario with biennial meetings and a reduced research budget, the Committee will have to make permanent changes to its meeting schedule and work structure in order to continue providing comprehensive information on the threats to and the status of cetacean stocks to the Commission. It is important to consider options to move the Committee's work forward in an efficient manner under a reduced budget scenario. A Steering Group (SG) will be created to explore these options once the Commission decides on the 2023-24 budget. This SG (Table 3) will be led jointly by the SC Chair and vice-Chair and shall include the Head of Science, Management and Conservation, Head of Finance and Administration, Head of External Affairs and Communications and appointed and volunteer members of the SC. The role of the SG is to develop approaches to progress with SC work, given forthcoming changes in budget and meeting structure. This could include harnessing fundraising opportunities. The terms of reference for the group are provided below.

Table 3

Proposed membership of the Steering Group to assist the SC to transition to new budget and meeting schedules.

Name	Role	Country	Comments
Zerbini	SC Chair (co-Convenor)	Brazil	
Porter	SC Vice Chair (co-Convenor)	UK	
Staniland	Head of Science, Conservation, and Management	IWC Secretariat	
Bartmeier	Head of Finance and Administration	IWC Secretariat	
Tandy	Head of External Affairs and Communication	IWC Secretariat	
Double	Head of Delegation	Australia	SC Convenor
Bjørge	Delegate	Norway	Past chair
Palka	Head of Delegation	USA	Past chair
Fortuna	Alternate Head of Delegation	Italy	Past chair
Iñiguez	Head of Delegation	Argentina	
Nelson	Alternate Head of Delegation	St. Lucia	SC Convenor
Seakamela	Head of Delegation	South Africa	
Choi	Head of Delegation	South Korea	To be confirmed
SC volunteer	TBD		
SC volunteer	TBD		

Steering Group terms of reference

(1) Assist the Committee in planning for a new reduced budget scenario and a revised meeting structure once the Commission agrees on a new budget for the IWC.

(2) Provide advice to the Commission with respect to:

- the existing SC meeting format and possible changes to optimize a new meeting schedule;
- the use of the SC research budget to support virtual and in-person meetings; and
- the alignment of SC and Commission meetings should the SC meeting schedule change.

Appendix 1

REPORT OF THE IWC BUDGETARY SUB-COMMITTEE ON BALANCING THE COMMISSION'S BUDGET (DOCUMENT VSM/2109/3.2.4/01 PRESENTED TO THE VIRTUAL MEETINGS OF THE IWC IN SEPTEMBER 2021)

BALANCING THE COMMISSION'S BUDGET: DISCUSSION GROUPS PROCESS AND OUTCOMES

June 2021

1. Background and context

1.1 The International Whaling Commission is facing a budget crisis. Unless the Commission makes changes, it will overspend by at least £329,000 in the next biennium (2023-24) and will be at risk of becoming insolvent in just a few years.

1.2 Member contributions have not increased for nearly a decade, while the Commission's operational costs (everything from Secretariat staff to meeting venues) have continued to rise with inflation. The Commission's work programs have also expanded due to the adoption of new resolutions and priorities put forward by the Commission while financial contributions remained frozen.

1.3 The Budgetary Sub-Committee (BSC) is tasked through its terms of reference with developing budget proposals for the Commission to consider. Recognising the urgent need to address the financial situation, the Bureau recommended in October 2019 that only balanced budget proposals be put forward to IWC68. Due to COVID-19, the Commission has not met since 2018 to consider options.

1.4 To support this task, the BSC convened two informal discussion groups in October 2020 to advise on possible areas of savings within the Commission's three budget streams (Secretariat, meetings and research) and how those savings could best be managed so as to have the least possible impact on the Commission's functions and deliverables.

1.5 The two groups each met three times between December 2020 and April 2021.

1.6 **Group 1** discussed areas of potential savings in the Secretariat and meetings budget. The group comprised the Commission's elected leadership – the chairs and vice chairs of the IWC, BSC, Finance and Administration Committee, Scientific Committee and Conservation Committee, as well as the Executive Secretary and the Secretariat's Head of Finance and Administration.

1.7 **Group 2** discussed areas of potential savings in the Scientific Committee's research budget and the Scientific Committee's share of the meetings budget. Membership of Group 2 was open to all Commissioners. The group comprised Commissioners or their delegates representing Australia, Brazil, Denmark, Mexico, the Netherlands, Portugal, Switzerland, the UK and the US. The Secretariat's Head of Science, Conservation and Management and the Secretariat's Head of Finance and Administration, and the Scientific Committee Chair and Vice Chair participated in an advisory capacity.

IWC68 postponement

1.8 The postponement of IWC68 to 2022 means the balanced budget proposal developed by the BSC would not be implemented until the 2023-24 biennium if agreed by the Commission. This provides additional time to conduct outreach and seek feedback on the budget proposal from members and observers, consider implementation of potential savings, and evaluate support for increases to contributions.

1.9 The balanced budget proposal, if agreed at IWC68, will become the new 'status quo' budget model for future bienniums. While the Commission will be encouraged to regularly review the impact and effectiveness of any implemented savings, any savings adopted in the balanced budget will be implemented on an ongoing basis.

1.10 As a result of in-person meetings and travel being postponed in 2020 and 2021, some expenditures planned for the current budget cycle did not occur. These one-off underspends will be carried over to fund meetings in 2022. While this is expected to allow the Commission to achieve a balanced bridge budget for 2022 without implementing budget reductions, this underspend is a one-off and will not solve the ongoing, longer-term budget problems.

Red House Sale

1.11 On 18 March 2021, the Commission agreed via postal vote to list the Commission's headquarters – the Red House – for sale. This difficult decision was made based on the Secretariat's advice that ongoing maintenance costs would exceed the cost of renting a smaller, impermanent workspace. If the Red House is sold the revenue will be used to boost the Commission's cash-reserves and improve cash-flow. Those revenues will not be drawn on to address the deficit.

Budget Reform Strategy

1.11 The Budget Reform Strategy, developed by the Budgetary Sub-committee as part of the Working Group on Operational Effectiveness (WG-OE) package of governance reforms, proposes best-practice budget management principles for the Commission including setting only balanced budgets, adopting zero-based budgeting, and forecasting budgets over a four-year period.

1.12 If agreed at IWC68, the Budget Reform Strategy will ensure the Commission remains financially sustainable into the future and avoids any further reliance on deficit budgets.

2. Summary of Discussions

Agreement to 'quick win' savings

2.1 Group 1 agreed to several 'quick win' savings options that could be considered in the 2022 bridge budget or the balanced budget proposal for the next biennium. These include:

Quick wins	Estimated savings and budget stream	Additional considerations
Reduce Commission meetings by one day	~£28k – Meetings Budget (biennial saving)	This is factored into the new meeting format being proposed by the WG-OE and will be considered by the Commission in that context.
No funded networking, Convenor's lunch and corporate gift at Scientific Committee meetings	~£7k – Meetings Budget (annual saving)	These events could be self-funded by delegations or others.

2.2 Group 1 also agreed the Commission could consider moving to virtual Bureau meetings. This could save up to £18k annually.

Agreement to propose the option to increase to member contributions

2.3 Both groups agreed options for increases to member contributions should be an option considered by the Commission.

2.4 The model proposed will depend on the response to outreach and consultation, but may include:

Options	Implication if agreed
8-10% increase in 2023, establishing a new baseline, plus an inflationary increase of ~2% annually thereafter	Addresses the current deficit. No significant savings would need to be agreed at this stage.
8-10% increase in 2023, establishing a new baseline.	Temporary solution that addresses the current deficit. Does not address the issue of Commission costs rising with inflation, and it is likely expenditure will again rise above income – meaning savings will still need to be found at a later date.
Inflationary increases of ~2% annually	This would address the ongoing issue of rising Commission costs but would not fully address the current deficit. Significant savings would still need to be found for 2023-24 to establish as new expenditure baseline.

2.5 The groups considered whether it would be possible to spread contribution increases over a couple of years to reduce the burden on members. The BSC advised against this option because:

- The Commission's cash reserve is almost depleted, so it needs to agree a fully balanced budget in 2023 and every year thereafter to avoid insolvency. If contributions are not raised by the full 8-10% in 2023, the Commission would still need to find savings at IWC68 to balance the budget.
- The Commission's expenditure is increasing each year due to inflation which means, if contribution increases were spread over 2-3 years, the increase would need to be as high as 7% each year to keep pace with inflation. For most capacity to pay Group 1 and 2 countries, the difference between a 7% and 8-10% increase would be minimal.

2.6 If contribution increases are agreed at IWC68, the first increase will be reflected in invoices due by 30 June 2023.

2.7 A proposal to increase contributions was presented at IWC67 in 2018 but was not supported by the Commission. COVID-19 will likely consolidate this position further. Significant outreach will be required over the next 12 months to ensure members are ready to give reasonable consideration to contribution increases at IWC68.

2.8 The BSC will prepare a contingency balanced budget proposal that does not account for increased contributions, in case the Commission decides against that option.

Agreement that the budget situation necessitates adjustment to Scientific Committee operations

2.9 Group 2 discussed possible savings from Scientific Committee operations (meetings budget and research fund).

2.10 Although some members of the group expressed concerns about the implications of any further budget adjustments (the Research budget was decreased by ~30% at IWC67) that will affect the Scientific Committee, there was a broad understanding that the Scientific Committee will need to absorb a portion of funding cuts to make up the deficit, noting that:

- Each Scientific Committee meeting costs around £140,000. Over a biennium, two Scientific Committee meetings cost approximately the same amount as the biennial Commission meeting.
- The Scientific Committee's advice and research is integral to the Commission fulfilling its mandate and although adjustments can be explored, the Scientific Committee's value is not in question.

- For the Scientific Committee to continue its work and maintain its reputation as the global authority for cetacean science, it must retain its expertise while operating within and contributing to a financially viable Commission.

2.11 The main savings option discussed was changes to Scientific Committee meeting structure, including a possible move to biennial meetings, which would likely save almost half the projected overall deficit. While members expressed concern with the potential impacts such a move could have on the outputs of the Scientific Committee, the agreed way to mitigate such impacts was through some mix of in-person and/or virtual intersessional meetings.

2.12 The key consequence of less frequent Scientific Committees meetings is a reduced volume of advice available to the Commission (although intersessional workshops could mitigate this). The key opportunities include a targeted agenda and streamlined reporting process ensuring all work and recommendations align with Commission priorities.

2.13 The group noted that the Commission has endorsed a substantial amount of scientific work which exceeds the available funds. This situation needs to be managed. Any changes to Scientific Committee meetings or priorities must be complemented by the Commission adopting realistic expectations of what the Scientific Committee can deliver, including revisiting previous directives to ensure they are still necessary, relevant, implementable and affordable.

2.14 Changes to meeting operations, such as moving to biennial meetings, will create complementary savings from the Research Fund. For example, it is likely less travel funds will be needed for Invited Participant (which are now budgeted in the Research Fund). The group agreed that opportunities for other low-risk savings from the research fund could be explored, including possible changes to how the Invited Participants budget line is managed.

2.15 It is also noted that the Scientific Committee developed options and recommendations, after reviewing the options formulated by the budget discussion groups, for possible future budget reductions related to meetings and the Research Fund at its recent meeting in April/May 2021.

Agreement to explore modest savings in Secretariat staff benefits
For legal reasons, this paper does not cover the specifics of savings to staff pay and benefits discussed

2.16 Group 1 discussed possible savings from the Secretariat's budget.

2.17 The Secretariat budget is primarily made up of staff pay and benefits (78%). Therefore, any significant savings to the secretariat budget will affect staffing and employment conditions. Significant savings to IT infrastructure and services have already been implemented.

2.18 The group agreed it is not acceptable for basic working conditions and benefits to be diminished to address the deficit. Rather, if the Commission decides to reduce the Secretariat's staffing budget, savings should only be found by reducing benefits that are above UK standards, or by reducing overall staffing levels (i.e. redundancies) and associated services to the Commission.

2.19 The working conditions offered to Secretariat staff include a modest package of benefits, some of which are slightly above UK standards. Although only generating minor savings, the group agreed that initiating consultations with staff around reducing/removing this category of benefits was acceptable. It was agreed that the other benefits should remain in place to ensure the Secretariat is able to attract and retain quality staff.

2.20 The group agreed it was not appropriate to reduce salaries to balance the budget. However, when new staff are recruited following natural turnover, salaries are aligned with market rates to ensure value for money for the Commission.

2.21 Although modest redundancies could be explored, the group acknowledged that there are significant risks associated with reducing the capacity of the Secretariat in terms of the level of service available to the Commission.

2.22 The group acknowledged the high caliber of the Secretariat staff and their flexibility, efficiency, professionalism, and work ethic.

Agreement that further savings in the meetings budget should be explored

2.23 Group 1 considered additional options for savings in the meetings budget in addition to the 'quick wins' and possible changes to Scientific Committee operations.

2.24 The Secretariat already works to reduce meeting costs, with the last two Commission meetings being more cost effective.

2.25 The group agreed to explore the possibility of virtual and reduced 'margins' meetings (prior to or following in-person Commission meetings) noting that the scope of these meetings has increased over time and their purpose and structure could be reviewed. The BSC will consult with the WG-OE to consider this in the context of the separate proposal for changes to the Commission meeting structure (and development or review of Terms of Reference for each of the Commission's subsidiary bodies).

3. Next steps

3.1 The BSC will develop balanced budget options for 2023-24, in consultation with relevant Commission subsidiary bodies. A draft proposal will be considered by the Bureau ahead of being considered at IWC68. This proposal will be accompanied by a report capturing the potential impact and management of various savings options.

3.2 The balanced budget proposal will be shared with Commission members and observers for their views in the lead up to IWC68.

3.3 Although the informal budget discussion groups are now dissolved, participants are best placed to lead outreach in their regions on increases to member contributions and the importance of balancing the Commission's budget. The BSC can support this outreach with messaging, papers, presentations etc.

3.4 The BSC, Secretariat, and Scientific Committee leadership welcome questions and engagement from any members wishing to further their understanding of the budget work.

Appendix 2

IMPLICATION AND CONSEQUENCES OF FURTHER CUTS TO THE IWC SCIENTIFIC COMMITTEE BUDGET OR MODIFICATION TO THE SC MEETING STRUCTURE (ANNEX K OF 2021 SC REPORT)

Robert Suydam, Alex Zerbini, Arne Bjørge, Mike Double, Miguel Iñíguez, Toshihide Kitakado, Mike Lundquist, Debi Palka, Randy Reeves, Mark Simmonds, Michael Stachowitsch, Anne-Marie Svoboda, and Horace Walters

1. BACKGROUND

The Commission has been facing financial difficulties for some time and will face at least a £329k deficit in the next biennium (i.e., 2022-2023). The Commission must balance its budget; otherwise it will become insolvent in just a few years. To balance the budget, an increase in revenues (possibly through increases in member dues, voluntary funds, or grants/awards), reduced expenses, or both will be needed. The current leadership of the Commission and subsidiary bodies have been requested to make difficult but necessary proposals for achieving a balanced budget.

The postponement of in-person SC meetings in 2020 and 2021 and the Commission meeting in 2021 have resulted in budget savings, which will help offset the deficit in the short-term. However, longer term budget solutions are Ωneeded, and discussions are on-going in several IWC subsidiary groups, including the Working Group on Operational Effectiveness.

Two budget groups were established by the Commission's Budgetary Sub-committee, with Bureau endorsement, to propose possible changes to the usual business of the IWC to help mitigate this budget crisis. The first group focused

on the Commission meeting and the Secretariat budgets and the second group focused on the SC research and meeting budgets. The SC Chair (Suydam) and Vice-chair (Zerbini) participated in both of those budget groups. Both groups discussed increasing revenues but focused on budget savings. Reports are now being drafted. Those groups agreed that discussions about reducing SC costs are not intended to diminish the value or effectiveness of the SC. The SC's advice and research are integral to the Commission fulfilling its mandate. However, achieving a balanced budget with substantial cuts must take into account the possible consequences of those cuts.

The purpose of this document is to provide to the Commission, the Secretariat, and the Working Group on Operational Effectiveness an assessment of the implications and consequences of possible budget reductions to the SC. We have divided the discussion into several sections, including information on the current SC budget, possible consequences of cuts to the research budget and the meeting structure, and recommendations for how the SC can help to address the IWC budget crisis.

2. CURRENT AND RECENT PAST SC BUDGETS

The SC operates under two separate IWC budgets: (1) a research budget; and (2) a meeting budget. Below is background information about both of those budgets.

2.1 Research budget

The budget crisis of the IWC was already evident in September 2018, when the IWC Commissioners agreed to reduce the SC research budget by ~£90,000 per annum (28%) to contribute with the IWC's longer-term goal of a balanced budget. The previous SC research budget had been ~£315,000 per annum. In 2018, the SC met in April and May and agreed a budget of that amount. Because the requested budget cuts occurred after the conclusion of the 2018 SC meeting, the then SC Chair (Fortuna) and vice-Chair (Suydam) worked with a small group of Commissioners and other delegates to recommend specific cuts to the proposed 2019-2020 SC budget to reach the requested reduction, which led to a revised annual SC budget of ~£226,000.

The revised SC research budget for the 2019-2020 biennium was attained by reducing the budgets for 18 projects, by zeroing out budgets for five projects (but to be considered for funding in the next biennium), and by recommending two projects be funded under the Small Cetacean Voluntary Fund. Savings were also realized by using underspends from previously approved projects. The annual research budget of the SC has remained at ~£226,000 since that time.

The research budget is divided into several categories:

- IWC-funded Invited Participants (IPs) to attend annual meetings.
- Contingency (for addressing new topics from the Commission or other needs, as allowable).
- Intersessional meetings/pre-meetings/workshops to address specific SC agenda items.
- Modelling/computing (e.g., development, maintenance, and testing of SLAs).
- Research projects, usually field projects.
- Databases (i.e., creation and maintenance).
- Reports (e.g., State of the Cetacean Environment Report [SOCER], mercury exposure in cetaceans).

Fig. 1 illustrates the distribution of funds across the above budget categories for 2019.

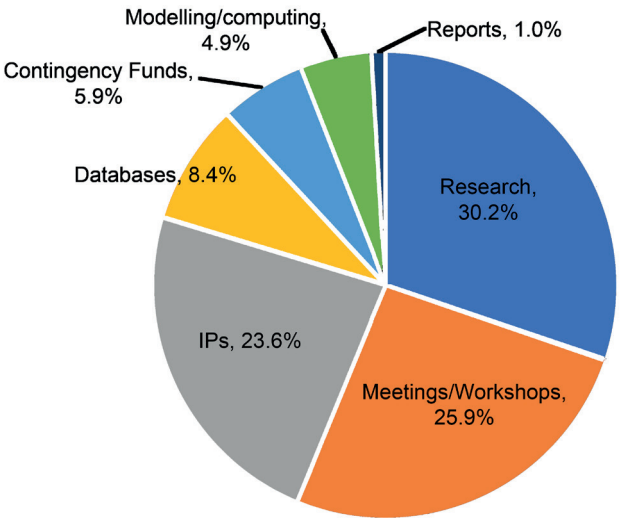


Fig. 1. Distribution of SC research funds across budget categories in 2019.

There are several other points to note:

- The SC research and SC meeting budgets are linked. Changes in one will likely have an impact on the other. For example, expenses for IWC-funded IPs to attend the annual meeting are included in the research budget. If the meeting structure changes (see below), there would be corresponding changes to the research budget.
- Many of the intersessional workshops and pre-meetings funded from the SC research budget are held in conjunction with the annual SC meeting to help reduce costs, such as travel. The intersessional workshops are often matched with non-IWC funding sources for expenses such as meeting room costs, travel for some participants, and other expenses.
- Many of the actual research projects funded by the research budget occur in locations where there are few alternative sources of funding. Those projects always have relatively small budget requests but provide valuable information required to advance the work of the SC. The results are usually very cost effective and frequently involve a substantial amount of matching and in-kind support.

The SC research budget contributes to the work of most sub-groups within the SC and also the Secretariat (Fig. 2).

Most of the research budget is distributed evenly across assessment, IPs/contingency, and topics that overlap with CC (Fig. 3).

The three figures would likely differ if looking at the distribution of funds from years prior to 2019 but do provide a reflection of how the SC has distributed funds to address Commission directives in the most recent years. The situation with restrictions on travel and research due to COVID-19 reduce the usefulness of looking at budgets from 2020 and 2021.

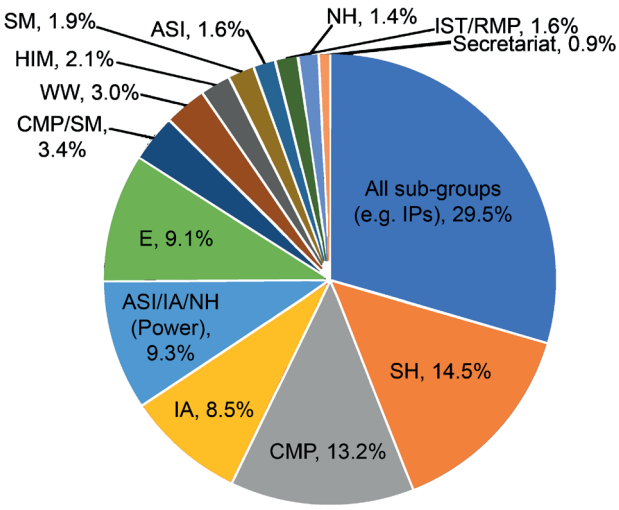


Fig. 2. Distribution of SC Research budget across sub-committees/sub-groups in 2019.

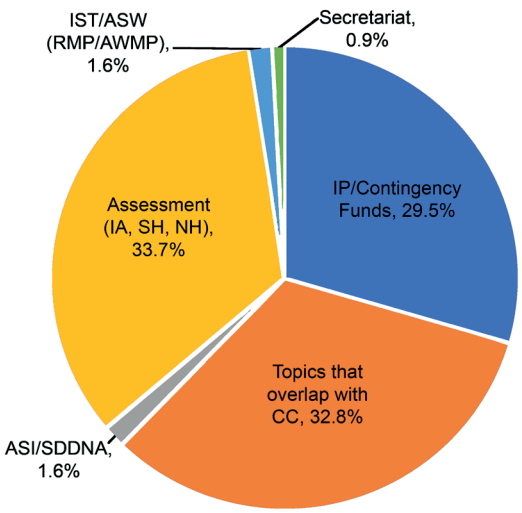


Fig. 3. Distribution of SC Research budget in 2019 distributed across assessments, Ips/contingency funds, topics that overlap with Conservation Committee, and other categories.

2.2 SC Meeting budget

As noted above, the SC research and meeting budgets are linked. The Secretariat-managed SC meeting budget covers the costs of meeting rooms, Secretariat travel and associated costs, overtime salary, coffee, etc. The cost of an annual in-person SC meeting is approximately £130,000. As noted above, the costs for IWC-funded IPs to attend the annual meeting of the SC are covered by the research budget.

Aside from travel expenses for IWC-funded IPs, it is also important to note that the travel, and associated costs, and salary for almost every other SC participant, whether delegates, self-funded IPs, or observers, are all donated by various IWC member governments, other local, regional or national governments, NGOs, IGOs, or other organizations. The amount of donated travel and time was estimated at a total of ~£3 million per annum by the former SC Chair (Fortuna) during budget discussions in 2018.

3. POSSIBLE CONSEQUENCES OF CHANGES TO THE SC MEETING STRUCTURE AND RESEARCH BUDGET

There has been a suggestion that the SC move to biennial meetings as one means of helping to solve the IWC's budget crisis. There are other options to consider as well, including reducing the length of meetings, holding virtual meetings, or some mix thereof.

During the past year or so, the Commission and its subsidiary bodies, including the SC, have demonstrated impressive flexibility and innovation to continue their work during the COVID-19 pandemic. An example of this flexibility is the virtual meetings of the SC in 2020 and 2021. Specific lessons have been learned within those virtual meetings, some of which could contribute to productive and effective future virtual meetings. It is also clear that virtual meetings are not a like-for-like replacement for in-person meetings in large part because of the long-standing relationships among SC members developed at annual in-person SC meetings.

Below are some specific options and consequences for changing the SC's meeting structure:

3.1 Biennial in-person meetings (possibly with virtual meetings or workshops in the intervening years)

- In-person meetings every other year would provide substantial cost savings (~£130,000 per biennium) to the IWC but could substantially impact the quantity of work, and thus advice and recommendations from the SC to the Commission. The SC would be further limited in its ability to respond in a timely manner to future requests from the Commission for analyses or information.
- If biennial meetings are instituted, the number of IWC-funded IPs (through the SC research budget) could also be reduced.
- Biennial meetings might diminish the capacity of the SC to test and revise SLAs, when necessary, for aboriginal hunts. Annual meetings allow the necessary SC members to discuss the highly technical aspects of this work, including the review of extensive and detailed results. Further, the SC research budget has provided funding for 'essential computing' critical for some of those tasks. Reductions in meeting frequency and funding could result in challenges for the SC to provide objective advice to the Commission about safe harvest levels for aboriginal hunts, especially if the information available for a whale stock is not within the bounds of the scenarios to which SLAs have already been tested.
- Reduced meeting frequency will make it difficult for the SC to conduct regular *Implementation Reviews* (IR) for each of the six ASW hunted stocks/populations. The SC has agreed to focus on one IR per year because the assessments can be quite complicated in some years for some populations. As endorsed by the Commission, the IR for each population is currently scheduled for every 6 to 7 years. Reducing the frequency of meetings could cause delays to IRs for aboriginal hunts resulting in possible delay in timely and informed advice to the Commission.
- Population assessments (through IA with support from NH and SH) of cetaceans not hunted by member governments will slow, resulting in less information about conservation concerns for selected populations. In light of climate change and increasing use of the ocean by people, delaying assessments may have serious conservation implications for some stocks.
- The SC has attempted to plan for succession regarding the highly technical assessments of cetacean populations as experienced personnel (within both the SC and Secretariat) near retirement or move to other projects or positions. Concerns exist about how the SC and Secretariat will maintain needed expertise. The same is equally true of some other aspects of our work where members of the Secretariat closely follow issues, such as the science related to climate change or ecotoxicology and further develop their own expertise. Moving to biennial meetings will likely further exacerbate this problem by providing fewer opportunities for new Secretariat staff and SC members to work alongside one another and learn from experienced personnel during regular in-person meetings.
- Our key work on pressing conservation issues, including associated mitigation measures and recommendations (from CMP, E, HIM, SM, WW), especially urgent ones, will also be delayed by moving to biennial SC meetings.
- Virtual meetings could be held during intervening years, but by necessity, virtual meetings result in a reduced number of available time slots for subcommittee sessions because of vast time zone differences among SC members.

However, even with those challenges, the virtual meetings in 2020 and 2021 provided opportunities for CMP, E, HIM and SM to advance their agendas in positive and helpful ways. WW did not hold a virtual session in 2020 and only two sessions in 2021.

- There is also concern that a biennial meeting may result in a general loss of momentum and, consequently, many members/participants could lose interest in the work of the SC. On the other hand, there are also advantages to biennial meetings with intervening virtual meetings, such as: reduced carbon footprint, less time away from home and families, reduced risk from traveling, and a greater opportunity for broader involvement of scientists from around the world in SC virtual meetings.

3.2 Reducing the Length of Annual Meetings

Reducing the length of annual meetings would have the benefit of annual in-person meetings, such as opportunities for more sessions per day, side meetings, and opportunities for small groups to more thoroughly discuss specific topics and devise report language that is more likely to result in consensus. Because of those advantages, in-person annual meetings, even reduced, would likely prove more productive than virtual meetings.

- Currently annual meetings are ~12 days long, but frequently there are pre- and post-meetings and workshops which extend the overall meeting timeframe.
- Reducing the meeting length would result in savings, including reduction in Secretariat overtime pay, reduction of staffing, and replacing coffee with water.
- The Secretariat estimates that reducing the annual SC meetings by ~5 days would provide a savings of ~£48k per biennium. Reducing annual meetings by ~5 days would almost certainly necessitate reductions to the agenda of work by the SC, with consequences similar to those mentioned above re: biennial meetings.

3.3 Hybrid Meetings

There has been some discussion about holding hybrid meetings, where some people participate in person and some are remote. While this may be appropriate in some circumstances (i.e., specific agenda items), it is unlikely to work well overall. Those attending in person would more likely be from nations with more financial resources. Those individuals would be more able to engage fully in discussions and in side meetings. Also, challenges due to time zone differences would be reduced for those participating in-person but not for those participating remotely. For those reasons, in-person meetings are preferred over hybrid meetings, except in special circumstances.

3.4 Research budget

There are some consequences of further reductions to the SC research budget not discussed above. They include:

- Reduced funding of research projects would likely have a disproportionate effect on regions and member countries with few other funding sources.
- Reduced number of in-person intersessional pre-meetings/workshops.
  - Intersessional pre-meetings are typically closely tied to the annual meeting to help reduce travel costs. Those meetings usually address topics that require more time to discuss than is available during the annual meeting. Results from those meetings are provided to the relevant sub-committee during the annual meeting for further consideration and inclusion in the sub-committee report.
  - Workshops are stand-alone meetings addressing a specific SC agenda item that is usually complex. A stand-alone and archived report is produced from each workshop. Workshop reports and recommendations are typically reviewed, with recommendations being revised as appropriate, endorsed and included in the annual SC Report.
  - Some of these pre-meetings and workshops could be conducted as virtual meetings.

4. COMMON CONSEQUENCES OF CHANGING THE SC MEETING STRUCTURE

If the meeting structure changes substantially, there will be common consequences regardless of the new structure. They include:

- Changing to biennial or reducing the length of SC meetings will by necessity result in a reduced agenda, which in turn will diminish the ability of the SC to address many important conservation and management problems and to provide timely, robust advice to the Commission.
- The SC would need guidance from the Commission about which agenda items have priority.
- The Commission would need to amend their expectations of the level and detail of results, outcomes, and recommendations from the SC.
- If the Commission adds additional items (through Resolutions, Schedule amendments, etc.) for the SC to address, consideration should be given to increasing the SC budget or reprioritising existing work, so that the SC can address the items in a timely manner.

5. POSSIBLE SOLUTIONS AND RECOMMENDATIONS

5.1 External funding

The SC strongly encourages the Commission to explore other sources of funding to help the IWC meet its budget crisis. The Secretariat has been working hard on external fundraising for some time but has not considered trying to replace IWC core funds used to support the SC with voluntary or grant funds. Part of that consideration is that there are challenges to supporting the SC with voluntary or grant funds, including complex application processes, expectations of granting agencies, and limited Secretariat staff to manage grants such as for reporting requirements. The SC also recognizes that the Commission has provided guidance through the 'Acceptance of Funds Policy' and 'Code of Ethical Fundraising'. The SC understands many of the challenges of external fundraising but is willing to engage in discussions about seeking external funding that could address specific SC projects or tasks suitable for those sources of funding.

5.2 Recommendations regarding budget cuts

The SC would prefer to meet annually. This is clearly the best approach for the SC to address the many items currently on its agenda. If funding cuts are necessary, we recommend consideration of the below options, with further consultation with the SC leadership for implementation of a reduction in funding.

(1) Hold in-person biennial meetings of the full SC.
(2) During intervening years, hold in-person workshops (which would need relatively little support from the Secretariat) for the highly technical sub-groups/sub-committees:
   (a) ASW and IST
   (b) IA and IST
   (c) ASI and SD-DNA would also benefit from holding in-person workshops in the intervening years given their workload, their technical nature (which makes virtual discussions more difficult) and due to their advisory role to other SC sub-groups.
   (d) There is considerable overlap in personnel among these sub-groups of the SC. An in- person workshop that includes all would be cost-effective, efficient and productive.
(3) Other sub-groups/sub-committees could hold virtual workshops during intervening years or in-person, if necessary and justifiable. Each group could schedule its own meeting according to the availability of its members. Some support would be needed by the Secretariat.
(4) Reduce the amount of funding for IPs, make appropriate arrangements for many of the IPs to attend meetings virtually, and seek external funding for IPs.
(5) Reduce the amount of funding for research projects while keeping in mind that many of the research projects occur in areas where there are few alternative sources of funding. Those projects are often relatively low cost, but provide valuable information required to advance the work of the SC. The results of these projects are often very cost effective and frequently involve a substantial amount of matching and in-kind support.

The SC fully recognizes the urgent need to reach a balanced budget within the IWC. The above recommendations are intended to help accomplish this but we acknowledge that changes to the SC budget and meeting structure will have consequences. In 2018, the Governance Review of the IWC stated:

> *'The IWC Scientific Committee (SC) is the premier body worldwide regarding cetacean science, comprising some of the greatest experts on cetacean biology in the world. The unique and enormous expertise on cetaceans in the SC provides IWC with the stature and credibility to remain as the main global body for cetacean management and conservation. The Review Team notes the Scientific Committee is a key strength of the IWC and every effort should be maintained to ensure its effectiveness and global pre-eminence on cetacean research' (http://archive.iwc.int/).'*

If the SC moves to biennial meetings and intersessional workshops (held in-person or virtually), and if the research budget is reduced, our ability to provide comprehensive information about the status of cetaceans in a timely manner to the Commission will be challenged. If SC budgets are reduced, we will plan our work according to guidance about priority topics from the Commission. We will continue to do our best to maintain a strong core of scientific expertise in the SC while attending to the constraints imposed by budget reductions.

Appendix 3

EXCERPT OF THE 2021 SC REPORT: SCIENTIFIC COMMITTEE CONCLUSIONS AFTER DISCUSSION OF DOCUMENT "IMPLICATION AND CONSEQUENCES OF FURTHER CUTS TO THE IWC SCIENTIFIC COMMITTEE BUDGET OR MODIFICATION TO THE SC MEETING STRUCTURE" (APPENDIX 2, ABOVE)

23.2 Scientific Committee discussion of future budget cuts

The Committee discussed Annex K. In 2018 the SC research budget was reduced by approximately one third and due to the financial difficulties currently facing the Commission, it would be wise for the Committee to plan for possible cuts in the future. Whilst the postponement of in-person meetings in 2021 and 2022 has resulted in budget savings which will help in the short-term, longer-term solutions are required. Two budget groups were established under the Commission's budgetary sub-committee, one of which focused on SC research and meeting budgets. The SC Chair and Vice-Chair participated in this group and discussed a range of possible scenarios to mitigate the effects of future budget reductions.

Regarding SC meeting structure, the implications of biennial in-person meetings were explored, along with reducing the length of the meetings. There was also discussion of hybrid meetings, in which some people attend in person, whist others participate remotely. The Committee would prefer to meet annually, but if funding cuts are necessary the Committee **recommends** the following approach:

(1) Hold in-person biennial meetings of the full SC.
(2) During intervening years, hold in-person workshops (which would need relatively little support from the Secretariat) for the highly technical sub-groups/sub-committees.
(3) Other sub-groups/sub-committees hold virtual workshops during intervening years or in-person, if necessary and justifiable.
(4) Reduce the amount of funding for IPs, make appropriate arrangements for many of the IPs to attend meetings virtually and seek external funding for IPs.
(5) Reduce the amount of funding for research projects while keeping in mind that many of the research projects occur in areas where there are few alternative sources of funding.

The Committee fully **recognises** the urgent need to reach a balanced budget within the IWC. The above recommendations are intended to help accomplish this but the Committee acknowledges that changes to the SC budget and meeting structure will have consequences.

In 2018, the Governance Review of the IWC stated:

> *'The IWC Scientific Committee (SC) is the premier body worldwide regarding cetacean science, comprising some of the greatest experts on cetacean biology in the world. The unique and enormous expertise on cetaceans in the SC provides IWC with the stature and credibility to remain as the main global body for cetacean management and conservation. The Review Team notes the Scientific Committee is a key strength of the IWC and every effort should be maintained to ensure its effectiveness and global pre-eminence on cetacean research' (https://archive.iwc.int/).*

Annex E

Report of the Abundance Steering Group

1. INTRODUCTORY ITEMS

The Abundance Steering Group met virtually, on 19-22 April 2022. Participants were: Allison, Bell, Biuw, Branch, Brandão, Butterworth, Cañadas, Choco, Citta, Doniol-Valcroze, Esteban, Ferguson, George, Givens, Hakamada, Ham, Herr, Hines, Jackson, Katara, Kelly, Lundquist, Matsuoka, Miller, Morishita, Nelson, New, Donovan, Øien, Porter, Punt, Robbins, Rogan, Ross-Gillespie, Schubert, Sigurdsson, Skaug, Solvang, Staniland, Suydam, Tandy, Víkingsson, Vermeulen, Walløe, Weinrich, Wilson, Witting, Zerbini.

1.1 Opening remarks

The Convenor, Givens, welcomed participants to the meeting, recalling that the Scientific Committee (SC) had agreed in 2016 to form the Standing Working Group for Abundance Estimates, Stock Status, and International Cruises (ASI) to ensure that abundance estimates used by the SC receive a consistent level of formal review. Since then, ASI has worked to develop a suitable review process and has undertaken many such reviews.

It had quickly become apparent that the workload for ASI was greater than could be accomplished during the annual SC meeting. Accordingly, in 2019 the SC agreed to form the Abundance Steering Group (ASG) to coordinate an intersessional review process. The ASG is comprised of the SC Chair and Vice Chair; the Secretariat's Head of Science, Conservation, and Management; the Secretariat's Head of Statistics; and the convenors of the following SC subcommittees and standing working groups: ASI, ASW, EM, IST, IA, NH, SM and SH. In addition to the members of ASG, numerous independent experts also participated in the ASG pre-meeting this year.

Givens thanked the participants for contributing their expertise to the pre-meeting, and he offered special thanks to the 25 independent reviewers (listed in Item 6) whose thoughtful reviews, voluntarily contributed intersessionally, would be relied upon during ASG deliberations at the pre-meeting.

1.2 Election of the Chair

Givens was elected Chair. New was elected Co-chair.

1.3 Appointment of Rapporteurs

Kelly and Doniol-Valcroze were appointed rapporteurs. Givens thanked them for their continuing commitment to helping ensure the success of ASG and ASI, and the outstanding work they contribute each year.

1.4 Adoption of Agenda

The agenda, as adopted, is given in Appendix 1.

1.5 Documents available

The following documents were available to the ASG: SC/68D/ASI/01, Bedrinana-Romano *et al.* (2018), Bradford *et al.* (2021), Branch (2007), Brandão *et al.* (2021), Calambokidis and Barlow (2020), Cooke and Jackson (2017), Félix *et al.* (2021), Galletti Vernazzani *et al.* (2017), Hakamada *et al.* (2009), Hakamada and Matsuoka (2016), Jefferson and Moore (2020), Lawson and Gosselin (2018), Leonard and Øien (2020; 2020b), Matsuoka and Hakamada (2014), Pace (2021; Pace *et al.* (2017; Pace *et al.* (2021), Renault-Braga *et al.* (2021), Smith *et al.* (2021), Solvang *et al.* (2021), Stewart and Weller (2021), Wenzel *et al.* (2020) and Williams *et al.* (2011). Reviews of these documents were also available to the ASG and have been archived by the Secretariat.

2. ASG PROCESS AND ICG RECOMMENDATIONS

As the ASG conducted the review process during the pre-meeting, several lessons about the process itself became apparent.

First, a concern raised during the ASG pre-meeting was that many analyses submitted for review use methods that are not described in detail in the submitted paper, requiring reviewers to access previous papers to make a full evaluation. This situation is quite common for papers submitted to the SC, given the long-term nature of many important cetacean research projects. This issue is compounded by the increasing need to recruit new reviewers who might not necessarily be fully aware of the long history of some of these studies and their consideration at the SC. While additional background papers could be provided to reviewers, this has the potential to add to their burden substantially. To reduce the burden, the senior author of each submission could be asked to provide one other document with detailed methods, if needed. However, not all papers submitted for review involve authors who choose to be engaged in the ASI review process. In general, it should be the responsibility of the Convenor requesting ASG review of a paper to provide the paper and sufficient other background material to ASG to facilitate the review. The ASG **recommended** that ASI convey this request to Convenors requesting ASI reviews.

Second, it was apparent that Convenors are sometimes uncertain about which papers to refer to ASI for review. Givens noted that ASI had tried to clarify this in 2021 by providing the following description of the intended role of ASI (IWC, 2022; item 11):

> *'The ASI was established to provide consistent, rigorous reviews of abundance estimates submitted to the Committee. It was also instructed to provide a broad overview of the abundance and status of whale stocks for the Commission and the public. Finally, the ASI offers advice on survey design, new technologies, data collection and analysis for abundance surveys coordinated by the IWC (POWER and SORP) and national research programmes. The ASI provides an advisory service for other sub-groups of the Committee upon request by individual convenors. Not all abundance estimates require review by ASI. Primarily, the ASI will review estimates that need to be endorsed for a specific purpose such as: (i) inclusion in the IWC Table of Accepted Abundance Estimates, including those on the IWC website; (ii) use in an assessment, other mission-critical modelling, or with RMP/AWMP calculations; (iii) informing the Commission on the status of stocks/species; or (iv) use as the basis for providing management advice and SC recommendations. However, there are also circumstances where information on abundance can be used by the Committee's subgroups to progress their work without review by ASI.'*

Although this was helpful, further discussion among convenors would also be beneficial. Staniland suggested that a decision tree might serve as a helpful reference. Givens agreed to raise the topic with the Convenors.

Third, the ASG noted that much cetacean research involves projects spanning many years. ASG drew attention to the importance of the long time series of data generated by such work, including whale (or calf) counts, abundance estimates, and photo-id databases. Regardless of how ASI categorizes abundance estimates arising from individual years or brief periods in such time series, the complete data record has inherent value for scientific insight, assessments and management. Furthermore, for some such long projects, regular abundance estimates are routinely provided (annually) as more data are collected, using the same survey and analysis methods as in prior years. In such cases, ASI does not need to review each new estimate when it becomes available. Instead, ASG **recommended** that ASI consider a process where such estimates could accumulate for several (perhaps 3) years before receiving review by ASI. After review, the set of recent prior estimates would all be added to the IWC Table of Agreed Abundance Estimates, if they are endorsed.

In addition to these general observations, the ASG discussed the following topics related to the review process.

2.1 Edits to Category descriptions

In 2021, the SC agreed to revise the categories used by ASI when endorsing abundance estimates, making some changes to clarify wording and adding Category 1B for very small stocks (see item 11.1.1 of IWC, 2022). The Committee also agreed that a small intersessional correspondence group would discuss how best to draw a distinction between categories 2 and 3 and would develop supplementary wording to be presented to the Committee in 2022 that explains how estimates in categories 1A, 1B, 2 and 3 might be used. The small group would also provide examples of the reasoning for choosing one category over another in various circumstances. Givens convened the small group intersessionally and expanded its remit to include consideration of suggestions for minor wording changes to clarify all the categories.

Although some progress was made, the small group did not provide a final document in time for consideration at this pre-meeting. Therefore, the ASG agreed to defer consideration of this item until ASI sessions during the upcoming SC meeting, with the expectation that a document would be provided before then.

During consideration of several abundance estimates at the pre-meeting (item 3, below) it was apparent that the category definitions would be improved by further clarifying matters related to stock definition and areas. Some surveys, and corresponding abundance estimates, are never intended to cover an entire stock, but rather to produce results for a specific area - often one relevant for management. The existing category descriptions are somewhat ambiguous about which category ASG/ASI should use when endorsing an estimate derived from a survey that did not cover an entire stock. The small group agreed to consider this issue as it prepared its recommendations for ASI.

2.2 Supplemental wording and examples to explain category selection

See Item 2.1 above.

2.3 Process for reviewing author revisions

Sometimes ASI recommends revisions to the analysis of an abundance estimate it has considered. Such guidance may be intended to help the authors improve their estimate so that it can be endorsed by ASI with a higher categorization (e.g. 1A or 2, instead of 3 or P).

For example, this situation occurred with several estimates of franciscana abundance, from various authors, which were first considered at the 2021 Workshop on the Status of the Franciscana (IWC, 2021b). Estimates were reviewed there, and suggestions for improvements were offered; these workshop outputs were subsequently reviewed and endorsed by ASI (see item 11.1.2 of IWC, 2022). In a follow-up franciscana workshop planned for June 2022, some revised and improved estimates that take account of those suggestions will be considered. Those estimates will subsequently be forwarded to ASG for consideration intersessionally. The question is how ASG should address the review of such estimates. The franciscana estimates are only an example; this situation arises regularly in ASG's work, and each case is somewhat different.

Options for ASG's review of revised estimates include: (i) solicitation of new, independent reviews; (ii) solicitation of reviews from the previous reviewers; or (iii) direct consideration of the revised estimate at the next ASG meeting without additional review, provided that the authors provide a detailed explanation of how the methodological suggestions were addressed. The complexity of the revisions will differ from case to case, so option (iii) may not always be practical, and the matter might best be handled on a case-by-case basis. However, any guidance provided to the ASG convenors would be helpful.

The ASG agreed that this question should be referred to ASI. Several of the papers under consideration at this pre-meeting included revisions in response to earlier ASI suggestions, and these were handled in a variety of ways during the intersessional period by the convenors of ASG. It was not necessary to consider the more general question now because it pertains to what ASG should do next year.

3. REVIEW OF ABUNDANCE ESTIMATES

The classification system used to categorize abundance estimates endorsed by ASI and included in the IWC Table of Agreed Abundance Estimates is explained in item 11.1.1 of IWC (2022). The ASG noted that although the categories have numeric labels (and one is 'Not Suitable'), they are not intended to rank the scientific quality or importance of studies. These categories are used only to identify how estimates can be used most appropriately by the Committee and its subgroups since many of the studies reviewed were not designed explicitly to inform the tasks undertaken by the SC.

For example, the estimate of North Atlantic minke whales (Solvang *et al.*, 2021) considered in Item 3.2 below is recommended for Category 1A; estimates in this category would be suitable for use in the Committee's Revised Management Procedure for commercial whaling. The estimate for Rice's whale (Garrison *et al.*, 2020; item 11.1.10 of IWC, 2022) endorsed last year by the SC as Category 1B was challenged by a low sighting rate and other issues, but is nevertheless very important to help guide management for this critically depleted species. An estimate for blue whales off Sri Lanka (Priyadarshana *et al.*, 2016; item 11.1.3 of IWC, 2022) endorsed last year as Category 3 was derived from a survey covering perhaps only 1-2% of the total geographic area occupied by the stock (thereby rendering the estimate without value for estimating total population abundance, and also being heavily susceptible to process error), but this estimate would potentially be very helpful for local management, including mitigating impacts from fishing and whale watching. All these estimates will prove very useful in the appropriate contexts and represent important scientific advancements, irrespective of their numerical category labels.

ASI **recommended** that all papers considered below should be assigned the highest level of Evaluation Extent (1, estimate was considered in detail by the sub-committee) in the IWC Table of Agreed Abundance Estimates, except for Cooke and Jackson (2017), which should be given an Evaluation Extent of 4 (estimate was partially considered by the sub-committee and a new method was used). The Evaluation Extent metric is discussed further by IWC (2014).

3.1 Indo-Pacific finless porpoise near Hong Kong

Jefferson and Moore (2020) present a study of the density and abundance of Indo-Pacific finless porpoises in waters to the south and east of Hong Kong, the first abundance estimate since the early 2000s (Jefferson *et al.*, 2002). Single-platform line-transect surveys in closing mode using medium-size vessels were conducted for small cetaceans in most of the waters around Hong Kong since 1996. The density and abundance of finless porpoises in the Hong Kong area were estimated using a Bayesian hierarchical framework, consisting of a Markov process model used to describe population dynamics and a distance-sampling observation model that links the line-transect data to the latent biological process. Time series analyses for both dry- and wet-season data from 1996 to 2019 showed annual fluctuations in abundance indices, but no evidence of a significant long-term trend in finless porpoise abundance in Hong Kong. In 2019, there were approximately 176 finless porpoises (corrected estimate) in Hong Kong's waters in the dry season (winter/spring), the season of highest use (where the abundance was adjusted using a correction factor to account for unsurveyed regions in certain years/seasons). The highest densities (0.535 porpoises/km^2) were recorded in South Lantau (southwest of Hong Kong) in the dry season.

The independent reviewers found the survey to be well designed, analysis methods to be excellent and well implemented, and the length of the survey data series to be valuable; the study itself was well documented. However, the reviewers noted it was difficult to understand what population component is being estimated, due to questions of stock definition, range, and seasonal movements; variable and excluded survey coverage; and the fact that the model treats seasons (wet and dry) separately. One reviewer also questioned the estimation of $g(0)$ using data from a towed POD (for acoustic detections), which is considered unreliable in other regions. Reviewers also noted the nature of the model also raised difficult questions about which estimates to treat as the 'final answer' for the IWC Table of Agreed Abundance Estimates. The correction factor (which aims to correct for unsurveyed regions in some years/seasons by assuming that proportions in different areas remain the same as what was observed in the early 2000s) is also not well supported, and leads to corrected total abundance estimates lacking coefficients of variation (CVs).

In discussion, the ASG noted it was difficult to judge how much of the population was covered by surveys. Porter commented by email that, in her view, Category 2 was appropriate, as the porpoises in the survey area comprise only a fraction of the larger population in the South China Sea.

The ASG agreed with the reviewers that the correction factor was not well supported. It was further noted that the ASI has never endorsed an abundance estimate that was reported without an associated measure of uncertainty. Therefore, ASG focused on the uncorrected estimates.

The presentation of a time series of abundance estimates in Jefferson and Moore (2020) also prompted the ASG to consider the question of how to summarise such abundance estimates (i.e. for the IWC's Table of Agreed Abundance Estimates). In the case of Jefferson and Moore (2020), the ASG noted that there were substantial fluctuations in the time series of estimates and that these estimates might also be correlated over time. Therefore, endorsing only the final abundance estimate might be misleading, and endorsing the entire series would ignore potential correlation. The ASG agreed that, when possible, the Secretariat should include variance-covariance matrices when adding time series to the IWC Table of Agreed Abundance Estimates, and that such information should be solicited from authors when it is not presented in the paper. Further discussion concerning the presentation and use of time series of abundance estimates is planned for ASI during the 2022 Committee meeting.

To summarise the abundance estimates in Jefferson and Moore (2020), the ASG agreed to calculate and recommend endorsement of inverse-variance weighted averages for three-year periods at the start, middle and end of the series, for both the wet and dry seasons, using the uncorrected estimates. The full time series of estimates is presented in Table 2 of the paper. By separating the start, middle and end periods of the series, it is hoped that these averages are not substantially correlated. The inverse-variance weighted average is a weighted mean where the contribution of each variable is weighted in inverse proportion to its variance. The appropriate standard error for a weighted mean was also calculated.

The ASG **recommended** that the following average uncorrected abundance estimates for Indo-Pacific finless porpoise in Hong Kong waters should be endorsed: during the wet season, 37 (CV=0.303) in 1996-98, 67 (CV=0.184) in 2007-09, and 77 (CV=0.207) in 2017-19; and during the dry season, 65 (CV=0.223) in 1996-98, 121 (CV=0.144) in 2007-09, and 108 (CV=0.140) in 2017-19. The ASG recommended that these averages be classified as Category 2.

3.2 North Atlantic common minke whales

Solvang *et al.* (2021) present abundance estimates of common minke whales in the northeast Atlantic based on survey data collected over the period 2014-19. This is the fourth survey cycle that Norway has conducted after a synoptic survey of the area in 1995. The surveyed area includes the RMP *Medium Area* E and the *Small Management Area* (*SMA*) CM. Cetaceans were searched for by naked eye from two independent platforms each manned with two observers following the protocols established for these surveys and also used in previous survey cycles. One special feature of these surveys is the tracking procedure introduced for the survey target species minke whale. The analyses of the present survey used a similar approach as previous analyses presented and discussed within the Scientific Committee. The total estimate for the entire surveyed areas (i.e. E+CM) was 149,722 minke whales (CV=0.15, including additional variance). The abundance estimate for the E *Medium Area* was 104,692 (CV=0.17, including additional variance) covering the years 2014-19; the estimate for the *SMA* CM was 37,020 (CV=0.261) for the year 2016. Other abundance estimates for *SMA*s within *Medium Area* E are given in Tables 2 and 5 of Solvang *et al.* (2021). The point estimates of total abundance in the Eastern *Medium Area* E have been very similar over the survey periods 1996-2001, 2002-07 and 2008-13 but show a 15% increase in the 2014-19 survey period. The authors attribute this increase to *SMA* increases in the Barents and North Seas at the expense of decreases at Svalbard (ES) and in the Norwegian Sea (EW). Such shifts in overall distributions are also known from historical analyses of long-term series of catch statistics. The minke whale abundance in the total survey area (E+CM) is about 50% higher than in the previous survey cycle. The increased abundance in E accounts for some of this, but a major contribution comes from the increase observed in *SMA* CM, the Jan Mayen area, which had its highest recorded abundance over all the survey cycles in the 2014-2019 cycle. The large shifts also seen in CM over several survey cycles may indicate that the adjacent *Medium Areas* E and C share a common minke whale population.

The independent reviewers noted that the analyses are only briefly described by Solvang *et al.* (2021), with the authors instead referring readers to previous published papers and reports (a situation addressed in Item 2 above). The reviewers generally viewed the analytical methods favourably and noted particularly the unique Norwegian analysis approach (hazard probability model) that was specifically developed for North Atlantic common minke whales. However, descriptions of the more recently developed variance estimation components of these analyses are in unpublished SC papers, e.g. Solvang *et al.* (2015) or papers in press. A reviewer suggested that a comparison between the Norwegian approach and more conventional approaches that are widely accepted at the SC like mark-recapture distance sampling (with an availability correction based on time-in-view) would be interesting and might reveal strengths or weaknesses of either approach. This reviewer also questioned why survey measurement error was not included in the final analysis, despite the authors demonstrating in Solvang *et al.* (in press) that it introduces negative bias in abundance estimates. The same applied to the authors ignoring clustering, despite it also likely introducing negative bias in abundance estimate. This reviewer also noted the reported increase in the abundance in the CM *SMA* as commensurate with a large decrease observed in adjacent Icelandic waters, as documented by Pike *et al.* (2020). The other reviewer noted a relatively small frequency of zero perpendicular distances for distances to minke whale groups and questioned if that was typical of the unique Norwegian line transect survey analysis methods.

Givens thanked the authors of this paper for agreeing at short notice to prepare a presentation of the paper for this ASG meeting, as it was not presented last year.

In discussion, the ASG reflected on the long history of development for the hazard probability approach, much of which had been presented to, and reviewed by, the Scientific Committee over several decades (Skaug *et al.*, 2004; Solvang *et al.*, 2015), but that the variance estimation approach had not had as much review. The authors agreed to a request from the ASG to produce a summary of how and when the Scientific Committee has previously reviewed the analysis methods developed since 1995 by Norway to generate abundance estimates in the Northeast Atlantic, particularly including the newer variance estimation methods. This summary is to be presented during the 2022 meeting of ASI.

The ASG also discussed the implications of estimating abundance by area and not by stock or population, as has been presented by Solvang *et al.* (2021). It was noted that the boundaries of the North Atlantic Management Areas had been defined along older stock definitions and that the Norwegian variant of the RMP used geographic areas instead of stocks. In addition, the Committee had previously noted that the abundance results in Solvang *et al.* (2021) would be useful for the *Implementation Review* of North Atlantic minke whales which is starting in 2022 (IWC, 2022, item 11.1.11). In that context, the ASG recalled that the RMP was tested under a variety of assumptions regarding the bias and uncertainty of abundance estimates provided as input, the quality of the surveys providing the underlying sightings data, and other factors. The ASG considered that the implications of the reviewer's concerns expressed above would not likely be of sufficient magnitude to prevent adequate performance of the RMP. The ASG did not attempt to resolve every listed concern.

The ASG **recommended** that the 2014-19 abundance estimate for common minke whales across the northeast Atlantic (*Medium Area* E + *Small Management Area* CM) in the summer of 149,722 (CV=0.15) be endorsed as Category 1A. The separate *Small Management Area* estimates are also **recommended** for Category 1A endorsement if they are needed for Committee work.

3.3 Eastern South Pacific humpback whales

Félix *et al.* (2021) describe a new population estimate for eastern South Pacific humpback whales (Breeding Stock G; BSG) based on mark-recapture models and fluke catalogues from 23 research groups. The sample includes 6,354 individuals: 1,698 (26.7%) from feeding areas and 4,656 (73.3%) from breeding areas, over the period 1991-2018. Mixture models with two different approaches (full likelihood and conditional likelihood) produced similar results of 11,784 (SE=266) and 11,786 (SE=266) whales, respectively. In both cases, a model with two mixtures (*Mth2*) provided the best fit. Sources of bias were associated with effort heterogeneity, population stratification, and the time scale.

Félix *et al.* (2021) was originally presented to the Committee in 2021 (items 8.4.1 and 11.1.9 of IWC, 2022). At the time, the Committee expressed an appreciation for the scale of the research effort to compile the many databases, and highlighted the commensurate value of the resulting dataset. Also noted were the challenges associated with the scale of the geographic area represented in the combined dataset, and that humpback whale movements throughout the area were not well understood. The Committee recognised the benefit of incorporating these data into future circumpolar assessments of the species. Concerns were raised about the assumptions of a closed population, sources of the samples, and that some of the CVs seemed unrealistically small. The paper was referred to the ASG for review during the 2021/22 intersessional period, with a request from the authors for advice on how the analyses could be improved.

Both reviewers acknowledged the effort that went into assembling and analysing these data and noted the value of the data for current and future population and trajectory estimates for BSG. The reviewers remarked that the task of obtaining abundance estimates using mark-recapture methods with such a large and complex data set was a substantial challenge, and that the analyses presented in IWC (2022) should be considered an impressive initial attempt. Attempts to model annual capture probabilities were stymied by issues with optimisation, resulting in the authors using closed population models. This was a point of concern for the reviewers on account of the long timespan of the study, and the likely births, deaths and movements that would occur during that time. Abundance likely varied over years, and it is therefore difficult to interpret a single abundance estimate for the entire time period. It was also noted that the abundance estimate pertains to a superpopulation (i.e., an estimate of all animals alive at any point during the time period of the sampling, and not those alive at any one specific time point). Also, it is difficult to judge whether the data adhere to the required assumptions. Another problem identified was variation in sampling effort across all the collated data, and that such variability will affect capture probabilities, but that was not directly accounted for in the model. Finally, the reviewers were also unsure as to what the demographic parameters represented in the likely event that the assumption of a closed population was being violated.

In discussion, the ASG noted the extraordinary amount of work required to collect and collate the data, and the value if this effort to the work of the Committee. Reference was also made to the value of having unique identification data from both feeding and breeding grounds.

It was also noted that the scope and complexity of such mark-recapture analyses is something the Committee may need to consider again in the near future for other stocks and species. The ASG **recommended** that ASI raise this issue with the convenors of NH and SH and seek their advice on the level of priority that might be assigned to developing better

guidance for such analyses. For the specific paper under consideration here, the ASG **recommended** that ASI consider the formation of a small group to help the authors of IWC (2022) improve their analyses, and also to develop expertise within the Committee for similar future work. Such a group should also include external participants with expertise in handling complex heterogeneity in capture probabilities. The establishment of such a small group was deferred to ASI to increase the opportunity to recruit participants and because convening this group may have budget implications.

The ASG **recommended** that the 1991-2018 abundance estimate for Eastern South Pacific humpback whales (Breeding Stock G) of 11,784 (SE=266) be endorsed as Category 3. The ASG also **recommended** that ASI consider how best to treat abundance estimates like this one, derived from capture-recapture data over such a long time span, particularly since this is a superpopulation estimate. This case is also concerning because the closure assumption is violated.

3.4 Bering-Chukchi-Beaufort Seas bowhead whales

SC/68D/ASI/01 [Ferguson *et al*. (2022)] presented an abundance estimate for Bering-Chukchi-Beaufort Seas (BCB) bowhead whales (*Balaena mysticetus*) based on aerial line transect survey data collected in the Beaufort Sea and Amundsen Gulf during August 2019 and analysed with a density surface model. To estimate transect detection probability, images were collected from a digital camera mounted to the belly port of an aircraft during a subset of the line-transect survey flights conducted in the study area in 2018 and 2019. To estimate the availability of bowhead whales depending on their observed activity states, two additional sources of information were used: (1) bowhead whale behaviour data collected in the study area during aerial focal follow studies in the 1980s and 1990s (Robertson *et al.*, 2013); and (2) estimates of the duration that an object at the surface is in an aerial observer's field of view. Estimates of bowhead whale abundance by activity state, fully corrected for availability and perception bias, were derived using a hierarchical generalized additive model, with group levels defined by three activity states: travelling; feeding in deep water; and cow-calf pairs or socializing whales. An estimate of the uncertainty in the overall abundance estimate was derived using the analytical methods of Bravington *et al.* (2021), which propagated the uncertainty from the detection functions through the spatial model, and then incorporated the uncertainty in the estimates of availability using the delta method. The resulting estimate of abundance was 17,175 whales (CV=0.237; 95% confidence interval 10,793-27,330).

The two independent reviewers praised the paper for combining state-of-the-art methods for spatial statistics with mark-recapture line transect methods, and for the attention to detail at all steps of the analysis. They noted that, as a result of using this sophisticated approach, the CV of the estimate was greatly reduced compared to the previous, design-based estimate from SC/68D/ASI/01 using the same survey data. Assuming full independence among components would have increased the CV from 0.237 to 0.41, and conventional stratified analysis yielded a CV of 0.54. The reviewers made suggestions to improve presentational clarity, which were addressed by the authors in their response (providing decomposition of the variance components, and additional discussion of caveats). The ASG thanked the reviewers for their detailed comments and suggestions.

In discussion, the ASG was reminded that this estimate was being considered by the SC for the first time and that the methodology was developed, in part, to provide a viable alternative to ice-based surveys, whose feasibility might decrease in the future due to climate change. The ASG discussed the edge effects visible in the plots of density surface model predictions and queried whether the total abundance estimate would be affected if the predicted numbers of bowhead whales in the cells exhibiting edge effects were set to zero. It was concluded that these effects likely are not large enough to greatly affect the results. The ASG also asked whether spatial variability in group size was investigated. The authors referred to the five group size metrics presented in Table B1 of the paper that were considered potential covariates in the detection function models, stating that none of these covariates was retained in the final detection function models during model selection. Additionally, the residual analysis suggested that the Tweedie distribution used for the spatial model was appropriate to fit the number of whales as a response variable rather than the number of groups. In response to a question on the mark-recapture model, the authors stated that identification of duplicate whale sightings was performed without a fixed set of criteria but was unambiguous for this species due to the lack of clustering of sightings observed during the survey.

The ASG **recommended** that the 2019 abundance estimate of 17,175 (CV=0.237, 95% CI 10,793-27,330) be endorsed as Category 1A.

3.5 North Atlantic right whales

Pace *et al.* (2017) used a mark-recapture model to estimate the abundance and trends of North Atlantic right whales (*Eubalaena glacialis*). Individuals are annually resighted at different rates, primarily due to varying stay durations among several principal habitats within a large geographic range. To better characterize changing abundance of North Atlantic right whales between 1990 and 2015, a state-space model with Jolly-Seber assumptions about population entry (birth and immigration) was fit to individual resighting histories using empirical Bayes methodology, accounting for the substantial individual capture heterogeneity. Estimates from this approach show that recapture rates have declined substantially in recent years. North Atlantic right whales' abundance increased at about 2.8% per annum from median point estimates of 270 individuals in 1990 to 483 in 2010, and then declined through 2015, when the final estimate was 458 individuals (95% credible intervals 444-471).

The independent reviewers agreed that the paper provides sufficient methodological detail for evaluation and that the methods and conclusions are appropriate. In particular, the reviewers noted that the separate likelihoods for the biological and observation processes allowed the observed variability in resighting rates to be attributed to changes in life history parameters or sampling effort. Moreover, the model allowed for heterogeneity in survival among individuals due to sex, age, and year with a combination of fixed and random effects. It was also noted that the authors explicitly tested the sensitivity of their results to their assumptions.

In discussion, the ASG noted that the approach's complexity and numerous random effects can make it difficult to assess model fit and validation. There was no evidence of any problem that would affect confidence in the estimates but the additional information on sensitivity using simulations from the paper's supplementary material would be useful for guiding future use of these estimates, such as for assessment and management.

The ASG agreed that the analysis of Pace *et al.* (2017) could be recommended for endorsement. However, it further noted that Pace (2021) used the same methods while extending the data time series to 2019, thereby producing additional, more recent results. The ASG **recommended** that the updated results in Pace (2021) should be used instead and accepted as Category 1A. Specifically, the ASG **recommended** endorsing the median of the posterior distribution and the 95% credibility interval from Pace (2021) and including the following in the IWC Table of Agreed Abundance Estimates: 262 (95% CI 259-262) in 1990, 308 (307-311) in 2000, 476 (472-478) in 2010 and 371 (359-381) in 2019. Pace (2021) also presented other information that was not discussed by ASG, including a newer version of the model with a different treatment of the process errors (the 'regime model'). The ASG **recommended** that the 'regime model' be reviewed by ASI.

Pace *et al.* (2021) used generalized linear models to derive estimates of cryptic mortality for North Atlantic right whales and found that observed carcasses accounted for only 36% of all estimated death during 1990-2017. They also found strong evidence that observed carcass counts were poor predictors of annual mortality, and that cause-of-death determinations from detected carcasses were not necessarily representative of cause-specific mortality rates in right whales.

The independent reviewers agreed that the modelling approach was reasonable although sometimes lacking in details. However, Pace *et al.* (2021) was not discussed further by the ASG because it does not provide estimates of population abundance. ASG will bring this paper to the attention of the Sub-Committee on Non-deliberate Human-Induced Mortality of Cetaceans (HIM) as it may be of interest.

3.6 Eastern North Pacific gray whales

Stewart and Weller (2021) provide updated results from shore-based surveys of eastern North Pacific (ENP) gray whales (*Eschrichtius robustus*) conducted by the Southwest Fisheries Science Center. Abundance estimates were obtained from visual survey data collected regularly off central California between December and February during the gray whale southward migration, adding to a time series that began in 1967 (Durban *et al.*, 2015; 2017; Laake *et al.*, 2012). This report presents a new estimate of abundance for ENP gray whales migrating between December and February 2019/20. A 23.7% decline in abundance from 2016 to 2020 (26,960 whales in 2015/16 and 20,580 whales in 2019/20) coincides with the unusual mortality event that started in 2019.

Reviewers noted that the analysis used well-tested, published methods to continue a time series of abundance estimates that have been endorsed by the SC for years.

In discussion, the ASG was reminded that the estimates for ENP gray whales include individuals from the Pacific Coast Feeding Group and some animals that feed off Sakhalin. It was also noted that estimates from different years have some common variables (e.g., sighting probability of shore-based observers) and therefore cannot be considered completely independent. Covariance information is available for the first part of the time series (Laake *et al.*, 2012) but not for recent years nor for the covariance between the Laake *et al.* (2012) and the Durban *et al.* (2015; 2017) series.

The ASG **recommended** that the 2019/20 abundance estimate of 20,580 (95% CI 18,700-22,870) be endorsed as Category 1A. It also **requested** Katara to inquire with the authors about whether the missing covariance information was available to add to the IWC Table of Agreed Abundance Estimates.

3.7 Southern right whales

Brandão *et al.* (2021 was presented to the Committee in 2021 (item 8.2.3.1 of IWC, 2022). The paper describes an update to a complex demographic model which was developed to explain patterns of southern right whale (*Eubalaena australis*) occurrence and calving rates in South African waters, and had recently been extended to include the possibility of an early abortion so that a receptive, pregnant whale can become pregnant again the following year (the 'delta-loop'). Abundance estimates were generated in the modelling effort, but these did not include measures of uncertainty, as the focus of the paper was on evaluating whether the new features included in the model were able to explain the higher variability (compared to the past) in recent survey counts, rather than generating abundance estimates for management purposes.

The independent reviewers noted the lack of standard errors reported in the document, as well as the fact that in some cases standard errors were not obtainable given that a Hessian had not yet been achieved in the minimisations. This may be due to model complexity, near over-parameterization, a coding error subsequently identified by the authors, and/or other factors.

In response to the reviewers, the authors explained that Brandão *et al.* (2021) is one of a series of papers that, ideally, should be considered in totality (a situation addressed in Item 2 above). Earlier papers (Brandão *et al.*, 2018) included uncertainty estimates, and a future paper will amend the model so that ad hoc penalty terms play a lesser role. Associated abundance estimates appropriate for management purposes will be presented to the Committee in the future. The authors also sought advice on suitable methods for uncertainty estimation, and the ASG recommended that this question be raised at ASI.

After considering this context for the research project, the ASG declined to make any recommendation on abundance estimates in this paper, as they had not been intended to be proposed for management purposes. The ASG looks forward to reviewing abundance estimates arising from this work in the future.

Smith *et al.* (2021) was presented to the Committee in 2021 (item 8.2.3.2 of IWC, 2022) and reported on long-running aerial surveys for southern right whales along the south-west coast of Australia (Cape Leeuwin to Ceduna). Between 1993 and 2020, surveys were undertaken to monitor the recovery of this species following commercial whaling. The aerial surveys provide counts of animals very close to the coastline, particularly focussing on cow-calf pairs in shallow, sheltered waters, in addition to being a platform to collect photo-ID data from all individuals detected. Smith *et al.* (2021) report on counts during the 2020 survey challenged by Covid-19 and provide a simple analysis of counts between 1993 and 2020. Furthermore, by using a multiplier developed from Argentinian and South African data (IWC, 2013), Smith *et al.* (2021) provide a rudimentary estimate of abundance for the Australian 'western' subpopulation of southern right whales, with no accompanying CV. Kelly reported that it is hoped more robust analysis methods can be applied to these data in the near future. The ASG encouraged such efforts.

The ASG did not make any recommendation to ASI regarding the abundance estimates presented in Smith *et al.* (2021). However, ASG **recommends** that ASI assign a suitable category if possible. The analyses of the count data by Smith *et al.* (2021) are simplistic, and the abundance estimate has no associated measure of uncertainty. However, the time series of relative abundance indices is potentially useful for assessment purposes. Finally, the ASG recognised the memory and outstanding contributions of John Bannister to this project, and cetacean science broadly, over many decades.

Renault-Braga *et al.* (2021) present a study of southern right whales wintering along the Brazilian coastline. This population was severely depleted by whaling which continued to the mid-1970s, and studies since the 1980s have suggested this population is now restricted to southern Brazil. Using photo-ID data obtained from standardized aerial surveys running parallel along the coastline from Florianópolis/SC (27°47.82'S; 48°31.98'W) to Torres/RS (29°23.76'S; 49°45.78'W) for the years 2004-18, mark-recapture methods were used to estimate survival, capture, recruitment, and population size using the POPAN model, and population growth rate using PRADEL models, although the POPAN model was used for the final assessment.

Renault-Braga *et al.* (2021) was discussed by the Sub-Committee on Conservation Management Plans, CMP, in 2021, where it was noted that this is the first update of the population trends for southern right whales in the Brazilian breeding ground since 2010. CMP requested that ASI review the abundance estimate.

The independent reviewers acknowledged the great extent of work that went into this study and the value of the dataset, agreeing that the methods used were appropriate for the data collected. However, the reviewers felt that a lack of detail in the description of the methods made the authors' analysis difficult to assess fully and expressed concern over the potential effect of heterogeneity in capture probability due to the failure to account for variation in individual behaviour. The reviewers also noted the low estimates of uncertainty associated with the capture probabilities, especially for adults, with the potential for some of the uncertainty to have been spuriously attributed to variation in other parameters, such as capture probability, which would influence the abundance estimate. Lastly, one reviewer felt that there was a lack of justification for choosing the POPAN model over the PRADEL model. Both reviewers recommended that the abundance estimates should currently be considered provisional.

In discussion, the ASG noted this was a work in progress. The authors of this paper have expressed an interest in collaborating with other SC scientists to improve their analyses. ASG suggested that the authors might work with the independent reviewers, noting that addressing the reviewers' comments would be an excellent start. New agreed to facilitate this potential collaboration.

The ASG **recommended** that the abundance estimates which were stated as 569 (±38) for females and 2,626 (± 737) for adults during winter 2004-18 (2011) be categorized as provisional, Category P. The ASG also noted that before finalized estimates are endorsed in the future, the '±' notation for uncertainty should be clarified by replacing it with a standard error, CV, or confidence interval.

3.8 North Pacific sei whales

Hakamada *et al.* (2009) report on abundance estimates for sei whales (*Balaenoptera borealis*) in the JARPN II offshore survey area (east of the Japanese coast, west of 170°E, north of 35°N, south of Russian and US EEZ), based on ship-based multi-species sighting surveys with different timing in different years. Due to the migration pattern of sei whales in the area suggested by the sighting survey data, abundance was estimated separately for the early and late seasons. Furthermore, in some instances, data from surveys conducted during two consecutive years were incorporated into the abundance estimate for a season.

Similarly, Hakamada and Matsuoka (2016) presented abundance estimates for sei whales in the JARPNII survey area for the years 2008, 2009, and 2011-12. Considering the migration pattern of these whales in the area suggested by previous analyses, the number of the whales was estimated separately for the early and late seasons. The estimates assumed $g(0)=1$. It is important to note that these estimates represent only a part of the population considered.

The ASG was reminded that these documents were originally reviewed in the 2020-21 intersessional period and considered by ASG and ASI at SC68C (item 11.1.6 of IWC, 2022). At that time, the SC concluded that additional information was required before the estimates could be fully evaluated and potentially endorsed. During the 2021-22 intersessional period, ASG requested that the authors provide this information, which was subsequently reassessed by the original reviewer. A second, independent review, covering the original papers and the new information, was also solicited. Reviewers were directed to focus on sei whales and estimates for other species were not considered.

The reviewers determined that the authors' responses clarified all methodological questions they had raised. Concerns remained about the assumption that $g(0)=1$ and the lack of covariates in the detection functions. Both reviewers also commented on how the timing of surveys relative to migration patterns affects the estimation and complicates the potential use of these estimates by the SC.

The issue of the fluctuation in the numbers of whales observed over years, which ultimately affects the interannual variability in abundance estimates, was raised in the discussion by the ASG. As Hakamada *et al.* (2009) noted, the survey vessels moved in the same direction as migrating sei whales in 2006, which could have caused the higher abundance estimate for that year. Conversely, in 2007, the timing of the surveys relative to migration dates may have caused abundance to be underestimated. The magnitude of these positive and negative biases is not well understood. To address this, the authors subsampled the data to include sightings in the peak migration areas in the early (May-June) and late (July-August) seasons, respectively. There was also a discussion of survey coverage: abundance estimates for sub-area 7 in 2006 were extrapolated to unsurveyed subdivision 7N and were only valid for the early season (Hakamada *et al.*, 2009, table 6), but for the late season the abundance estimates were based on data from 2007 (table 5).

In considering these caveats, the ASG noted that the usefulness of these estimates depends on the objectives; they cannot be used for the entire North Pacific stock, but some operating models can account for the spatial and temporal structure and thus make use of partial stock estimates. Since this review was requested by the Sub-Committee on In-depth Assessments (IA), the ASG noted that these estimates should be useable for an in-depth assessment if the areas and periods are clearly defined. It was also noted that if these estimates were ever combined with those of the POWER surveys, the result would cover a large part of the population's range.

The ASG initially proposed to recommend endorsement (as Category 1A) of all of these estimates, including those given by subarea (SA9) and their subdivisions (SA9N), as well as the combined estimates for the entire study area, while emphasizing that these estimates are only representative of specific locations and periods. However, additional concerns were raised in discussion regarding the appropriateness of combining survey data from multiple years (2002/03, 2004/05) when inter-annual variability is unknown but potentially high, particularly within relatively small areas (e.g. SA8 and SA9 had their subdivisions surveyed in different years). This discussion was not resolved within the time available to the ASG. Therefore, ASG **recommended** that ASI consider this concern more thoroughly when reviewing these estimates. In addition, it was noted that a table listing all estimates by year, period (early or late) and sub-area and any further spatial subdivisions for which abundance was estimated, is required. This information is given in Hakamada and Matsuoka (2016) for the 2008-12 estimates but there is insufficient information in Hakamada *et al.* (2009) to create such a table for the 2002-07 estimates.

3.9 North Pacific blue whales

Bradford *et al.* (2021) report on abundance estimates for 21 species of cetaceans in the U.S. Exclusive Economic Zone of the Hawaiian Islands (Hawaiian EEZ) using ship-based, line-transect surveys conducted in 2002, 2010, and 2017. Low encounter rates in the study area required that sightings of the same and similar species be pooled with sightings from previous line-transect surveys when estimating detection functions. Group size and Beaufort Sea State were the most important factors affecting the detectability of cetacean groups. Only one blue whale sighting was made on effort over 3 years, resulting in abundance estimates of 0, 137 (CV 1.12), and 0 in 2002, 2010, and 2017, respectively.

The independent reviewers were directed to only consider the blue whale estimates, and both had strong praise for the survey and analytical methods. The main concern raised was the scarcity of sightings, which likely reflects blue whale distribution and movement patterns in the area. The authors suggested using the highest of the estimates (i.e. 137) as the best estimate for blue whale abundance in the Hawaiian EEZ during the survey period. However, in discussion, the ASG disagreed. Instead, the average of the three estimates should be used (i.e. 46). Calculation of the CV of this average is sensitive to assuming that the variances for the years with zero abundance are either zero or equal to the estimated variance for 2010. While the missing variances are arguably non-zero, they are likely not as large as that of 2010. For simplicity, it was assumed that the 2002 and 2017 variances were equal to zero, recognizing that this may artificially decrease the resulting CV.

In discussion, it was clarified that the Sub-Committee on the other Northern Hemisphere whale stocks, NH, requires this estimate mostly to have general information about the distribution of blue whales and the proportion of the population that might have been missed by surveys conducted at higher latitudes. Some concern was expressed about the use of *g*(0)=0.55 in the estimate, which was informed by Barlow (2015) and seemed low for blue whales. The consensus was that this value was likely due to persistently high Beaufort sea states.

The ASG endorsed all three estimates for 2002, 2010 and 2017 as Category 3, and **recommended** that the average of 46 (CV 1.12, 95% CI 8-269) be considered the best estimate for the overall abundance of blue whales in the Hawaiian EEZ for the summer-fall period. The ASG did not specify a year to associate with this average abundance but intended it to be broadly indicative of summer-autumn abundance during the span of the surveys. Late in the meeting, renewed attention was focused on the fact that the non-zero abundance estimate (137 for 2010) was based on a single on-effort sighting. The ASG **recommended** that ASI consider this issue more carefully before deciding on the final endorsement of the annual estimates or the average.

Calambokidis and Barlow (2020) provide updated abundance estimates for blue and humpback whales on the US West Coast from mark-recapture estimates based on photo-identifications work conducted by Cascadia Research Collective (CRC) and collaborators through 2018. Several models were explored but the Chao estimate is the one that best accounts for the heterogeneity of capture probabilities. Thus, for blue whales in the eastern North Pacific, the best estimate of abundance was 1,898 (SE=161) based on the most recent four years of data (2015-18).

Reviewers expressed several concerns about the lack of details in the methods and thought that the estimates presented are best interpreted as 'superpopulation' estimates (i.e., an estimate of the number of blue whales that spend some time along the U.S. west coast at some point during four years). In discussion, however, the ASG recognized that this report provides updated estimates using methods and data that have been thoroughly reviewed and used in previous assessments (Calambokidis and Barlow, 2004; 2013; 2017; Calambokidis *et al.*, 2017). Moreover, the new estimates are consistent with previous ones.

The ASG **recommended** that the abundance estimates for the entire time series be accepted as Category 1A and that estimates of 1,422 (CV 0.093, 95%CI 1,186-1,705) for 1998, 1,397 (CV 0.075, 95%CI 1,205-1,619) for 2008 and 1,898 (CV 0.085, 95%CI 1,607-2,241) for 2018 be added to the IWC Table of Agreed Abundance Estimates. These years were chosen to reduce the correlation among tabled estimates.

3.10 Southeast Pacific blue whales

Bedrinana-Romano *et al.* (2018) describe a study of blue whale (*Balaenoptera musculus*) abundance and distribution in Chilean Northern Patagonia, within 25km of the coast. Bayesian hierarchical species distribution models (HSDMs) were constructed using: small boat-based line transect data from 2009 (summer), 2012 (autumn) and 2014 (autumn); presence-only data from 2009 to 2016 (summer-autumn); and a range of environmental and spatial covariates, such as chlorophyll α concentration, sea surface temperature, local oceanography and distance to the coastline. The HSDMs involved combining a binomial *N*-mixture model (modified for zero-inflated Poisson data) of blue whale group counts from line transect data with logistic regression for modelling presence-only data, allowing both models to share covariate parameters for improving estimation precision. The HSDMs were also used to derive abundance estimates. Based on the line-transect data only, precautionary minimum abundance estimates for 2009 (the year with the most data) were provided in Table 1 of the paper as 356 (median), with a 95% credibility interval of 191-652. An abundance estimate that used both the line-transect and presence-only data was also reported, but the authors expressed the view that there was the potential for spatial and temporal bias in the presence-only data to confound the covariate analysis.

The abundance estimates presented in Bedrinana-Romano *et al.* (2018) were discussed briefly by the SH subcommittee in 2018 (item 3.3.1 of IWC, 2019). The primary comments then were that the geographic area covered by the surveys was not likely to represent the whole Chilean blue whale population and that the inter-annual fluctuations in blue whales in the study area are also observed in local mark-recapture data.

The independent reviewers felt that the analyses were generally appropriate, but that the paper lacked some detail about analysis methods. One reviewer noted the discrepancy between the abundance estimates presented in figure 2 of Bedrinana-Romano *et al.* (2018) compared to those presented in table 1 of the paper. The authors responded that the underlying environmental data used for figure 2 comprised a single covariate only, whilst for table 1, the environmental covariates included depended on model selection. The reviewers also noted a lack of information regarding which availability sample was used for the presence data, which had a noticeable effect on abundance estimates. However, the authors were of the view that the differences in abundance estimates between the models with and without the presence only data was instead due to the different environmental predictors used in the models. The authors also advised that they are undertaking more work to fully understand the biases arising from the presence-only data. One reviewer also noted that the reported inter-year variability of blue whales in this study region makes it challenging to design surveys to estimate this population's abundance and habitat preferences. Finally, the ASG noted that the survey region was unlikely to cover the summer geographic extent for this stock.

Both the mean and median abundance estimates were reported in the paper, but because the analysis was undertaken in a Bayesian framework, the ASG decided that estimates of the median abundance would be more appropriate to report. Hines queried whether the potential biological removal (*sensu* Wade, 1998) calculated by Bedrinana-Romano *et al.* (2018) should be assessed, but ASG sought to limit ASG/ASI focus to the evaluation of the abundance estimate itself. How an estimate might be used by the SC, other organisations or national management agencies fell outside the remit of ASI.

The ASG **recommended** that the 2009 summer abundance estimate of 356 (95% CRI 191-652) for blue whales in Chilean Northern Patagonia be endorsed as Category 2.

Williams *et al.* (2011) present a model-based abundance estimate of Chilean blue whales using effort and sightings from a survey along the Chilean coastline undertaken by the SOWER programme in December 1997-January 1998 during the southward transit leg to its Antarctic survey area. This project was first considered by SH in 2009 (item 3.1 of IWC, 2010), at which time only a preliminary estimate was available. Williams *et al.* (2011) describe the aim of the Chilean component of the 1997/98 SOWER survey as maximising encounters with Chilean blue whales to collect a variety of data and samples - and, as such, track placement and coverage did not adhere strongly to standard design-based protocols. Two vessels undertook the survey, each starting at opposite ends of the north-south extent of the survey area and meeting in the middle, with about 8.5% spatial coverage of the survey area. The 'count' method (*sensu* Hedley and Buckland, 2004) formed the core of the model-based analysis, with a GAM used to model the variation in whale densities over space, with an offset term provided by the effective search area. Twenty-six blue whale sightings (30 animals) were included in the detection function. A simple half-normal detection function from binned perpendicular distances was fitted due to the small number of sightings. Twenty-three sightings were available for the spatial model. Mild overdispersion in the counts per segment was dealt with using a Tweedie distribution. Space was the only covariate, and a soap-film smoother was used to help dampen some extreme predictions near the survey area boundary The abundance estimate was given as 303, with a 95% CI of 176-625, for December 1997-January 1998 for the region bounded from 18°30'S to 38°S, and between 12 nautical mile territorial boundary of Chile's coast out to a boundary delineated by a combination of historical catch limits, the 200 nautical mile exclusive economic zone (EEZ) and the time limits of the survey. Two errata have been issued for this paper since it was published in 2011, but neither describes errors that would change the abundance estimate presented (Errata and Williams *et al.*, 2012; 2017). Those corrections only changed the estimated pre-exploitation abundance (and hence inferences about recovery and population trajectory).

The reviewers of Williams *et al.* (2011) noted that although the paper was brief, and did not contain some technical details which would have aided the review process, they believed that the overall methodology and abundance estimates presented were sound, with no critical errors. The reviewers also noted that given that the density surface models used to estimate abundance were based on spatial covariates only, there was no capacity to extrapolate into waters not surveyed. Further, since the survey region almost certainly did not cover the geographic extent of the population, neither the model nor the underlying data could support an unbiased estimation of the population size. This was reiterated in the discussion when the ASG noted that the survey did not cover waters <12 nautical miles from the coastline, which is where blue whales are typically found, nor did it cover areas further south where blue whales are typically found during the December-January period. As such, it was suggested that the mismatch between the survey area and the likely areas of higher blue whale densities meant the resultant abundance estimate for the Chilean blue whale population was probably substantially negatively biased. The ASG did not consider these points to be a criticism of the study, given the multiple factors influencing the original survey design and because the current understanding of where blue whales are at that time of the year was not achieved until after the survey was concluded. The abundance estimate for the actual area surveyed was considered reasonably sound.

The ASG **recommended** that the December 1997-January 1998 abundance estimate of 303 (95% CI 176-625) for the survey area be endorsed as Category 2. It is further **recommended** that when this estimate is included in the IWC Table of Agreed Abundance Estimates, a note should be added to indicate that the estimate is likely to be substantially negatively biased for this population of blue whales due to the location of the survey area.

Galletti Vernazzani *et al.* (2017) reported on photo-identification surveys conducted in the waters off Isla Grande de Chiloé, southern Chile from 2004-12 and Isla Chañaral, northern Chile, in 2012. During surveys between late January to late April, 1,070 blue whales were encountered yielding, after photo-quality control, 318 and 267 unique photographs of the left and right lateral flank, respectively. Due to the lack of matches on the Isla Chañaral photo-ID dataset, only data from southern Chile was selected to conduct mark-recapture analysis, and open population models were used to estimate about 570-760 whales feeding seasonally in this region. POPAN superpopulation abundance estimates for the feeding ground in 2012 are 762 (95% confidence intervals, CI=638-933) and 570 (95% CI=475-705) for left and right aspect datasets, respectively. Results from closed population models were similar. Estimates of trend revealed strong annual variation in abundance, peaking in 2009 and suggesting a fluctuating use in the survey area over time, likely related to prey densities. High inter-annual return rates suggest a degree of site-fidelity of individuals to Isla Grande de Chiloé. The number of whales using this feeding ground is smaller than a previous 2012 abundance estimate combining 2004-2012 data from Isla Grande de Chiloé and single-year data from Isla Chañaral (Brownell *et al.*, 2015; Galletti Vernazzani *et al.*, 2015).

Preliminary results from Galletti Vernazzani *et al.* (2017) were presented to SH in 2016 (item 5.3.1 of IWC, 2017a). At that time, SH noted that the abundance estimate should only apply to this region and not the broader Chilean blue whale population, given most of the data was collected from the Chiloé feeding ground. However, while the survey area described by Williams *et al.* (2011) was much further north, satellite telemetry suggested that Chiloé blue whales also travel through this area (Hucke-Gaete *et al.*, 2016), making it unclear what proportion of the population is being estimated.

The independent reviewers of Galletti Vernazzani *et al.* (2017) noted that this paper represents an important, long-term photo-ID study of Chilean blue whales. One reviewer noted that the blue whale population on the Chiloé feeding ground was difficult to study, given the low resighting rate, but was also confused about how to reconcile such a low resighting rate with the suspected high site fidelity. The other reviewer noted the inferred heterogeneity in visitation rates to the archipelago and expressed concern that it would be difficult to account for this heterogeneity robustly due to the low detection probabilities (0.02-0.27). Coupled with the relatively small area being studied, this underscores the fact that these estimates are likely to be an underestimate of the total number of whales in the subpopulation. In response to the reviews, the authors of Galletti Vernazzani *et al.* (2017) stated that the presence of blue whales on the Chiloé feeding ground is quite dynamic and their reported abundance estimates do not represent a broader population, but only the survey region.

The ASG commended the authors for collecting and processing this valuable long-term dataset. Jackson added that while there was no change in apparent abundance through time, there was considerable fluctuation in the use of the feeding ground, probably due more to environmental variation, and not to fluctuations in the biological parameters of the population itself. In discussion, the ASG noted that whale transience would negatively impact abundance estimation, but that the severity of the impact remained unclear. The ASG also believed that more consideration of how to summarise POPAN superpopulation estimates like this one would be helpful.

In determining the category, it was noted that the authors summarised their work as follows:

> *'nine years of data reveal that the Chiloé feeding ground is used by a small number of whales in the mid-hundreds which have high inter-annual fidelity to this region',*

which would seem to match the definition of a Category 3 estimate, in that it gives only a broad impression of the abundance. The ASG **recommended** that the superpopulation abundance estimates of 762 (95%CI 638-933; left side) and 570 (95%CI 475-705; right side) for the survey area for the period 2004-12 be endorsed as Category 3.

Cooke and Jackson (2017) present a reanalysis of data described in Galletti Vernazzani *et al.* (2017), which was undertaken during the 2016 SC meeting (item 5.3.2 of IWC, 2016). Given the inter-annual fluctuation in abundance seen in the Isla de Chiloé dataset, the resightings showed a skew typical of a transient/resident mixture. Therefore, the abundance of blue whales from the Chiloé area might be more appropriately modelled using a mark-resighting framework that explicitly accounts for residency and transience. An individual state-space model previously used for gray (Cooke *et al.*, 2016) and right whales (Cooke *et al.*, 2015) was applied. Each whale was assigned a probability of being either a resident or a transient, and the sampling and availability model accounted for the side of the animal that would be photographed. Both open and closed models were attempted, although details of these were not provided. The authors preferred an open model fit, which gave an abundance estimate of 450 (CV=0.17), which applied to the middle of the timespan, being approximately mid-way through 2008. The resident proportion was estimated at 41-45%. The left/right ratio was estimated to be 51:49. This is close enough to the true population value of 50:50, so the 'error' that results from not forcing this ratio to be 50:50 can be assumed to be negligible.

One independent reviewer suggested that it was difficult to properly appraise Cooke and Jackson (2017) due to the lack of detail in the paper. They further doubted whether the transient animal issue was particularly severe or even worth addressing. The other independent reviewer felt a transience issue was present and a serious concern for abundance estimation, as the SC had highlighted previously (item 5.3.1 of IWC, 2017b). This reviewer thought the analyses in Cooke and Jackson (2017) went some way to resolving concerns about transience. The reviewers also noted there was equal support for both the open and closed population models, but that these led to quite different abundance estimates.

In discussion, Givens asked whether the state-space model approach used for gray whales had been independently reviewed. There seemed to be no specific SC review of the modelling for the previous southern right whale and gray whale applications of this approach, although IWC (2016, item 4) and IWC (2017a, item 3.2.2) discuss modelling outputs. Comments highlighted that previous use of the state-space modelling approach faced a similar critique when the approach was applied to Sakhalin gray whales (Cooke *et al.*, 2017). When ASI reviewed that analysis in 2017, they noted that there was insufficient detail in the paper to judge the modelling and requested more information, including 'full details of the likelihood function and how posterior samples were generated', and further details on the time series data, before it could be used in management advice (item 3.1.1.7 of IWC, 2018a). The ASG considered how it might be possible to facilitate a further methodological review, and whether it would be advisable to postpone the conclusion of the assessment of SH blue whales until such a review was obtained. Jackson suggested that a review of the state-space modelling methods would be valuable for the work of SH, and of the Committee more broadly, and that it would be worth waiting another year if a

review was possible. However, it was further noted that such a review is not imminent. Consequently, ASG believed that ASI should categorise the existing abundance estimate, with the understanding further information on the modelling may be available in the future. It was noted that since the Committee has experience with the application of the approach for several species, the underlying model and methods have been discussed repeatedly. Such familiarity with the approach is reassuring, although it falls short of full evaluation and endorsement. Finally, advice was given that a similar model had been fully specified in the appendices of Brandão *et al.* (2021) and that those appendices might prove useful in reviewing the approach.

The ASG **recommended** that the abundance estimate of 450 (CV=0.17) for the survey area be endorsed as Category 2, but that it should be given an Evaluation Extent of 4 (the estimate was partially considered by the sub-committee and a new method was used). A review of the full details of the modelling should be required before this abundance estimate might be used for management advice.

3.11 Antarctic blue whales

Matsuoka and Hakamada (2014) describe abundance estimates for Antarctic blue whales (*Balaenoptera musculus intermedia*) south of 60°S for regions across the IWC Management Areas IIIE+IV+V+VIW (i.e. 35°E-145°W) using sighting data collected from 1995/96-2008/09 from Antarctic sighting surveys from the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA) and JARPAII. Blue whales were encountered throughout the surveys and were widely distributed without apparent aggregation. Abundance estimates were obtained using standard line transect analysis methods under the assumption of $g(0)=1$. Several abundance estimates are given in Matsuoka and Hakamada (2014) according to: season-level survey strata for the years 2005/06-2008/09 (table 3a), IWC Management Area (table 4a), and combinations thereof (table 5). Blue whale abundance estimates for the period 1995/96-2004/05 at the level of IWC Management Area were first given in tables 5a-5d of Matsuoka *et al.* (2006), which were then reproduced in Matsuoka and Hakamada (2014. In summary, the blue whale abundance estimate for the 1995/96 summer season for the combined IWC Management Areas IIIE+IV+V+VIW was reported as 300 (CV=0.308); the corresponding estimate for the 2008/09 summer season was 1,223 (CV=0.345). Neither CV accounts for potential additional variance.

The results in Matsuoka and Hakamada (2014) were originally presented as part of the review of the JARPAII Special Permit Research Programme (item 6.3.1 of IWC, 2015). During the 2014 discussion, the review panel noted the 2005/06-2008/09 surveys probably covered the peak of blue whale abundance south of 60°S. The panel also made several recommendations for improvement to analyses for estimating the abundance of blue whales including: a more thorough description of methods and assumptions; more consideration of issues around small sample sizes; and a clearer explanation of differences between ideal and realised tracklines, and the implications thereof. Various abundance estimates arising from the 1995/96-2004/05 surveys (Matsuoka *et al.*, 2006) were reviewed in 2006, but the blue whale abundance estimates were not mentioned specifically (items 2.4.2 and 2.5.2 of IWC, 2008a).

Considering Matsuoka and Hakamada (2014), the independent reviewers noted that the data collection and survey designs have been well described. They considered these to be the standard methodology for abundance estimation adopted by the Committee, and essentially the same as those used for estimates generated from IDCR/SOWER data. The reviewers also noted that while there was poor coverage in some areas and years, the analytical solutions described to combine abundances across areas were reasonable.

In discussion, the ASG considered whether blue whale abundance estimates should be evaluated at the area-level or for all areas combined (across IWC Management Areas IIIE+IV+V+VIW). Branch reported that in the past (e.g. Branch, 2008; IWC, 2009, item 3.2), he had used the abundances reported in Matsuoka and Hakamada (2014), and that he tended to favour the combined IIIE+IV+V+VIW estimates, including tracking these through time to study trend. A question was raised as to whether Antarctic blue whales have any population structure and, if so, whether it coincided with the IIIE+IV+V+VIW area boundaries. Branch reported that it is thought that there is only one circumpolar population of Antarctic blue whales, but that there were differences of opinion among researchers, and some hotspots are known to exist. It was also noted that while there was no doubt that the combined survey region of IIIE+IV+V+VIW did not cover the entire circumpolar distribution of Antarctic blue whales in the austral summer, the IIIE+IV+V+VIW survey region is still a very large proportion of the area south of 60°S. Furthermore, this region also covered many degrees of latitude, from the coastline up to 60°S, arguably making it representative of (despite not fully covering) the entire circumpolar region.

The ASG **recommended** that the abundance estimate of 300 (CV=0.308) for the 1995/96 summer season, for the combined IWC Management Areas IIIE+IV+V+VIW (i.e., 35°E-145°W, south of 60°S), and an abundance estimate of 1,223 (CV=0.345) for the IWC Management Areas IIIE+IV+V+VIW for the 2008/09 summer season, be endorsed as Category 1A. The separate IWC *Management Area* estimates are also **recommended** for Category 1A endorsement if these are required for Committee work.

Branch (2007) presents a study of Antarctic blue whale (*Balaenoptera musculus intermedia*) sightings during the three complete circumpolar surveys of IWC's IDCR/SOWER programme. The IDCR/SOWER ship-borne surveys have completely circled the Antarctic three times: 1978/79-1983/84 (CPI); 1985/86-1990/91 (CPII); and 1991/92-2003/04 (CPIII), covering

strata totalling 64.3%, 79.5% and 99.7% of the ocean surface between the pack ice and 60°S. During the surveys, blue whale sightings were rare but were recorded in all regions. Respective circumpolar abundance estimates were 453 (CV=0.40), 559 (CV=0.47) and 2,280 (CV=0.36), with corresponding mid-years of 1981, 1988 and 1998 for the areas surveyed (alternative estimates of 'comparable areas' are also offered in table 4 of the paper). The CPIII estimates are the most complete and recent for this subspecies. These abundance estimates are negatively biased because some Antarctic blue whales may have been north of 60°S or in the pack ice at the time of the surveys and because a small number of blue whales on the trackline were probably missed. Furthermore, a small proportion of pygmy blue whales, probably less than 1%, may have been included in the sightings. Preliminary results from the study were presented to SH in 2007 (items 7.3 and 7.4 of IWC, 2008b), but no specific discussion was reported.

Independent reviewers noted that the field protocols and survey designs for the IDCR/SOWER sighting surveys were well described, and that the analysis methods were standard and accepted by the Committee. One reviewer suggested the assumption of $g(0)=1$ was probably appropriate but observed that the detection functions for CPI and CPII show unusual shapes and poor fit. As noted by Branch (2007), this has been observed elsewhere in the IDCR/SOWER data and may have been a function of the small number of sightings before the use of the process of 'smearing' to deal with heaped distance and angle estimates. The reviewer also offered evidence of concentrations of Antarctic blue whales observed north of 60°S during the summer months (Calderan *et al.*, 2020), and so suggested that the abundance estimates presented here might be negatively biased. Furthermore, this reviewer felt that due to the problems in the detection function fit, the abundance estimate from CPIII was the only result adequate for conservation and management advice.

In discussion, the ASG reflected on the suggestion by an independent reviewer to consider only the CPIII abundance estimate. It was noted that the odd detection function fits, particularly for CPI, might have also been driven by protocols focused on Antarctic minke whales, particularly because most sightings of blue whales occurred closer to the ice edge when the vessel was seeking to maximize minke sightings for Discovery marking purposes. It was further suggested that it was unlikely that the poorly fitting detection functions in CPI and CPII would have substantially altered the abundance estimates. The ASG also noted the tracklines during CPI did not typically extend fully to 60°S, but Branch suggested that since the peak of blue whale density was near the ice edge, the northern limits of the trackline during CPI was not likely to introduce substantial negative bias. To determine the potential for negative bias from animals north of 60°S, it was noted that data from the JSV series (Butterworth and Geromont, 1995; Miyashita *et al.*, 1995) might be informative, although those data may be too geographically coarse for such use. Another potential source of information is the commercial catch series for blue whales, however, that ended long before the IDCR/SOWER surveys were undertaken, so its use is also limited. Regarding the survey protocols and track design for CPI, it was agreed that whilst these were focussed on Antarctic minke whales, overall CPI was still capable of supporting reliable estimates of Antarctic blue whale abundance.

The ASG **recommended** that the circumpolar (and south of 60°S) abundance estimates of 453 (CV=0.40) for CPI (1978/79-1983/84; mid-year 1981), 559 (CV=0.47) for CPII (1985/86-1990/91; mid-year 1988) and 2,280 (CV=0.36) for CPIII (1991/92-2003/04; mid-year 1998) be endorsed as Category 1A. These estimates should also be footnoted with a suggestion that the survey designs and sighting protocols for CPI differed somewhat from those of CPII and CPIII. Furthermore, separate 'comparable areas' abundance estimates (table 4), and IWC Management Area estimates (table 5), are also **recommended** for Category 1A endorsement if these are required for Committee work.

3.12 North Atlantic humpback whales

Leonard and Øien (2020b) report on shipboard line-transect surveys of the northeast Atlantic. Minke whales were the target species, but abundance estimates were also presented for other species, including humpback whales. A multiyear mosaic survey design was used, with two independent observer platforms operating in passing mode, and estimates were derived using mark-recapture distance sampling techniques, correcting for perception bias. The abundance of humpback whales was estimated as 9,749 (CV=0.34, 95% CI: 4,947-19,210) for the 2002-07 period and as 12,411 (CV=0.30, 95% CI: 6,847-22,497) for the 2008-13 period.

Leonard and Øien (2020a) report on surveys of the same area in 2014-18 using the same design and analysis as above. The estimated abundance for humpback whales was estimated to be 10,708 (CV=0.38, 95% CI: 4,906-23,370).

All independent reviewers for the two papers agreed as to the high quality of the survey and analytical methods, and the exemplary application of mark-recapture distance sampling analysis methods. The consensus was that the abundance estimates are suitable for use in assessment and management. It was noted that the data were separated into three long periods (2002-07, 2008-13, 2014-18) to ensure that enough detections existed to fit the detection functions, which means that any population change that may have occurred within each of these survey periods will not be detected. One reviewer noted the need to be careful regarding the apparent increase in abundance between the first two time periods due to a 10% increase in the area covered by the second survey and suggested that using density measures for comparisons between periods might be a better option than using estimated absolute abundance.

In discussion, the ASG noted that although estimates were provided for small geographical blocks (that had been optimized for minke whales), it would be more appropriate, and consistent with previous assessments, to report the humpback whale estimates at the scale of the entire survey area.

The ASG **recommended** that these estimates be endorsed as Category 1A. The three time periods were analysed separately (no pooling of data) and thus can be considered independent.

Wenzel *et al.* (2020) reported on photographic sighting histories of humpback whales in the Cape Verde Islands to estimate population size, survival and recruitment using a Jolly-Seber mark-recapture model. The data spanned the winter/spring months between 1990 and 2018 and include a compilation of several formal survey efforts as well as a large amount of citizen science observation (whale watching trips). The results suggested strong site fidelity to this breeding ground. Only the data from 2010 to 2018 was used in the abundance estimate, and the estimated total number of humpback whales occurring in this area in this period was 272 (SE 10).

Both independent reviewers highlighted the potential for bias in the estimates due to issues with detectability (mentioned by the authors) and spatial and temporal heterogeneity in sampling effort that cannot be accounted for by the Jolly-Seber model. This could lead the population estimate to be biased low, and the lack of clarity in the data pre-selection process also contributes to the potential for bias.

In discussion, the ASG noted that humpback whales breeding in the Cape Verde Islands likely represent the remnants of a historically larger breeding population and that this region is difficult to survey. Stock identification questions still need to be resolved, but there was consensus that despite some caveats, this estimate represents a valuable improvement over previously available information that could be useful for an in-depth assessment.

Therefore, the ASG recommended that the estimate of 272 (CV 0.037, 95%CI 253-292) be endorsed as Category 1B.

Lawson and Gosselin (2018) report on a wide-scale aerial survey of the Canadian waters of the Atlantic in Aug.-Sep. 2016. The survey had not focused on any one species and was timed to coincide with the expected peak abundance of the cetacean species of greatest interest. One of the researchers' goals was to compare the 2016 survey estimates to those obtained from an earlier wide-scale aerial survey conducted in 2007. To allow for this, and other comparisons, the survey methodology remained as similar as possible to that used in 2007 and to that used by the US National Oceanographic and Atmospheric Administration (NOAA) for similar surveys. A dual-observer approach was taken to collect data appropriate for estimating perception bias using the mark-recapture distance sampling framework, and estimates of availability were derived using methods described by Laake *et al.* (1997) combined with published surfacing rates. Abundance estimates were generated in two strata: (1) Newfoundland and Labrador (NL); and (2) Gulf of St Lawrence, Scotian Shelf and Bay of Fundy region (Gulf+SS+BoF). For the Newfoundland and Labrador region, a corrected humpback whale abundance estimate was given as 8,439 (CV=0.494); for the Gulf of St Lawrence, Scotian Shelf and Bay of Fundy region, a corrected abundance estimate of 1,854 (CV=0.400) was provided.

The independent reviewers both considered the study to constitute a well-designed and extensive aerial survey and the resulting data to be very valuable. The reviewers considered the double-observer approach to be appropriate and welcome, with nothing to indicate the presence of major errors. They noted, however, that the results were difficult to interpret on account of there being multiple aircraft, detectability corrections, survey regions, and species. Furthermore, both reviewers noted that whilst the humpback whale abundance estimate presented for the Newfoundland and Labrador region was quoted as being corrected for both availability and perception bias, it seemed that the availability component may have been left out.

In discussion, the ASG considered how much of the population was covered by the survey region at the time of year it was undertaken. Robbins reported that the two survey regions would each be considered to have partial coverage of the eastern Canadian feeding stock, which in turn is one subset of the North Atlantic Population. The NL survey area would have achieved full coverage of the Newfoundland and Labrador areas. The Gulf+SS+BoF survey area is more complicated in that it covers a portion of the eastern Canadian feeding grounds in the Gulf of St Lawrence and the Scotian Shelf and a portion of the Gulf of Maine feeding grounds. One reviewer suggested scoring the two surveys separately and Robbins commented that, of the two, she considered the NL survey region to provide the most important result from this study for the North Atlantic humpback assessment planned by NH. In discussion, others agreed that those results are especially valuable because they represent complete coverage of a large portion of the eastern Canadian feeding area for which there are relatively few other recent or historical abundance data.

The ASG **recommended** that the abundance estimate of 8,439 (CV=0.494) for Aug.-Sep. 2016 for the Newfoundland and Labrador region be endorsed as Category 1A, and the abundance estimate of 1,854 (CV=0.400) for the Gulf of St Lawrence, Scotian Shelf and Bay of Fundy region be endorsed as Category 2. However, this recommendation should be considered further by ASI after clarification about whether an availability correction was used for the Newfoundland and Labrador region. Doniol-Valcroze volunteered to enquire with the authors and report back to ASI.

3.13 Franciscana

SC/68D/CMP/17 [Crespo *et al*. (2021)] present new abundance estimates for franciscana, but the document was submitted after the deadline for ASG review. Relevant convenors have agreed that this paper will be noted by the Sub-Committee on Conservation Management Plans, CMP, who may request that the paper be reviewed by ASG in the next intersessional period for future consideration by ASI at SC69.

4. CONSIDERATION OF STATUS OF STOCKS

The Scientific Committee, through the work of ASI, has been developing an approach to present information on the status of whale stocks to the Commission and the public (IWC, 2018b; 2020; 2021a; 2022). Originally planned as a biennial document, a Status of Stocks Website was deemed more practical and useful in recent Committee discussions, and ASI has begun developing methods and website content.

Last year the Committee requested a more detailed website proposal, and an intersessional correspondence group (ICG) was formed to progress this work (items 11.4 and 11.6 of IWC, 2022). The goal of the proposed Status of Stocks Website is not to replace or contradict existing IWC web pages, nor to replicate either the intent of or material contained in, information sources such as the IUCN Red List. Instead, the Committee wishes to highlight its quantitative assessments, which provide a view of status that is different in character to those provided elsewhere. Specifically, the Committee intends that the information provided in the Status of Stocks Website should be based on the stock assessment modelling work conducted for the Committee's in-depth assessments, AWMP and RMP development, some *Implementation Reviews*, and so forth. There remains a question as to whether the information on the Status of Stocks Website should include information about stocks not assessed via population modelling, and if so, what sort of information would be provided.

On behalf of the ICG, Givens, Punt and Allison developed a detailed proposal that included examples for three assessed stocks (eastern North Pacific gray whales, North Atlantic minke whales, and Bering-Chukchi-Beaufort Seas (BCB) bowhead whales), as well as for several unassessed stocks such as the vaquita and eastern Canada – West Greenland (ECWG) bowhead whales. This proposal was shared with communications and IT specialists from the Secretariat. A team from the Secretariat volunteered to present their vision for how such content could be interwoven with the IWC website, www.iwc.int; see Item 4.2.

4.1 The ICG proposal

The proposal suggested organizing the website into three levels of increasing technicality.

(1) A Welcome Page providing summary indicators of status for all assessed stocks at a glance,
(2) Status Summary Pages providing plain language status assessments for individual species or stocks, and
(3) Status Details Pages providing technical information about how the results in each Status Summary Page were derived, and a single Methods Page that provides a general description of the Committee's approach to assessment modelling and the calculation of the statistics reported on the proposed website.

The proposal is very dependent on an Abundance Page summarizing abundance estimates for assessed stocks. The IWC website already includes a page with information on abundances, so the proposal addressed modifications to that page; see below.

The proposal makes no appreciable changes to the mathematical modelling and statistical summary of the assessments that ASI has developed for the Status of Stocks project in recent years. These technical details are given by (IWC, 2018b; 2020; 2021a; 2022).

The Welcome Page aims to provide an overall summary of the status for all assessed stocks that could be understood at a glance without reference to technical detail. This information would be displayed in a tabulated format, displaying simple indicators of the level to which abundance has been reduced (referred to as depletion in SC discussion and 'relative abundance' in the proposed website content) and population change for each stock or species. A new feature is radial colour 'thermometer' graphs for indicating (on a continuous scale) the estimated values and uncertainty ranges for relative abundance and change, which supplement the discrete categories and labels discussed last year. While those category labels are still displayed below the thermometer, the new graph emphasizes the continuum of the estimates and their uncertainty. The proposal noted that numerical summaries of depletion are not without problems, given that populations may grow beyond pre-exploitation levels (original carrying capacity) - as may be the case, for example, for BCB bowheads - and given that some SC assessments use current carrying capacity as a reference level, instead of the pre-exploitation level, often for the pragmatic reason that the latter is difficult to reconcile with estimates of historical catches and the dynamics models employed. A plain language explanation of carrying capacity, depletion, and these potential problems is essential. Other new additions in the proposal include renaming the status summary statistics to 'Relative Abundance and '30-Year-Change', as well as changing the names for the discrete categories associated with them.

The Status Summary Pages would provide a summary of the status of individual stocks/populations. A page for a stock would include:

- an image of the species and a map of approximate stock boundaries;
- comments about stock definition;
- information regarding any current or recent exploitation;
- the most recent direct abundance estimate (i.e., from a survey, not an assessment model);
- links to pages on www.iwc.int where additional information about the species can be found;
- a table of pooled assessment results (Relative Abundance and 30-Year Change);

- a trajectory plot, potentially followed by a summary statement on recovery; however, the ASG has noted potential issues with standardising language about recovery across different stocks/populations;
- a list of known threats to the stock;
- a statement about data quality and date of the last update; and finally
- links to more technical details in the corresponding Status Details Page and the Methods Page.

The proposal recommended that technicalities and citations should be avoided on a Status Summary Page.

When there are multiple stocks of a species, the Status Summary Page has the potential to be confusing, especially if not all stocks had been assessed using the SC's assessment modelling approach. This would lead to inconsistencies in the information displayed and how it was derived. More generally, it was noted that the development of Status Summary Pages would require careful consideration of exactly what the assessment should cover, e.g., stocks, aggregations, and/or areas, and this aspect becomes even murkier when stocks mix. The general approach adopted by ASI in previous years was that when an assessment covered a large region having potentially multiple stocks or sub-stocks, results from selected highly plausible stock scenarios are pooled, and the results for each stock are then reported individually and in total. That approach would be continued here.

The most technically detailed level of the Status of Stocks Website would be found on the Status Details Pages. Given the nature of the information required to specify an assessment fully and summarize the results, the Status Details Pages might be PDFs rather than webpages. A Status Details Page would contain a description of the trials, MSYR values, the reference population level (pre-exploitation or current carrying capacity), and more details on the modelling exercise. The assessment results would be tabled per trial, as well as pooled over all trials in the manner previously agreed by ASI. Citations of published papers and SC documents would be required to explain the assessment framework fully.

For both the Status Summary Pages and the Status Details Pages, the proposal emphasized the importance of obtaining advice and review from species/stock experts. Modelling experts would also be required to explain the trial specifications in plain language on the website and to provide references to background documents.

The proposed Methods Page is also highly technical, explaining the basic principles of assessment modelling; concepts such as carrying capacity and depletion; the Relative Abundance and 30-Year Change statistics used to summarise status in simple terms; how to calculate statistics and combine them over trials; thresholds for categorizing depletion and change, and the labels for those categories. Given the level of detail, the Methods pages might also be better in PDF format.

As mentioned previously, an Abundance Page already exists on the IWC website (*iwc.int/about-whales/estimate*), and the Status of Stocks website would link to it frequently. However, the page does not currently mirror (or link to) the IWC Table of Agreed Abundance Estimates. That Table includes additional estimates, more recent estimates, and estimates for more diverse areas/stocks/species, than those listed on the Abundance Page. The proposal recommended that the Abundance Page should be updated to provide access to the Table, or that some attention be paid to making the two sources of information more comparable.

4.2 The Secretariat proposal

Kate Wilson, Communications Officer for the Secretariat, explained a proposal to integrate the new pages being developed by the SC with the existing content on status at *www.iwc.int.* The intent was to build on the existing introductory level information, developing this into a new sub-section on status which comprised an introduction, background information section and stock assessment pages.

Noting that this is an evolving project and that the number of assessments available would grow gradually, the Secretariat proposed short- and longer-term approaches to the stock assessment pages. In the short term, the content would be divided into separate pages containing status summaries, status tables and assessment details. In the longer term, they proposed that all the available stock assessment information for each stock would be merged onto a single page, beginning with the simple summary and graphics, and moving through to the more detailed and technical content. This longer-term approach aims to simplify the site, assist user navigation and encourage users towards the more technical information.

The Secretariat highlighted that status is one of the most frequently sought topics on the website, and the aims of the Status of the Stocks initiative appear entirely compatible with the aim of updating and improving existing website content. The Secretariat welcomed the opportunity to work with the SC on this initiative.

4.3 Discussion of proposals

Givens thanked the Secretariat for engaging with the ICG and ASI so comprehensively at this early stage of the development process, and for providing a demonstration of how the Status of Stocks Website could be integrated into *www.iwc.int*. In his view, the demonstration showed that the Secretariat and ASI shared largely compatible visions for the final product and that this should energize the development process in ASI.

Staniland commented that the ICG and Wilson had done an enormous amount of work so far, both for the separate proposals, and then in the subsequent work to demonstrate their compatibility. In the Secretariat's view, the IWC website would benefit from more information about the status of stocks, which is a matter of very high concern among the public.

Wilson advised that the current content pages of the IWC website mirror language from SC reports. This was deliberate to ensure clarity and consistency because the public has access to the SC reports through the website. More detailed content, like that which the ICG has proposed, could also be presented in a similar way, but this would require careful presentation to avoid confusion. Wilson also stated that the IWC website currently presents information about whales at three levels, from introductory through to 'practitioner' level, with the latter including technical reports, endorsed protocols, and guidelines. Givens noted that the three-level design of the ICG proposal intentionally mimicked this strategy.

The ASG noted that Wilson's demonstration appeared to include essentially all the content from the ICG proposal, with the Welcome Page being separated by species initially but reconstituted as a single page in the long term. The existing status information (where portions of the Welcome Page would initially be inserted) on *www.iwc.int* is currently quite basic. While this provides the level of information many members of the public are seeking, the Status of Stocks project offered the opportunity for readers with a deeper interest to obtain information with far greater scientific detail. Wilson added that the two-stage treatment for the Welcome Page was recommended because the Status of Stocks project represented ongoing work; it will take several years to accumulate sufficient information to warrant a single Welcome page. She added that the existing status information was last updated in 2019 and will soon be due for revision.

The Secretariat also thought it important to include text on how the SC's assessments differ from those of other organisations. This is particularly important for the IUCN, given that IUCN Red List statuses are currently referenced in many places on *www.iwc.int*.

ASG supported this idea, and Givens asked a small group (Donovan, Butterworth, Punt) to provide a presentation to ASI at the SC meeting to articulate how the SC assessments differ from assessments based on the IUCN Red List categories and criteria. It was noted that the IUCN Red List was originally intended to provide rapid assessments of as many species as possible to identify any potential problems and to flag the need for further investigation, especially for species where less information may be available than is typically the case for fisheries and marine mammals. Another point of difference between IUCN and SC status assessments is that IUCN usually focuses on species instead of stocks. Furthermore, it was noted that IUCN criteria are applied uniformly across species, leaving little room for more nuanced interpretations. Butterworth expressed concern that labels such as 'endangered' are designed to be attention-grabbing. Information sources for IUCN are subject to different levels of scrutiny and can involve expert opinion, whereas formal SC assessments are almost wholly empirical modelling exercises. Representatives from the IUCN were not present at the pre-meeting and unable to present their views; further discussions on this are planned for SC68D, including ASI consideration of the small group presentation comparing SC assessments and the IUCN Red List.

Givens asked the ASG to consider whether the Status of Stocks website should also address species/stocks for which comprehensive population models are not available, noting that such situations can be quite diverse, ranging from the vaquita (for which the concept of status is extremely important) to ECWG bowheads (for which there are good data available, but no SC assessment, and the stock is not depleted). Jackson added that it would also be important to consider whether model-based status assessments developed and published outside of the Committee's work should be included on the Status of Stocks Website. If so, the evaluation of such assessments and the priority for their inclusion would require discussion.

Different suggestions were made to address this issue, including noting on the website that the Committee has considered such unmodeled stocks, but only including information there that had been fully reviewed by the Committee. This would particularly pertain to assessments conducted and published outside the SC. Alternatively, available information and external assessments could be reviewed by relevant SC subgroups to synthesize expert judgment. For data-limited stocks, a qualitative assessment might be sufficient, and the status information would not need to be more detailed than what is displayed on the proposed Welcome Page and Status Summary Page, absent the assessment modelling results. Givens noted that the ICG proposal included the use of the 'Suspected…' qualifier for such cases on the Welcome Page, and the status of 'Unknown' for cases even more poorly understood. He also pointed out that the proposal included a system for rating data quality, which would be noted on the Status Summary page.

Givens also advised that in the initial phases of the Status of Stocks project, a list of candidate stocks was produced (table 14 of IWC, 2021a), with priority given to stocks for which assessments have been completed. The ASG considered whether cases like the vaquita should also be prioritized highly. The ASG concluded that ASI should prioritize both types of situations, particularly given that the Committee has made strong statements about the need to take action to reduce human-induced mortality to zero for stocks such as North Atlantic right whales and various smaller cetaceans. Butterworth cautioned against prioritizing too many at-risk stocks for initial inclusion because users of the website might understand the frequency of such listings to suggest the IWC has grave concerns for a consequently artificially high proportion of the world's cetacean populations. It is not yet clear how stocks that are neither data-poor nor have been formally assessed by the Committee (e.g. ECWG bowheads) should be prioritised.

In choosing stocks to assess, ASG noted that there are probably three levels of preparedness for assessment: (1) stocks for which in-depth assessments, *Implementations* or *Implementation Reviews*, have already been conducted; (2) stocks

that are currently in the process of undergoing an in-depth assessment, or for which one is planned in the future; and (3) populations with potentially little available information, but for which there is no need for detailed modelling because the status is already clear, such as vaquita. Givens noted that it was not necessarily easy to compile assessment results even for stocks in the first category. For example, for the BCB bowhead assessment in the ICG proposal, he and Punt had relied on some *ad hoc* assumptions and best guesses about technical specifications, since the abundance and catch data as well as the assessment modelling approach itself had changed since the early 2000s when the development process for the bowhead SLA had fully documented an assessment approach. Thus, even the notion of 'completed' work is not straightforward. A comment was offered that accepted robust assessments, management approaches, and evaluations were not meant to be updated, but the case of the BCB bowhead whales suggested that the requirement may have to change. Givens added that, in his view, assessment results on the proposed website should be updated regularly, both as new data are obtained and as methodology changes. A rolling schedule, similar to the regular *Implementation Reviews* for the AWMP, was suggested.

Further ASG discussion focused on details of summarizing assessment results. It was noted that the Schedule within the International Convention for the Regulation of Whaling contains a framework for the classification of stocks (para. 10), and ASG considered whether that was relevant for summaries on the proposed Status of Stocks Website. In the view of the ASG, the Schedule language was outdated, and the Committee should work with scientific languages and practices currently in use.

Concern was expressed about uncertainties inherent in assessing the status of a stock, and the potential that displays of results could lead to a false impression of high precision for a reader not well versed as regards scientific uncertainty. There are considerable uncertainties, for example, in models of stock structure and hypotheses for the trials and sensitivity tests chosen for assessments. The overall conclusion about status must acknowledge this uncertainty. To address this, ASI's agreed status assessment approach integrates disparate trials, and the proposed thermometers display a range of uncertainty. The inclusion of introductory text highlighting the nature of uncertainty in science, especially as applicable to whale stock assessment, was suggested. However, the ASG also noted the public's potential misinterpretation of 'uncertainty' as 'ignorance'. Care would be needed to avoid degrading the Committee's work through an over-emphasis on uncertainty. The Secretariat's communication and information experts would help ensure that the explanation of scientific uncertainty was well-balanced.

Attention was drawn to the difficulty of distilling a complex stock assessment down to an interpretable and scientifically defensible one- or two-dimensional metric to present to the public. Two thermometers and single-word descriptors summarizing population status are proposed, recognizing that stock status is a two-dimensional concept: how many whales are there (relative to some reference level), and how is that abundance changing? For the trajectory plots on Status Summary Pages, it was suggested that a short, simple sentence describing the depletion, recovery and trend shown in the plot might also help convey status in plain language.

There was disagreement as to the extent to which the language summarizing status should adopt a 'bland' scientific tone or advocacy language. It was noted that some members of the Committee might wish to see advocacy language, particularly when stocks/populations are facing dire outcomes; others were concerned, however, that use of such language might decrease respect for the authoritative nature of the science-based results provided. In the ICG proposal, advocacy language about the vaquita was taken verbatim from past SC reports. This disagreement about tone will be particularly relevant in cases where assessment would be based more on judgment than model results.

Wilson mentioned challenges associated with including maps to delineate population distributions, including the cost of copyrights, and how existing maps might not necessarily be accurate, visually appealing, or otherwise suitable. She suggested that ASI might approach members of the Committee who could contribute their time and technical skills to producing tailored maps in the future. Alternatives would likely require funding, although eliminating maps from the website design is an option as well.

The ASG asked Wilson how the Committee and the Secretariat might most effectively work together on this initiative, noting particularly that this will involve: species-level experts; experts from both the SC and the Secretariat for designing and wordsmithing content; a different collaborative team from the SC and Secretariat to undertake all the analysis and computing; and periodic updates (e.g., every 5-10 years). Wilson offered to assist with honing accessible language once there was some agreement on content. In terms of timelines, a relevant milestone for the Secretariat is the delivery of the Intersessional Report[1], which the Secretariat publishes roughly one month before an upcoming Commission meeting. Staniland asked the Committee to help identify key experts within the Committee or beyond, who could help develop the first draft of a Status Summary Page for each chosen stock. This could then be sent to the Committee, or some subset thereof, for approval. The ASG considered that an editorial group comprised of convenors could identify and work with species-experts within their sub-committees; this would avoid the Secretariat having to liaise with too many people.

[1] *https://archive.iwc.int/pages/view.php?search=%21collection24481+&k=&modal=&display=list&order_by=title&offset=0&per_page=240&archive=&sort=DESC&restypes=&recentdaylimit=&foredit=&ref=6977.*

Givens expressed concern about the degree to which progress on this project was currently contingent on very heavy contributions from the ASI Convenors, Punt, and Allison. One or more other Committee members are needed to champion this project and serve as 'content creation editors' who would recruit species experts, supervise work to draft Status Summary Pages, coordinate work with assessment modelling experts, and help interface with the Secretariat. Without a broader and deeper commitment of effort from Committee members, the project was, in his view, unlikely to be completed. He also suggested that the two intersessional correspondence groups established last year to support the Status of Stocks Website project be reorganized to better clarify their roles.

5. WORKPLAN

The ASG identified the following tasks for its workplan.

- Finalize a draft proposal for potential edits to category descriptions (Item 2.1), supplemental wording and examples to explain category selection (Item 2.2), and clarification of how the context of the stock definition, survey area, and intended use of an estimate should (or should not) influence category choice. Donovan and Butterworth agreed to provide this document sufficiently in advance of the upcoming ASI meeting for participants to review and discuss.
- Contact the authors of Lawson and Gosselin (2018) to check whether their estimate of humpback whale abundance in the Newfoundland and Labrador stratum had a correction for availability (Item 3.12). Doniol-Valcroze agreed to inquire and report back to ASI.
- Contact the authors of Bedrinana-Romano *et al.* (2018) to confirm which is their preferred abundance estimate for 2009 (Item 3.10). Kelly agreed to inquire and report back to ASI.
- Contact the authors of Stewart and Weller (2021) about whether the missing covariance information was available to add to the IWC Table of Agreed Abundance Estimates (Item 3.6). Katara agreed to inquire, and add such information to the table if it is available.
- Contact the second reviewer of Renault-Braga *et al.* (2021) to inquire whether he would be willing to join Ferguson in helping those authors improve their abundance estimate (Item 3.7). The authors have already expressed an interest in such collaboration. New agreed to inquire.
- Prepare brief information for a presentation at ASI regarding the differences between the IUCN Red List and the SC's planned Status of Stocks Website (Item 4). Donovan, Butterworth, and Punt agreed to provide this in advance of the relevant ASI session.
- Clarify the role of ASI and which papers are most suitable for convenors to request ASI to review (Item 2). Givens agreed to initiate such discussions with other convenors.
- Bring Pace *et al.* (2021) to the attention of HIM (Item 3.5). Givens will do this.
- Request the authors of Hakamada *et al.* (2009) to provide a table of estimates by year, period (early or late) and sub-area and any further spatial subdivisions for which abundance was estimated, for the 2002-07 estimates, so that the results are tabled at the same resolution as similar results from such cruises (Hakamada and Matsuoka, 2016; Item 3.8). Katara agreed to make this request.

6. ADOPTION OF REPORT

Givens thanked the rapporteurs, Kelly and Doniol-Valcroze, for their key contributions to the success of the pre-meeting. He also thanked the independent reviewers who generously contributed their time and expertise: L. Bedriñana-Romano, T. Branch, A. Cañadas, R. Chandler, P. Conn, C. Donovan, T. Eguchi, M. Ferguson, R. Fewster, M. Fujiwara, A. Gilles, D. Johnson, R. Leaper, N. Kelly, L. New, C. Oedekoven, H. Okamura, D. Pike, J. Potts, J. Roberts, J.A. Royle, D. Sigourney, B. Stevenson, R. Williams, and an anonymous reviewer.

The report was adopted by email on 2 May 2022.

REFERENCES

Barlow, J. 2015. Inferring trackline detection probabilities, *g*(0), for cetaceans from apparent densities in different survey conditions. *Mar. Mamm. Sci.*31: 923-43. [Available at: *https://doi.org/10.1111/mms.12205*].

Bedrinana-Romano, L., Hucke-Gaete, R., Viddi, F.A., Morales, J., Williams, R., Ashe, E., Garces-Vargas, J., Torres-Florez, J.P. and Ruiz, J. 2018. Integrating multiple data sources for assessing blue whale abundance and distribution in Chilean Northern Patagonia. *Divers. Distrib.* 00: 1-14. [Available at: *https://doi.org/10.1111/ddi.12739*].

Bradford, A.L., Oleson, E.M., Forney, K.A., Moore, J.E. and Barlow, J. 2021. Line-transect abundance estimates of cetaceans in U.S. waters around the Hawaiian Islands in 2002, 2010, and 2017. *NOAA Tech. Mem.* NMFS-PIFSC-115. [Available at: *https://doi.org/10.25923/daz4-kw84*].

Branch, T.A. 2007. Abundance of Antarctic blue whales south of 60°S from three complete circumpolar sets of surveys. *J. Cetacean Res. Manage.* 9(3): 253-62.

Branch, T.A. 2008. Current status of Antarctic blue whales based on Bayesian modeling. Paper SC/60/SH7 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 10pp. [Paper available from the Office of this Journal].

Brandão, A., Ross-Gillespie, A., Vermeulen, E. and Butterworth, D.S. 2021. Updated extension of a photo-identification based assessment model to southern right whales in South African waters to allow for the possibility of an early abortion of the calf in the model. 36pp. Paper SC/68C/SH/05 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 36pp. [Paper available from the Office of this Journal].

Brandão, A., Vermeulen, E., Ross-Gillespie, A., Findlay, K. and Butterworth, D.S. 2018. Updated application of a photo-identification based assessment model to southern right whales in South African waters, focussing on inferences to be drawn from a series of appreciably lower counts of calving females over 2015 to 2017. Paper SC/67b/SH22 presented to the IWC Scientific Committee, April-May 2018, Bled, Slovenia (unpublished). 19pp. [Paper available from the Office of this Journal].

Bravington, M.V., Miller, D.L. and Hedley, S.L. 2021. Variance propagation for density surface models. *Journal of Agricultural, Biological and Environmental Statistics* 26: 306-23. [Available at: *https://doi.org/10.1007/s13253-021-00438-2*].

Brownell, R.L., Jr., Galletti Vernazzani, B., De Vos, A., Olson, P.A., Findlay, K., Bannister, J.L. and Lang, A.R. 2015. Assessment of pygmy type blue whales in the Southern Hemisphere. Paper SC/66a/SH21 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 26pp. [Paper available from the Office of this Journal].

Butterworth, D.S. and Geromont, H.F. 1995. On the consequences of longitudinal disaggregation of the Japanese scouting vessel data in the northward extrapolation of IWC/IDCR cruise estimates of abundance of some large whale species in the Southern Hemisphere. Paper SC/47/SH20 presented to the IWC Scientific Committee, May 1995 (unpublished). 8pp. [Paper available from the Office of this Journal].

Calambokidis, J. and Barlow, C. 2013. Updated abundance estimates of blue and humpback whales off the US west coast incorporating photo-identifications from 2010 and 2011. Document PSRG-2013-13 presented to the Pacific Scientific Review Group Meeting, 2-4 April 2013, Marriott Hotel, Del Mar, CA, USA.

Calambokidis, J. and Barlow, J. 2004. Abundance of blue and humpback whales in the eastern North Pacific estimated by capture-recapture and line-transect methods. *Mar. Mamm. Sci.* 20(1): 63-85.

Calambokidis, J. and Barlow, J. 2017. Trends in the abundance of humpback whales in the North Pacific Ocean from 1980 to 2006. Paper SC/A17/NP10 presented to the Workshop on the Comprehensive Assessment of North Pacific Humpback Whales, 18-21 April 2017, Seattle, USA (unpublished). 16pp. [Paper available from the Office of this Journal].

Calambokidis, J. and Barlow, J. 2020. Updated abundance estimates for blue and humpback whales along the U.S. West Coast using data through 2018. U.S. Department of Commerce. *NOAA Tech. Mem.* NMFS-SWFSC-634. [Available at: *https://www.cascadiaresearch.org/files/publications/Calambokidis%26Barlow%202020%20UpdatedBlue%26HumpbAbund%20NOAA%20TM-634.pdf*].

Calambokidis, J., Barlow, J., Flynn, K., Dobson, E. and Steiger, G.H. 2017. Update on abundance, trends, and migrations of humpback whales along the US west coast. Paper SC/A17/NP13 presented to the Workshop on the Comprehensive Assessment of North Pacific Humpback Whales, 18-21 April 2017, Seattle, USA (unpublished). 18pp. [Paper available from the Office of this Journal].

Calderan, S.V., Black, A., Branch, T.A., Collins, M.A., Kelly, N., Leaper, R., Lurcock, S., Miller, B.S., Moore, M., Olson, P.A., Sirovic, A., Wood, A.G. and Jackson, J.A. 2020. South Georgia blue whales five decades after the end of whaling. *Endang. Spec. Res.* 43: 359-73. [Available at: *https://doi.org/10.3354/esr01077*].

Cooke, J. and Jackson, J. 2017. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. Appendix 6. Reanalysis of Chiloé Island blue whale mark-recapture data 2006-11. *J. Cetacean Res. Manage. (Suppl.)* 18: 263.

Cooke, J., Rowntree, V. and Sironi, M. 2015. Southwest Atlantic right whales: interim updated population assessment from photo-id collected at Península Valdés. Paper SC/66a/BRG23 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 9pp. [Paper available from the Office of this Journal].

Cooke, J.G., Weller, D.W., Bradford, A.L., Sychencko, A.O., Burdin, A.M., Lang, A.R. and Brownell, R.L., Jr. 2017. Population assessment update for Sakhalin gray whales, with reference to stock identity. Paper SC/67a/NH11 presented to the IWC Scientific Committee, May 2017, Bled, Slovenia (unpublished). 9pp. [Paper available from the Office of this Journal].

Cooke, J.G., Weller, D.W., Bradford, A.L., Sychencko, O., Burdin, A.M., Lang, A.R. and Brownell, R.L., Jr. 2016. Updated population assessment of the Sakhalin gray whale aggregation based on a photoidentification study at Piltun, Sakhalin, 1995-2015. Paper SC/66b/BRG25 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 14pp. [Paper available from the Office of this Journal].

Durban, J., Weller, D., Lang, A. and Perryman, W. 2015. Estimating gray whale abundance from shore-based counts using a multilevel Bayesian model. *J. Cetacean Res. Manage.* 15: 61-68.

Durban, J.W., Weller, D.W. and Perryman, W.L. 2017. Gray whale abundance estimates from shore-based counts off California in 2014/15 and 2015/16. Paper SC/A17/GW06 presented to the Fourth Workshop on the Rangewide Review of the Population Structure and Status of North Pacific Gray Whales, April 2017, La Jolla, CA, USA (unpublished). 5pp. [Paper available from the Office of this Journal].

Errata and Williams *et al.* 2012. Errata to article in the June 2011 issue of *Conservation Biology* (vol. 25, no. 3): Chilean Blue Whales as a Case Study to Illustrate Methods to Estimate Abundance and Evaluate Conservation Status of Rare Species, pp. 526-535. *Cons. Biol.* 26(2): 378. [Available at: *https://doi.org/10.1111/j.1523-1739.2012.01852.x*].

Errata and Williams *et al.* 2017. Erratum to the article in the June 2011 issue of *Conservation Biology* (vol. 25, no. 3), Chilean Blue Whales as a Case Study to Illustrate Methods to Estimate Abundance and Evaluate Conservation Status of Rare Species, pp. 526-535. *Cons. Biol.* 31(2): 490-91. [Available at: *https://doi.org/10.1111/cobi.12880*].

Félix, F., Acevedo, J., Aguayo-Lobo, A., Ávila, I.C., Botero-Acosta, N., Calderón, A., Cáceres, B., Capella, J., Carnero, R., Castro, C., Cheeseman, T., Dalla Rosa, L., Dellabianca, N., Denkinger, J., Friedlaender, A., Guzmán, H., Haase, B., Haro, D., Hucke-Gaete, R., Llano, M., Oviedo, L., Pacheco, A., Pacheco, J., Palacios, D.M., Palacios-Alfaro, J., Pallin, L., José Pérez, M.J., Rasmussen, K., Sanchez-Godinez, C., Santillán, L., Secchi, E., Torres, M.A. and Vásquez, E. 2021. Humpback whale breeding stock G: updated population estimate based on photo-ID matches between breeding and feeding areas. Paper SC/68C/ASI/02 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 19pp. [Paper available from the Office of this Journal].

Galletti Vernazzani, B., Jackson, J.A., Cabrera, E., Carlson, C. and Brownell, R.L., Jr. 2015. Estimates of Chilean blue whale abundance and trends by mark-recapture techniques. Paper SC/66a/SH10rev1 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 17pp. [Paper available from the Office of this Journal].

Galletti Vernazzani, B., Jackson, J.A., Cabrera, E., Carlson, C.A. and Brownell Jr., R.L. 2017. Estimates of abundance and trend of Chilean blue whales off Isla de Chiloé, Chile. *PLoS One* 12(1): e0168646. [Available at: *https://doi.org/10.1371/journal.pone.0168646*].

Garrison, L.P., Ortega-Ortiz, J. and Rappucci, G. 2020. Abundance of marine mammals in waters of the US Gulf of Mexico during the summers of 2017 and 2018. *National Marine Fisheries Service*: 56. [Available at: *https://doi.org/10.25923/3px6-9v48*].

Hakamada, T. and Matsuoka, K. 2016. The number of the western North Pacific common minke, Bryde's and sei whales distributed in JARPNII Offshore survey area. Paper SC/F16/JR12 presented to the Expert Panel Workshop of the Final Review on the Western North Pacific Japanese Special Permit Programme (JARPN II), 22-26 February 2016, Tokyo, Japan (unpublished). 14pp. [Paper available from the Office of this Journal].

Hakamada, T., Matsuoka, K. and Miyashita, T. 2009. Distribution and the number of western North Pacific common minke, Bryde's, sei and sperm whales distributed in JARPN II offshore component survey area. Paper SC/J09/JR15 presented to the Expert Workshop to Review Results of JARPN II, 26-30 January 2009, Tokyo, Japan (unpublished). 18pp. [Paper available from the Office of this Journal].

Hedley, S. and Buckland, S.T. 2004. Spatial models for line transect sampling. *Journal of Agricultural, Biological and Environmental Statistics* 9: 181-99.

Hucke-Gaete, R., Viddi, F.A., Bedriñana-Romano, L. and Zerbini, A. 2016. Satellite tracking of blue whales (*Balaenoptera musculus*) from Patagonia (Chile) to Galapagos (Ecuador): novel insights into migratory pathways along the Eastern South Pacific. Paper SC/66b/SH16 presented to the IWC Scientific Committee, June 2016, Bled, Slovenia (unpublished). 11pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2008a. Report of the Intersessional Workshop to Review Data and Results from Special Permit Research on Minke Whales in the Antarctic, Tokyo, 4-8 December 2006. *J. Cetacean Res. Manage. (Suppl.)* 10:411-45.

International Whaling Commission. 2008b. Report of the Scientific Committee. Annex H. Report of the sub-committee on other Southern Hemisphere whale stocks. *J. Cetacean Res. Manage. (Suppl.)* 10:207-24.

International Whaling Commission. 2009. Report of the Scientific Committee. Annex H. Report of the sub-committee on other Southern Hemisphere whale stocks. *J. Cetacean Res. Manage. (Suppl.)* 11:220-47.

International Whaling Commission. 2010. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 11(2):218-51.

International Whaling Commission. 2013. Report of the IWC Workshop on the Assessment of Southern Right Whales. *J. Cetacean Res. Manage. (Suppl.)* 14:437-62.

International Whaling Commission. 2014. Report of the Scientific Committee. Annex Q. Report of the *adhoc* group to develop a list of 'accepted' abundance estimates. *J. Cetacean Res. Manage. (Suppl.)* 15:416-17.

International Whaling Commission. 2015. Report of the Expert Workshop to Review the Japanese JARPA II Special Permit Research Programme, 24-28 February 2014, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 16:369-409.

International Whaling Commission. 2016. Report of the Scientific Committee. Annex F. Report of the Sub-Committee on Bowhead, Right and Gray Whales. *J. Cetacean Res. Manage. (Suppl.)* 17:204-23.

International Whaling Commission. 2017a. Report of the Scientific Committee. Annex F. Report of the Sub-Committee on Bowhead, Right and Gray Whales. *J. Cetacean Res. Manage. (Suppl.)* 18:185-202.

International Whaling Commission. 2017b. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 18:230-63.

International Whaling Commission. 2018a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 19:1-101.

International Whaling Commission. 2018b. Report of the Scientific Committee. Annex Q. *Ad hoc* Working Group on Abundance Estimates, Status and International Cruises. *J. Cetacean Res. Manage. (Suppl.)* 19:376-98.

International Whaling Commission. 2019. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 20:211-38.

International Whaling Commission. 2020. Report of the Scientific Committee. Annex Q. Report of the Standing Working Group on Abundance Estimates, Stock Status and International Cruise (ASI). *J. Cetacean Res. Manage. (Suppl.)* 21:277-99.

International Whaling Commission. 2021a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 22:1-122.

International Whaling Commission. 2021b. Report of the Workshop on the Review of the Status of the Franciscana, virtual meeting, 7-9 April 2021. *J. Cetacean Res. Manage. (Suppl.)* 23:23pp.

International Whaling Commission. 2022. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 23: 1-171.

Jefferson, T.A., Hung, S.K., Law, L., Torey, M. and Tregenza, N. 2002. Distribution and abundance of finless porpoises in Hong Kong and adjacent waters of China. *Raffles Bull. Zool.* Supplement 10: 43-56.

Jefferson, T.A. and Moore, J.E. 2020. Abundance and Trends of Indo-Pacific Finless Porpoises (*Neophocaena phocaenoides*) in Hong Kong Waters, 1996-2019. *Front. Mar. Sci.* [Available at: *https://doi.org/10.3389/fmars.2020.574381*].

Laake, J.L., Calambokidis, J., Osmek, S.D. and Rugh, D.J. 1997. Probability of detecting harbour porpoise from aerial surveys: Estimating *g*(0). *J. Wildlife Manage.* 61(1): 63-75.

Laake, J.L., Punt, A.E., Hobbs, R., Ferguson, M., Rugh, D. and Breiwick, J. 2012. Gray whale southbound migration surveys 1967-2006: an integrated re-analysis. *J. Cetacean Res. Manage.* 12(3): 287-306.

Lawson, J. and Gosselin, J.-F. 2018. Estimates of cetacean abundance from the 2016 NAISS aerial surveys of eastern Canadian waters, with a comparison to estimates from the 2007 TNASS. [Paper SC/25/AE/09. Available from NAMMCO].

Leonard, D.M. and Øien, N.I. 2020a. Estimated abundances of cetacean species in the northeast Atlantic from Norwegian shipboard surveys in 2014-2018. *NAMMCO Sci. Publ.* 11. [Available at: *https://doi.org/10.7557/3.4694*].

Leonard, D.M. and Øien, N.I. 2020b. Estimated abundances of cetacean species in the northeast Atlantic from two multiyear surveys conducted by Norwegian vessels between 2002-2013. *NAMMCO Sci. Publ.* 11. [Available at: *https://doi.org/10.7557/3.4695*].

Matsuoka, K. and Hakamada, T. 2014. Estimates of abundance and abundance trend of the blue, fin and southern right whales in Areas IIIE-VIW, south of 60°S, based on JARPA and JARPAII sighting data (1989/90-2008/09). Paper SC/F14/J05 presented to the JARPAII Special Permit Expert Panel Review Workshop, 24-28 February 2014, Tokyo, Japan (unpublished). 27pp. [Paper available from the Office of this Journal].

Matsuoka, K., Hakamada, T., Kiwada, H., Murase, H. and Nishiwaki, S. 2006. Distribution and standardized abundance estimates of humpback, fin and blue whales in the Antarctic Areas IIIE, IV, V and VIW (35°E-145°W) south of 60°S. Paper SC/D06/J7 presented to the Intersessional Workshop to Review Data and Results from Special Permit Research on Minke Whales in the Antarctic, Tokyo, 4-8 December 2006 (unpublished). 37pp. [Paper available from the Office of this Journal].

Miyashita, T., Kato, H. and Kasuya, T. 1995. *Worldwide Map of Cetacean Distribution Based on Japanese Sighting Data*. Vol. 1. National Research Institute of Far Seas Fisheries, Shimizu, Japan. 140pp.

Pace, R.M. 2021. Revisions and further evaluations of the right whale abundance model: improvements for hypothesis testing. *NOAA Tech. Mem.* NMFS-NE-269: 54. [Available at: *http://catalog.gpo.gov/F/?func=direct&doc_number=001151826&format=999*].

Pace, R.M., Corkeron, P.J. and Kraus, S.D. 2017. State-space mark-recapture estimates reveal a recent decline in abundance of North Atlantic right whales. *Ecol. Evol.* 7: 8730-41. [Available at: *https://doi.org/10.1002/ece3.3406*].

Pace, R.M., Williams, R., Kraus, S.D., Knowlton, A.R. and Pettis, H.M. 2021. Cryptic mortality of North Atlantic right whales. *Conservation Science and Practice* 3(2): e346. [Available at: *https://doi.org/10.1111/csp2.346*].

Pike, D.G., Gunnlaugsson, T., Sigurjómsson, J. and Víkingsson, G. 2020. Distribution and abundance of cetaceans in Icelandic waters over 30 years of aerial surveys. *NAMMCO Sci. Publ.* 11. [Available at: *https://doi.org/10.7557/3.4805*] .

Priyadarshana, T., Randage, S.M., Alling, A., Calderan, S., Gordon, J., Leaper, R. and Porter, L. 2016. Distribution patterns of blue whale (*Balaenoptera musculus*) and shipping off southern Sri Lanka. *Regional Studies in Marine Science* 3: 181-88.

Renault-Braga, E.P., Groch, K.R. and Simoes-Lopes, P.C. 2021. Numerical population estimates update for Southern right whales in Brazil. 8pp. Paper SC/68C/CMP/10 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 8pp. [Paper available from the Office of this Journal].

Robertson, F.C., Koski, W.R., Thomas, T.A., Richardson, W.J., Würsig, B. and Trites, A.W. 2013. Seismic operations have variable effects on dive-cycle behaviour of bowhead whales in the Beaufort Sea. *Endang. Spec. Res.* 21: 143-60.

Skaug, H.J., Øien, N., Schweder, T. and Bothun, G. 2004. Abundance of minke whales (*Balaenoptera acutorostrata*) in the northeastern Atlantic; variability in time and space. *Can. J. Fish. Aquat. Sci.* 61(6): 870-86. [Available at: *https://doi.org/10.1139/f04-020*].

Smith, J.N., Kelly, N., Double, M.C. and Bannister, J.L. 2021. Population trend in right whales off southern Australia 1993-2020. Paper SC/68C/SH/18 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 15pp. [Paper available from the Office of this Journal].

Solvang, H., Skaug, H. and Øien, N.I. In Press. Consideration of measurement errors for the Norwegian common minke whale (*Balaenoptera acutorostrata acutorostrata*) surveys. *J. Cetacean Res. Manage.* 22: 16. [Available from the Office of this Journal].

Solvang, H.K., Skaug, H.J. and Øien, N.I. 2015. Abundance estimates of common minke whales in the Northeast Atlantic based on survey data collected over the period 2008-2013. Paper SC/66a/RMP08 presented to the IWC Scientific Committee, May 2015, San Diego, CA, USA (unpublished). 11pp. [Paper available from the Office of this Journal].

Solvang, H.K., Skaug, H.J. and Øien, N.I. 2021. Abundance of common minke whales in the Northeast Atlantic based on survey data collected over the period 2014-2019. 12pp. Paper SC/68C/ASI/04 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 12pp. [Paper available from the Office of this Journal].

Stewart, J.D. and Weller, D.W. 2021. Abundance of eastern North Pacific gray whales 2019/2020. U.S. Department of Commerce. *NOAA Tech. Mem.* NMFS-SWFSC-639. [Available at: *https://doi.org/10.25923/bmam-pe91*].

Wade, P.R. 1998. Calculating limits to the allowable human-caused mortality of cetaceans and pinnipeds. *Mar. Mamm. Sci.* 14(1): 1-37.

Wenzel, F.W., Broms, F., Lopez-Suarez, P., Lopes, K., Veiga, N., Yeoman, K., Rodrigues, M.S.D., Allen, J., Fernald, T.W., Stevick, P.T., Jones, L., Jann, B., Bouveret, L., Ryan, C., Berrow, S. and Corkeron, P. 2020. Humpback whales (M*egaptera novaeangliae)* in the Cape Verde Islands: Migratory patterns, resightings, and abundance. *Aquat. Mamm.* 46: 21-31. [Available at: *https://doi.org/10.1578/AM.46.1.2020.21*].

Williams, R., Hedley, S.L., Branch, T.A., Bravington, M.V., Zerbini, A.N. and Findlay, K.P. 2011. Chilean blue whales as a case study to illustrate methods to estimate abundance and evaluate conservation status of rare species. *Cons. Biol.* 25(3): 526-35.

Appendix 1

AGENDA

1. Introductory items
   - 1.1 Opening remarks
   - 1.2 Election of the Chair
   - 1.3 Appointment of Rapporteurs
   - 1.4 Adoption of the agenda
   - 1.5 Documents available and online schedule
2. ASG process and ICG recommendations
   - 2.1 Edits to category descriptions
   - 2.2 Supplemental wording and examples to explain category selection
   - 2.3 Process for reviewing author revisions (may defer to ASI)
3. Review of Abundance Estimates
   - 3.1 Indo-Pacific finless porpoise near Hong Kong
   - 3.2 North Atlantic common minke whales
   - 3.3 Eastern South Pacific humpback whales
   - 3.4 Bering-Chukchi-Beaufort Seas bowhead whales
   - 3.5 North Atlantic right whales
   - 3.6 Eastern North Pacific gray whales
   - 3.7 Southern hemisphere right whales: Australia, South Africa, and Brazil
   - 3.8 North Pacific sei whales
   - 3.9 North Pacific blue whales
   - 3.10 Southeast Pacific blue whales
   - 3.11 Antarctic blue whales
   - 3.12 North Atlantic humpback whales
   - 3.13 Franciscana
4. Consideration of status of stocks
   - 4.1 Review proposals
   - 4.2 Future workplan
5. Workplan
6. Adoption of Report

Annex F

Catches Reported for the 2021 Season

S. Burkett, E. Whittle, I. Katara and C. Allison

Table 1

Summary of Aboriginal subsistence catches reported for the 2021 season.

Country	Year	Species	Males	Females	Total landed	Struck and lost	Total strikes	Comments
Denmark								
West Greenland	2021	Fin	1	1	2	-	2	-
	2021	Minke	30	137	167	10	177	-
	2021	Humpback	3	2	5	-	5	2 whales also bycaught in snow crab fishing gear
East Greenland	2021	Minke	8	12	21*	-	21	-
St Vincent and The Grenadines								
	2021	Humpback	1	-	1	-	-	-
	2022[1]	Humpback	-	-	-	1	1	-
USA								
	2021	Bowhead	31	26	57	13	70	-
Russian Federation								
	2021	Gray	66	60	126	1	127	Inc. 4 'stinky' whales
	2021	Bowhead	-	-	0	-	0	-

[1]The 2022 data refer to the first quarter of 2022. *Includes 1 minke whale of unknown sex.

Table 2

Summary of non-ASW catches reported for the 2021 season.

Nation	Year	Species	Males	Females	Total Landed	Lost	Total	Infractions/comments
Norway								
	2021	Minke	131	437	568	9	577	-
Republic of Korea								
	2021	Minke	-	1	12[2]	-	12	Infractions
Iceland								
	2021	Minke	-	1	1	-	1	-

[2]Includes 11 minke whales of unknown sex.

Table 3

Summary of catches reported for the 2021 season by non-member nations.
In addition, some sperm whale catches are believed to be taken in Indonesia (of the order of 20-30 whales/year).

Nation	Year	Species	Males	Females	Total Landed	Lost	Total	Comments
Canada								
Eastern Arctic – Nunavut Settlement Area	2021	Bowhead	1	1	2	-	2	-
Japan								
Pelagic	2021	Bryde's	69	118	187	-	187	-
	2021	Sei	5	20	25	-	25	-
Coastal	2021	Minke	50	41	91	-	91	-

Annex G

Extinction Initiative – Next Steps

Members: Simmonds, Cipriano, Hines, Jimenez, Minton, Porter, Rojas-Bracho, Stimmelmayr, Zerbini.

RATIONALE

The Extinction Initiative (EI) grew out of what is arguably the key mission of the IWC, namely, to prevent the extinction or local extirpation of cetacean species or populations.

Since our last meeting, a new dedicated webpage has been added to the IWC site in support of the initiative: *https://iwc.int/management-and-conservation/cetaceans-and-extinction*. (Many thanks to the Secretariat for their great work on this.)

The next step is to provide the IWC, the globally recognized intergovernmental body for cetacean research, conservation and management, with a mechanism to express its concern in a timely manner to the broader public about such impending or newly documented events.

This is to be achieved by developing and completing statements using pre-agreed templates for species or populations of concern. This would represent a significant contribution to the IWC's communication and outreach efforts.

MECHANISM

The Commission is requested to endorse the statement template and permit the Scientific Committee (SC) to issue statements of concern intersessionally (i.e. between Commission meetings) related to one of two circumstances.

(i) A cetacean species or distinct population is possibly extinct or has gone extinct.
(ii) There is a sudden grave concern about the survival of a cetacean species or distinct population.

These statements will not stray from the pre-agreed template. They will be based on best scientific knowledge and will either be generated at a SC meeting or, if the timing of the precipitating incident precludes this, by a group of appropriate experts appointed by the Chair and Vice-Chairs of the SC and the Conservation Committee (CC). The statement will be published on the IWC website and brought to the attention of the media.

The template for the statement is provided in Appendix 1 and the relevant section from last year's SC report is given in Appendix 2.

The IWC Bureau (which is not a decision-making body) would be notified before any such statement is issued, and a report would be provided to the Commission when it next meets.

TERMS OF REFERENCE FOR THE EXTINCTION INITIATIVE WORKING GROUP

To support the request for authorization to further develop and use the extinction/extirpation statement template, the Extinction Initiative Working Group will, before IWC69, craft an example of a completed 'sample' for the franciscana.

Appendix 1

EXTINCTION INITIATIVE: OUTLINE TEMPLATE FOR A FORMAL STATEMENT BY THE SCIENTIFIC COMMITTEE

Please note: this is a skeleton template, providing a structure for a statement but not the specific content which would need to be tailored. The template covers three scenarios: (a) an extinction; (b) an extirpation; and (c) an expression of serious concern. Some paragraphs are generic and apply to all three scenarios – Some paragraphs would be tailored (a) (b) or (c) depending on which scenario is applicable.

Image 1: photograph or illustration of species

Title (a) Extinction of [common name (genus species)]

Title (b) Disappearance from XX region of XX species

Title (c) Serious concern of extinction or local extirpation raised: XX species (in XX region)

Opener (a) The International Whaling Commission today reports on the extinction of XXX species.

Opener (b) The International Whaling Commission today reports that XX species is assessed to have disappeared from XX region. Whilst populations still exist in other parts of [the world] this is grave news for the species as a whole.

Opener (c) The International Whaling Commission today warns that extinction or local extirpation is an imminent risk for XX and sets out the actions needed now to prevent this.

Generic Para 1:

IWC assessment is based on **[** quote taken from IUCN Red List or equivalent authoritative source: status, dates and link to relevant page **]**

Generic Para 2:

Historical numbers (dates, references)
Trend of decline over time
Epoch/time of extinction

Image 2: distribution map or illustration

Generic Para 3:

Major threats/impacts responsible for decline/extinction: **[** entanglement in fishing gear/ship strikes/pollution/habitat degradation/directed takes/combination/other **]**

Generic Para 4:

Successful and unsuccessful management efforts made including by IWC **[** alternative fishing gear/ rerouting of shipping lanes/protected area/capture for *ex-situ* conservation/combination/other **]**

Para 5 (a): Why this wasn't enough to prevent extinction and what lessons have been learned going forward.

Para 5 (b): Actions that must be taken now to prevent this extirpation, potentially leading to the extirpation of other populations and extinction of the species.

Para 5 (c): Actions that must be taken now before population size is so low that measures are too late to be effective including simple explanation of the biological background and bottleneck.

Generic Para 6:

The big picture: meaning/repercussions (ecological, societal) of extinction: various roles of the species/population as **[** predators/ecosystem engineers etc.; loss of biodiversity; loss for economy/tourism? **]**

Generic close:

Re-assessment of our relationship with our environment. There has never been a more appropriate time to take stock, learn lessons and do things differently in the future.

What actions can an individuals and/or stakeholder organisations take to make a difference?

Appendix 2

EXTRACT FROM THE RELEVANT PART OF LAST YEAR'S SCIENTIFIC COMMITTEE MEETING REPORT

ITEM 19. EXTINCTION INITIATIVE

19.1 Extinction Initiative Report

Michael Stachowitsch (Austria) presented an update on the Extinction Initiative. This initiative grew out of a suggestion at SC/68B that the Committee should be better prepared to address the potential extinction of a cetacean species, possibly by preparing in advance a template for a statement noting that such an event had occurred (IWC, 2021, p.96). The initiative was initially developed within the Small Cetacean sub-committee but was continued by an intersessional group including participants from other sub-committees, and has had extensive support from the Secretariat, including coordination of the effort by Kate Wilson.

This initiative was developed to address a key component of the IWC's mission – preventing cetacean extinction – and builds off momentum to identify species or populations of particular concern to better address potential extinction. The initiative provides a mechanism for the IWC to respond in a timely manner to an actual extinction of a cetacean species, to be proactive in highlighting pending extinctions, and it increases communication and outreach efforts.

In the following intersessional period, this initial extinction initiative was expanded to encompass two tasks: (1) to create a new IWC webpage on extinction and cetaceans; and (2) to develop templates for statements, to be issued by the IWC, warning that extinction of a species or extirpation of a local population seemed likely to happen in the near future, was also developed. The templates are intended to communicate news of an extinction to the public and perhaps raise support for measures to help avert such a catastrophe. The IWC website page has text focused more generally on the topic of extinctions and an explanation of the IWC's crucial role in addressing 21st century threats and preventing cetacean extinctions[1]. The text in the extinction and extirpation templates, and the website, have been developed as communications tools to facilitate outreach and education, and do not commit the IWC to any specific actions. The IWC webpage on extinction and cetaceans went online on 3 March 2021 (UN World Wildlife Day).

Templates were developed for species of concern, divided into three extinction scenarios: actual extinction, serious concern of extinction raised, and disappearance from a region (extirpation). Draft versions to test these templates are being prepared for franciscana, vaquita, Hector's and Maui dolphins, and Rice's whale. This initiative was presented to and endorsed by the Conservation Committee in 2021, with the intention to proceed as a joint or parallel project, as the CC is already working on directly relevant issues.

The Scientific Committee recognized the Secretariat's excellent work on the website, and thanked Wilson and the Secretariat for putting it together, noting that it looks very professional and has added considerably to IWC's outreach efforts to the general public. The Committee also noted that public education as well as communication from the SC to the Commission is an important aspect of the Committee's work.

In discussion, it was noted that identifying and prioritizing vulnerable species and populations is a difficult task, that different fora with different objectives would likely come up with different lists, and that within the SC there are various similar or related efforts. The Abundance Estimates, Stock Status and International Cruises (ASI) sub-committee is developing a status of stocks list, starting with baleen whale stocks that are at risk and for which there are takes, and distinguishing between data-rich/data-poor species, as well as incorporating anthropogenic threats into their considerations; a website page with that list is also planned. IUCN publishes a list of the most endangered species (IUCN, 2021; see item 19.2, this report), and many Committee members contribute to that effort; the approach and criteria used for that effort do not necessarily overlap with IWC's in-depth assessments of species and stocks. The recently formed IUCN Cetacean Specialist Group adjunct, ICPC (item 16.2.1) is planning to hold a two-day workshop just before the upcoming Society for Marine Mammalogy biennial in Palm Beach, Florida, 13-17 December 2021, and one of the items planned for that workshop is initiation of such an extinction risk/priority ranking exercise.

It was noted that the discussion about this at SC/68C had also led to the development of an independent statement of concern signed by many SC members and others from more than 40 countries. This statement was made public in September 2020 and presented at the Conservation Committee[2]. During discussion a concern regarding timing was expressed, since the next Commission meeting is not until 2022, meaning first statements of concern would not go out until 2023, which could be problematic if any concerns involve critically endangered species that require action before that time.

A proposal was made that any species of urgent concern so identified could be presented to the Commission at its special meeting in September 2021. Additional next steps require broader consensus and input from other areas of expertise, including outside of the IWC. These steps include identifying the most vulnerable species or populations, prioritizing the

[1] *https://iwc.int/cetaceans-andextinction*.

[2] See 'The Real and Imminent Extinction Risk to Whales, Dolphins and Porpoises', *https://www.mammalresearchinstitute.science/whale-unit*.

taxa for which IWC statements should be prepared, and, in close cooperation with the Secretariat, recommending to the Commission that specific statements be made public. An intersessional steering group was created to advance this work. Members include: Cipriano, Cooke, Hines, Jiménez, (Sarah) Malette, Minton, Parsons, Porter, Rojas-Bracho, Scheidat, Simmonds, Torres-Flores, Trujillo, Slooten, Stachowitsch, Stimmelmayr and Zerbini. Simmonds agreed to act as Convenor. It was suggested that the Convenor of this steering group for the extinction initiative be added to the ASI small working group.

REFERENCES

International Whaling Commission. 2021. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 22: 1-222.

IUCN. 2021. *IUCN Red List of Endangered Species*.

Annex H

Bycatch and Ship Strikes of Large Cetaceans Reported in the National Progress Report Database

Complied by Marion Hughes, IWC Secretariat

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	Other fishing gear	How observed	References
Australia 2021																							
PR/R/24818	2021	2022	Southern Ocean	Southern right whale	Portland	Narrawong, Portland	-	-	-	-	-	-	-	-	-	-	-	1	Southern rock lobster	FPO	-	Scientist	PR/B/929 | Victorian Bio-diversity Atlas, DELPW, unpubl.
PR/R/24819	2021	2022	Southern Ocean	Humpback whale	-	36 n.miles S of Port Campbell	-	-	-	-	-	-	-	-	-	-	-	1	Southern rock lobster	FPO	-	Scientist	PR/B/929 as above
PR/R/24865	2021	2022	Indian Ocean	Humpback whale	City Beach, Perth, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	Western rock lobster (WCRLMF)	FPO	-	Fisherman	-
PR/R/24866	2021	2022	Indian Ocean	Unid. large whale	Avalon Bay reef, Mandurah, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	LX	-	Public	-
PR/R/24873	2021	2022	Southern Ocean	Humpback whale	Coles Bay	-42.1534, 148.2604	-	-	-	-	-	-	-	-	-	-	-	1	Rock lobster	FPO	-	Public	-
PR/R/24906	2021	2022	Indian Ocean	Humpback whale	Turquoise Bay, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	GN	-	-	-
PR/R/24907	2021	2022	Indian Ocean	Humpback whale	Rottnest Island, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope	-	-
PR/R/24908	2021	2022	Indian Ocean	Humpback whale	Carnarvon, WA	-	-	-	-	-	-	-	-	-	1	-	-	-	Deep sea crabs	NK	Deep sea crabs; pro	Fisherman	-
PR/R/24909	2021	2022	Indian Ocean	Humpback whale	Albany, WA	-	-	-	-	-	-	-	-	-	-	-	1	-	Mussel	NK	Mussel; aquaculture	-	-
PR/R/24910	2021	2022	Indian Ocean	Humpback whale	Greenough, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	Octopus	NK	Octopus; developmental	-	-
PR/R/24911	2021	2022	Indian Ocean	Humpback whale	Exmouth, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope	-	-
PR/R/24912	2021	2022	Indian Ocean	Humpback whale	Albany, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope	-	-
PR/R/24913	2021	2022	Indian Ocean	Humpback whale	Jurien Bay, WA	115.039258; -30.273859	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope	Public	-
PR/R/24914	2021	2022	Indian Ocean	Humpback whale	Flinders Bay, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope and floats	-	-
PR/R/24915	2020	2022	Indian Ocean	Humpback whale	Yeagerup, WA	-	-	-	-	-	-	-	-	-	1	-	-		-	MIS	Unknown; rope	-	-
PR/R/24916	2020	2022	Indian Ocean	Humpback whale	Mandurah, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	Octopus	LL	Octopus (OIMF)	-	-
PR/R/25022	2020	2022	Indian Ocean	Humpback whale	Busselton, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	Western rock lobster	FPO	Western rock lobster (WCRLMF)	-	-
PR/R/25024	2020	2022	Indian Ocean	Humpback whale	Moore River, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	Western rock lobster	FPO	Western rock lobster (WCRLMF)	-	-

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	Other fishing gear	How observed	References
Australia 2021 cont.																							
PR/R/25025	2020	2022	Indian Ocean	Humpback whale	Albany, WA	-	-	-	-	-	-	-	-	-	-	1	-	-	-	MIS	Unknown; rope	-	-
PR/R/25027	2020	2022	Indian Ocean	Humpback whale	Forrest Beach, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	Octopus	LL	Octopus (OIMF)	-	-
PR/R/25029	2020	2022	Indian Ocean	Humpback whale	Kalbarri, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	Deep sea crabs	NK	Deep sea crabs (WCDSCMF)	-	-
PR/R/25030	2020	2022	Indian Ocean	Common minke whale	Lighthouse Bay, Exmouth, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope	Observer or inspector	-
PR/R/25034	2020	2022	Indian Ocean	Humpback whale	Tantabiddi, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope and floats	-	-
PR/R/25037	2020	2022	Indian Ocean	Humpback whale	Tantabiddi, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	Western rock lobster	FPO	Western rock lobster (WCRLMF)	Public	-
PR/R/25039	2020	2022	Indian Ocean	Humpback whale	Two Rocks, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	Western rock lobster	FPO	Western rock lobster (WCRLMF)	Fisherman	-
PR/R/25040	2020	2022	Indian Ocean	Humpback whale	Tantabiddi, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope and floats	-	-
PR/R/25044	2020	2022	Indian Ocean	Humpback whale	Jurien Bay, WA	114.8575; -30.264983	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope and floats	Public	-
PR/R/25045	2020	2022	Indian Ocean	Humpback whale	Dongara, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope and floats	Public	-
PR/R/25046	2020	2022	Indian Ocean	Humpback whale	Geographe, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	Western rock lobster	FPO	Western rock lobster (WCRLMF)	-	-
PR/R/25047	2020	2022	Indian Ocean	Humpback whale	Jurien Bay, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	Western rock lobster	FPO	Western rock lobster (WCRLMF)	-	-
PR/R/25048	2020	2022	Indian Ocean	Humpback whale	Pinnaroo Point/Iluka, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope and floats	-	-
PR/R/25049	2020	2022	Indian Ocean	Humpback whale	Ocean Reef, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	Western rock lobster	FPO	Western rock lobster (WCRLMF)	Public	-
PR/R/25050	2020	2022	Indian Ocean	Humpback whale	Albany, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope and floats	-	-
PR/R/25051	2020	2022	Indian Ocean	Humpback whale	Lancelin, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope and floats	Fisherman	-
PR/R/25052	2020	2022	Indian Ocean	Humpback whale	Avalon, Comet Bay/Dawesville, Mandurah, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	Western rock lobster	FPO	Western rock lobster; recreational	-	-
PR/R/25053	2020	2022	Indian Ocean	Humpback whale	Rottnest Island, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	Western rock lobster	FPO	Western rock lobster (WCRLMF)	-	-
PR/R/25059	2021	2022	Indian Ocean	Humpback whale	6km W King Billy Bay, Green Head, WA	114.967833; -30.069	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope and floats	Public	-
PR/R/25180	2021	2022	Pacific Ocean - South	Humpback whale	Sunshine Coast to the Gold Coast	-	-	-	-	1	-	-	-	-	-	-	-	3	White, tiger and bull sharks	NSC	-	Fisherman	-

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	Other fishing gear	How observed	References
Australia 2021 cont.																							
PR/R/25181	2021	2022	Pacific Ocean - South	Humpback whale	Hervey Bay	153.01116; -25.13116	-	-	-	-	-	-	-	-	-	-	-	1	-	FPO	-	Scientist	-
PR/R/25182	2021	2022	Pacific Ocean - South	Unid. large whale	-	145.77575; -15.50903	-	-	-	-	-	-	-	-	-	-	-	1	-	RG	-	Public	-
PR/R/25358	2021	2022	Indian Ocean	Humpback whale	W of Rottnest Island, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	Unknown; rope	-	-
PR/R/25430	2021	2022	Pacific Ocean - South	Humpback whale	Broulee	-35°50’5.759, 150°12’49.5	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	-	Public	-
PR/R/25431	2021	2022	Pacific Ocean - South	Humpback whale	Sydney Heads	-33°50’8.488, 151°17’19.877	-	-	-	-	-	-	-	-	-	-	1	-	-	MIS	-	Public	-
PR/R/25432	2021	2022	Pacific Ocean - South	Humpback whale	Miners Beach, Port Macquarie	-31°28’10.941, 152°56’4.528	-	-	-	-	-	-	-	-	-	-	1	-	-	FIX	-	Public	-
PR/R/25433	2021	2022	Pacific Ocean - South	Humpback whale	Tacking Point	-31°28’38.75, 152°56’20.034	-	-	-	-	-	-	-	-	-	-	-	1	-	FIX	-	Public	-
PR/R/25434	2021	2022	Pacific Ocean - South	Humpback whale	Lennox Head	-28°48’ 34.599816, 153°36’ 22.29084	-	-	-	-	-	-	-	-	-	-	-	1	-	FIX	-	Public	-
PR/R/25435	2021	2022	Pacific Ocean - South	Humpback whale	Port Stephens	-32°42’ 0.770724, 152°12’ 22.15584	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	-	Public	-
PR/R/25436	2021	2022	Pacific Ocean - South	Humpback whale	Clovelly	-33°3’30.051, 151°17’2.852	-	-	-	-	-	-	-	-	-	-	-	1	-	FIX	-	Public	-
PR/R/25437	2021	2022	Pacific Ocean - South	Humpback whale	Potter Point, Kamay Botany Bay National Park	-33°59’50 .348, 51°14’55 .393	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	-	Public	-
PR/R/25438	2021	2022	Pacific Ocean - South	Humpback whale	Corindi Beach	-30°1’47.531, 153°12’9.253	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	-	Public	-
PR/R/25439	2021	2022	Pacific Ocean - South	Humpback whale	Crowdy Head	-31°50’30.48, 152°45’10.548	-	-	-	-	-	-	-	-	-	-	-	1	-	FIX	-	Public	-
PR/R/25440	2021	2022	Pacific Ocean - South	Humpback whale	Port Stephens	-32°42’46.692, 152°11’19.14	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	-	Public	-

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	Other fishing gear	How observed	References
Australia 2021 cont.																							
PR/R/25441	2021	2022	Pacific Ocean - South	Humpback whale	Thirroul	-34°18′53. 064, 150°55′46.128	-	-	-	-	-	-	-	-	-	-	-	1	-	FIX	-	Public	-
PR/R/25442	2021	2022	Pacific Ocean - South	Humpback whale	Port Macquarie	-31°26′57. 552, 152°55′50.376	-	-	-	-	-	-	-	-	-	-	-	1	-	FIX	-	Public	-
PR/R/25443	2021	2022	Pacific Ocean - South	Humpback whale	Green Island, Smokey Cape	-30°54′43. 02, 153°5′12.732	-	-	-	-	-	-	-	-	-	-	-	1	-	FIX	-	Observer or inspector	-
PR/R/25444	2021	2022	Pacific Ocean - South	Humpback whale	Fingal Head	-28°12′0. 72, 153°34′9.768	-	-	-	-	-	-	-	-	-	-	-	1	-	NSC	-	Public	-
PR/R/25445	2021	2022	Pacific Ocean - South	Humpback whale	Woolgoolga	-30°6′42. 552, 153°12′32.832	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	-	Public	-
PR/R/25446	2021	2022	Pacific Ocean - South	Humpback whale	Maroubra	-33°56′59. 813268, 151°15′25.138	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	-	Public	-
PR/R/25447	2021	2022	Pacific Ocean - South	Humpback whale	Tura head	-36°51′19. 656, 149°56′57.984	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	-	Public	-
PR/R/25448	2021	2022	Pacific Ocean - South	Humpback whale	Ballina	-28°51′34. 236, 153°35′54.96	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	-	Public	-
PR/R/25449	2021	2022	Pacific Ocean - South	Humpback whale	Queenscliff Beach	-33°47′3. 084, 151°17′25.152	-	-	-	-	-	-	-	-	-	-	-	1	-	MIS	-	Public	-
PR/R/25450	2021	2022	Pacific Ocean - South	Humpback whale	Whale beach	-33°36′37 .008, 151°19′54.12	-	-	-	-	-	-	-	-	-	-	1	-	-	NSC	-	Public	-
PR/R/25451	2021	2022	Pacific Ocean - South	Humpback whale	Culburra beach	-34°55′55. 776, 150°47′20.076	-	-	-	-	-	-	-	-	-	-	1	-	-	MIS	-	Public	-

ID	Contacts	Explanation
Australia 2021 cont.		
PR/R/24818	PR/C/465 | M. Watson (*mandy.watson@delwp.vic.gov.au*)	Sub-adult grey-coloured animal. Pot line entangled around tail stock. Attempted disentanglement but sea conditions unsuitable. Whale disappeared overnight. Aerial search conducted for several days between Port Phillip and South Australian border. Whale not located.
PR/R/24819	PR/C/465 | M. Watson (as above)	Reported by a marine mammal observer on drill rig. Rig crews dispatched and removed floats but left line entangled on whale.
PR/R/24865	PR/C/1588 | Wildlife Protection (*wildlife.protection@ dbca.wa.gov.au*); PR/C/1589 | J. How (*Jason.How@dpird.wa.gov.au*)	26/05/2021. Reported from fishing vessel, entangled in fishing gear for western rock lobster (WCRLMF), evaded disentanglement. 27/05/2021. Unidentified whale reported by a fisherman as being entangled in cray pot, red buoy and netting, between Scarborough and Fremantle Port, Perth (presumed same sighting reported to other government department next day or same individual).
PR/R/24866	PR/C/1588 | Wildlife Protection (as above)	31/10/2021. A member of the public reported sighting a whale entangled in fishing line.

ID	Contacts	Explanation
Australia 2021 cont.		
PR/R/24873	PR/C/1382 | K. Carlyon (*kris.carlyon@dpipwe.tas.gov.au*)	Sighted 18/03/2021. Gear identifies it as same animal that became entangled in rock lobster gear on 29/11/2020 south of Bruny Island (reported in 2020 Progress Report). Partially disentangled by public.
PR/R/24906	PR/C/1589 | J. How (as above)	17/08/2021. Temperate demersal gillnet, whale seen free swimming, evaded disentanglement, covered in net not resighted.
PR/R/24907	PR/C/1589 | J. How (as above)	18/08/2021. Whale tethered, no floats or pot seen when disentangled.
PR/R/24908	PR/C/1589 | J. How (as above)	05/08/2021. Whale caught in mainline, dead when winched to the surface.
PR/R/24909	PR/C/1589 | J. How (as above)	27/07/2021. Disentangled, poor condition with orca attack scarring.
PR/R/24910	PR/C/1589 | J. How (as above)	02/07/2021. Disentangled short distance from fishers gear.
PR/R/24911	PR/C/1589 | J. How (as above)	25/06/2021. Evaded disentanglement, tracker attached, not relocated.
PR/R/24912	PR/C/1589 | J. How (as above)	24/06/2021. Only initial sighting, not disentangled.
PR/R/24913	PR/C/1589 | J. How (as above)	18/06/2021. Sighted by member of public on kayak, no further sightings, not disentangled. 19/06/2021. Presumed record from following day is reference to same individual; sighted by a member of the public - Jurien 1km north of harbour, entangled in unknown gear, rope and floats, response mounted but not found.
PR/R/24914	PR/C/1589 | J. How (as above)	20/05/2021. Sighted from shore just off Augusta marina, but no further sightings, not disentangled.
PR/R/24915	PR/C/1589 | J. How (as above)	16/12/2020. Whale carcass washed up with unknown ropes and floats, was washed away before gear recovered.
PR/R/24916	PR/C/1589 | J. How (as above)	21/09/2020. Large adult whale anchored in octopus longline, snapped free and evaded disentanglement with kegging attached.
PR/R/25022	PR/C/1589 | J. How (as above)	08/09/2020. Float and whale sighted then evaded, not disentangled.
PR/R/25024	PR/C/1589 | J. How (as above)	30/08/2020. Entangled and anchored in local fisherman's gear, no further sightings, not disentangled.
PR/R/25025	PR/C/1588 | Wildlife Protection (as above) PR/C/1589 | J. How (as above)	27/08/2020. Tight tail wrap no trailing rope, necrotized tail old entanglement, not disentangled. Reported fortuitously during large whale disentanglement training (LWDT) so response was rapid. Animal was reported by one of the commercial whale watching boats in the Middle Channel (between Breaksea and Michaelmas Islands), Albany. Team responded and located the whale. The tail was in an advanced necrotic state and the whale appeared unable to use it, preferring its pectoral fins for propulsion. The opinion was that even if there was a deeply embedded entanglement that could be removed, it would not aid in the whales survival; it was in general poor condition and the injured tail was adjudged as being incompatible with the long-term survival of the animal. It was therefore decided that no attempt would be made to try and locate any remnant entanglement by further cutting into the whales injured peduncle. All vessels returned to Princess Royal Harbour, Albany, and completed their final training exercises.
PR/R/25027	PR/C/1589 | J. How (as above)	22/08/2020. Calf tethered, freed same afternoon (disentangled).
PR/R/25029	PR/C/1589 | J. How (as above)	18/08/2020. Approximately 800 metres of rope, not disentangled.
PR/R/25030	PR/C/1589 | J. How (as above)	18/08/2020. Species identification uncertain - small whale (minke?), sighted once by air.
PR/R/25034	PR/C/1589 | J. How (as above)	15/07/2020. Kegging buoys attached, then removed late in day. Evaded.
PR/R/25037	PR/C/1589 | J. How (as above)	14/07/2020. Sighted by whale watching boat, partial disentanglement.
PR/R/25039	PR/C/1589 | J. How (as above)	10/07/2020. Disentangled.
PR/R/25040	PR/C/1589 | J. How (as above)	07/07/2020. Sighted off Tantabiddi boat ramp, no further sightings, not disentangled.
PR/R/25044	PR/C/1589 | J. How (as above)	25/06/2020. Self release 9n.miles off Jurien Bay witnessed by whale watching vessel. 26/06/2020. Presume record from following day is in reference to the same individual; sighted by a member of the public, 9n.miles west Jurien, cray rope, disentangled.
PR/R/25045	PR/C/1589 | J. How (as above)	20/06/2020. Spotted by jetski off Dongara, then milling nearshore north of town that afternoon, not disentangled.
PR/R/25046	PR/C/1589 | J. How (as above)	14/06/2020. Government officers removed most gear, partially disentangled.
PR/R/25047	PR/C/1589 | J. How (as above)	06/06/2020. Entangled in two sets of gear, tracked and disentangled.
PR/R/25048	PR/C/1589 | J. How (as above)	02/06/2020. Small yellow float above tail nothing else visible, sighted Pinnaroo Point then off Iluka, not disentangled.
PR/R/25049	PR/C/1589 | J. How (as above)	21/05/2021. Freed by public.
PR/R/25050	PR/C/1589 | J. How (as above)	18/05/2020. Sighted from shore, no further sightings, not disentangled.
PR/R/25051	PR/C/1589 | J. How (as above)	13/05/2020. Recreational fisher spotted and entangled whale 15n.miles off Lancelin towing a red float, not disentangled.
PR/R/25052	PR/C/1589 | J. How (as above)	20/04/2020. Beach sighting Avalon heading north. Re-sighted Comet Bay and Dawesville, not disentangled.
PR/R/25053	PR/C/1589 | J. How (as above)	25/03/2020. Juvenile entangled and freed near Rottnest (disentangled).
PR/R/25059	PR/C/1588 | Wildlife Protection (as above)	17/08/2021. Whale response team engaged, whale freed itself before team could respond, single tail wrap.
PR/R/25180	PR/C/832 | StrandNet (*strand.data@des.qld.gov.au*)	-
PR/R/25181	PR/C/832 | StrandNet (as above)	-
PR/R/25182	PR/C/832 | StrandNet (as above)	-

ID	Contacts	Explanation
Australia 2021 cont.		
PR/R/25358	PR/C/1588 | Wildlife Protection (as above)	14/08/2021. 10m humpback whale tethered, west of Rottnest Island, evaded, not disentangled.
PR/R/25430	PR/C/1599 | S. Lorigan (*shona.lorigan@environment.nsw.gov.au*)	27/02/21. Recreational fishers returning to Broulee spotted an adult whale which appeared to have two white foam buoys around tail about the size of soccer balls. Witnesses described floats being attached to rope with a bit of green or brown weed fouling, but was nearly dark. Whale was smaller in size (around 8m) whale tail slapping, possibly not heavily encumbered. Despite extensive alerts whale not resighted.
PR/R/25431	PR/C/1599 | S. Lorigan (as above)	16/05/21. Whale watching cruise saw a green rope wrapped from the fluke to the flank of one of two juvenile humpback whales travelling together. Whale appeared to be approx. 9-10m in length. Suspected entanglement is on the tail fluke and runs along the flank. Whale also had vessel strike scars. Whale was pec slapping at the time observed therefore possibly not heavily encumbered; whale was swimming north and speed appeared normal; no further sightings. 18 May. Whale watch operator reviewed images and believed entanglement had come off the animal, but unsure if it was a pectoral wrap which was unseen. Speculation entanglement was heavy duty monofilament fishing line.
PR/R/25432	PR/C/1599 | S. Lorigan (as above)	01/06/21. Adult humpback whale out north of Shelly Beach 3km. Moving slowly. Whale is now with another humpback. Sighted again on 02/06/2022 at Gallows Beach, Coffs Harbour. 04/06/2022. Evans Head, managed to evade rescue crews. 06/06/2022. Kingscliff, another attempt to disentangle. 07/06/21. Rescue completed by Sea World off Broadbeach QLD.
PR/R/25433	PR/C/1599 | S. Lorigan (as above)	02/06/21. Smaller immature whale (3 whales off Tacking Point Light House 2km off shore, 35m depth) has a rope around the dorsal fin with a white buoy a few meters behind.
PR/R/25434	PR/C/1599 | S. Lorigan (as above)	04/06/21. Pilot from a light aircraft travelling from Ballina northwards at 600ft. Circled an adult whale and noted it was towing mess of ropes and 3 white floats. Monitored/left to fend for itself as it was only sighted from air, no rescue available. Report relayed via Air Traffic Control Ballina following a request for assistance searching for an entangled adult whale suspected of being in the area.
PR/R/25435	PR/C/1599 | S. Lorigan (as above)	05/06/21. A passenger of *Moonshadow* TQC Cruise noticed a braided mooring rope across the back of an adult whale being watched. From photo, rope looks to be slightly larger diameter, but very little other detail recognisable. Little detail other than whale entangled moving freely, large rope around body, no obstructing pectoral or tail, with one other whale travelling north. Sighting info wouldn't have allowed for a tracked rescue attempt as vessel did not stay.
PR/R/25436	PR/C/1599 | S. Lorigan (as above)	06/06/21. Whale first observed at South Maroubra Headland with 2-3 white buoys trailing behind. Moving north, quite fast. Tracked along eastern beaches and last seen at the Gap near South Head just after 5pm. Partially disentangled by water police. 6/7.30pm. Whale close to shore at Wategos Beach, Byron Bay. Entangled around its tail.
PR/R/25437	PR/C/1599 | S. Lorigan (as above)	18/06/21. Whale sighted close to shore (less than 500m out) off Potter Point (Kamay Botany Bay National Park) traveling north at 4knots. Rope entanglement around the dorsal fin and trailing an orange basketball sized float about 5m behind tail. Second humpback is accompanying the entangled whale.
PR/R/25438	PR/C/1599 | S. Lorigan (as above)	17/06/21. 4pm Whale off Corindi Beach, 500m offshore entangled in ropes with red and white floats. Humpback rolling and waving pectoral flippers. National Parks and Wildlife Service attended shore based observation point, but too late in the day for any response, no further sightings.
PR/R/25439	PR/C/1599 | S. Lorigan (as above)	27/06/21. Whale reported entangled off Crowdy headland, Crowdy Bay National Park. Animal last seen swimming strongly north at around 5knots from Tacking Point around 1630hrs.
PR/R/25440	PR/C/1599 | S. Lorigan (as above)	05/07/21. Entangled whale at Port Stephens. An adult whale about 2km out from shore and travelling north at 1 nautical mile per hour with 3 other whales. Whale is only caught on the tips of the tail fluke. The rope looks like multicolour fishing rope. Although the person reporting the whale stated that something is being dragged behind the whale, no buoys were sighted.
PR/R/25441	PR/C/1599 | S. Lorigan (as above)	09/07/21. Adult humpback entanglement in 50m of water off Thirroul. Whale has two 20 litre white containers and one red float visible. Travelling with at least two other whales. Reported to be travelling at 7-10 knots though this could be 7-10km/hr. Person (recreational fisher) reported whale went under his vessel and he tried to disentangle.
PR/R/25442	PR/C/1599 | S. Lorigan (as above)	20/07/21. Reported late in the day so no chance to deploy a large whale disentanglement team. Adult humpback whale, travelling north at 2-3 knots, entangled in a mess of rope around tail and trailing ropes with 3 white floats 10m behind tail and further rope trailing behind that.
PR/R/25443	PR/C/1599 | S. Lorigan (as above)	31/07/21. Whale sighted around 16:00hrs by National Parks staff working at Smokey Cape. Whale is 300m due east of Green Island, 3 to 4 yellowish floats, and rope wrapped around the tail. swimming behaviour erratic, with multiple direction changes. Swimming at surface.
PR/R/25444	PR/C/1599 | S. Lorigan (as above)	11/08/21. Surfers reported an immature whale tangled in QLD Shark Control Program nets at Coolangatta. Gear was removed but a length of chain and an anchor remain wrapped on the peduncle. Whale became mobile and moved into NSW waters. Tracking device attached. Rescue abandoned on 17:00hrs. 12 Aug. Whale was located 42km due east of Fingal Head in Commonwealth waters. Anchor and 25m chain removed but some chain and netting still on tail. Three red A3 size floats with Qld Govt markings and SCP contact details are attached to the tail (but deflated). The operation ended approximately 50km east of Brunswick Heads in Commonwealth waters. The whale was swimming strongly and has been moving in a southerly direction. 14 Aug. Sighted by recreational vessel, whale approx. 8n.miles out from Mooloolabah. 18 Aug. Unconfirmed report of animal further north today. Still in QLD.

ID	Contacts	Explanation
Australia 2021 cont.		
PR/R/25445	PR/C/1599 | S. Lorigan (as above)	17/09/21. One adult humpback whale with white rope and floats around its head and body heading south accompanied by another adult and calf. Last sighted at Woolgoolga headland 9.45am.
PR/R/25446	PR/C/1599 | S. Lorigan (as above)	25/09/21. Report of 7m immature humpback whale with short length of rope trailing from mouth. Whale is free swimming south with mother alongside. First sighted off Bondi Golf Course in a group of four whales.
PR/R/25447	PR/C/1599 | S. Lorigan (as above)	24/09/21. Entanglement of an adult humpback whale, appears to be body wrap, 500m off Tura Head (far South Coast). Travelling south when observed, travel speed at 5kph. Sighting from shore with basic binoculars, so difficult to determine with confidence, but appears to be body wrap of light coloured ropes, no floats seen. Entanglement confirmed by member of National Parks LWD Team from headland. Too late in the day (plus strong S winds) for any on water response. Swim speed prediction suggests animal may move into Victorian or Bass Straight waters before conditions improve. Victorian and Tasmanian agencies notified.
PR/R/25448	PR/C/1599 | S. Lorigan (as above)	Entangled whale sighted off SE QLD late on 04/10/21. Observed towing a red float. If travel speed is maintained (4knots) it should be in Ballina by (05/10/21), Coffs Harbour on 06/10/21 and Port Macquarie by Thursday 07/10/21. All National Parks and Wildlife Service branches notified as well as partner agencies. No further sightings.
PR/R/25449	PR/C/1599 | S. Lorigan (as above)	10/10/21. Adult whale sighted at Queenscliff beach and observed trailing 2 buoys. No photos or further description of buoys. Whale was observed swimming south and past north head. Volunteer organisation (ORRCA) on headlands further south to try and confirm entanglement details but no further sightings.
PR/R/25450	PR/C/1599 | S. Lorigan (as above)	16/10/21. Calf caught in the shark net at northern end of Whale Beach. Calf is struggling in the shark net. The calf is entangled around the tail. Two adult whales in the vicinity however unconfirmed. Calf successfully released by National Parks and Wildlife Service disentanglement team.
PR/R/25451	PR/C/1599 | S. Lorigan (as above)	21/10/21. Whale spotted by the public off Penguin head Point; dragging floats approx.. 50m behind, 2 white buoys, 200m off shore. Heading south. Animal was travelling quickly, with another whale of similar size. Victorian and Tasmanian colleagues notified and they disentangled and released the whale.

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	Individuals data are available?	Fishing gear	How observed
Columbia 2011-2021																						
PR/R/24711	2021	2022	Pacific Ocean - South	Humpback whale	Uramba Bahía Málaga National Park	-	-19.937347	-	-	-	-	-	-	-	-	-	1	-	-	Yes	GTR	Scientist
PR/R/24713	2021	2022	Pacific Ocean - South	Humpback whale	Uramba Bahia Málaga National Park	-	77°19'12"W/ 3°58'12"N	-	-	-	-	-	-	-	-	-	-	1	-	Yes	GN	Scientist
PR/R/24715	2016	2022	Pacific Ocean - South	Humpback whale	Parque Nac-ional Natural Uramba Bahía Málaga	Yubarta	3.91774, -77.37307	-	-	-	-	-	-	-	-	-	-	-	2	Yes	NK	Scientist
PR/R/24716	2021	2022	Pacific Ocean - South	Humpback whale	Uramba Bahía Málaga National Park	-	77°19'12"W, 3°58'12"N	-	-	-	-	-	-	-	-	-	-	1	-	Yes	NK	Scientist
PR/R/24718	2019	2022	Pacific Ocean - South	Humpback whale	Uramba Bahia Málaga National Park	-	77°19'12"W, 3°58'12"N	-	-	-	-	-	-	-	-	-	-	1	-	Yes	GTR	Fisherman, public
PR/R/24719	2019	2022	Pacific Ocean - South	Humpback whale	Uramba Bahia Málaga National Park	-	77°19'12"W, 3°58'12"N	-	-	-	-	-	-	-	-	-	-	1	1	Yes	GTR	Scientist

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	Individuals data are available?	Fishing gear	How observed
Columbia 2011-2021 cont.																						
PR/R/24720	2019	2022	Pacific Ocean - South	Humpback whale	Uramba Bahia Málaga National Park	-	77°19'12"W, 3°58'12"N	-	-	-	-	-	-	-	-	-	-	1	1	Yes	GTR	Scientist, observer or inspector
PR/R/24721	2021	2022	Pacific Ocean - South	Humpback whale	Gulf of Tribuga	-	77°16'58;W, 5°50'37N	-	-	-	-	-	-	-	-	-	-	1	-	Yes	GTR	Fisherman, public
PR/R/24722	2019	2022	Pacific Ocean - South	Humpback whale	Oceanic waters of Colombia	-	83°12'W, 2°32'N	-	-	-	-	-	-	-	-	1	-	-	-	Yes	LLD	Observer or inspector
PR/R/24723	2019	2022	Pacific Ocean - South	Humpback whale	Juradó	-	77°48'51"W, 7°08'41"N	-	-	-	-	-	-	-	-	1	-	-	-	Yes	LL	Observer or inspector, public
PR/R/24728	2011	2022	Pacific Ocean - South	Humpback whale	Uramba Bahia Malaga National Natural Park	Yubarta	3.90639,-77.37671	-	-	-	-	1	-	-	-	-	-	-	-	Yes	GTN	Observer or inspector
PR/R/24729	2012	2022	Pacific Ocean - South	Humpback whale	Uramba Bahia Malaga National Natural Park	Yubarta	3.90947,-77.37877	-	-	-	1	-	-	-	-	-	-	-	1	Yes	NK	Observer or inspector
PR/R/24730	2012	2022	Pacific Ocean - South	Humpback whale	Nuquí, Golfo de Tribugá, Chocó.	Yubarta	5.71131,-77.27629	-	-	-	-	-	-	-	-	-	-	2	-	Yes	GTR	Public
PR/R/24731	2013	2022	Pacific Ocean - South	Humpback whale	Bahía Solano, Chocó, Colombia	Yubarta	6.29073,-77.43713	-	-	-	-	-	-	-	-	-	-	-	1	Yes	NK	Observer or inspector

ID	Contacts	References	Explanation
Columbia 2011-2021 cont.			
PR/R/24711	PR/C/1584 | I.C. Avila (*isabel_c_avila@yahoo.com*)	PR/B/968 | *Enmallamientos accidentales recientes de ballenas jorobadas en el Pacifico colombiano.* Avila, I.C., Isaza, E., Ortega, L.F., Angulo, E. A., Melo. | Published PR/B/969 | *Recent accidental entanglements of humpback whales in the Colombian Pacific.* Avila, I.C., Ortega, L.F., Isaza, E., Angulo, E. | Unpublished	An adult was observed swimming with his tail tangled in a surface gillnet.
PR/R/24713	PR/C/1584 | I.C. Avila (as above)	PR/B/968 | As above. PR/B/969 | As above.	Calf had its pectoral fin tangled in a rope.
PR/R/24715	PR/C/1585 | Fundación Yubarta (*fundacion.yubarta@gmail.com*)	-	The event was registered during research surveys. Two adults were entangled and one of them was seen very stressful and tired. It got close to our boat. The team try to help it but we did not have the right tools to do it.
PR/R/24716	PR/C/1584 | I.C. Avila (as above)	PR/B/968 | As above. PR/B/969 | As above.	Adult was reported with its tail entangled in a fishing net but it was not released.

ID	Contacts	References	Explanation
Columbia 2011-2021 cont.			
PR/R/24718	PR/C/1584 | I.C. Avila (as above)	PR/B/968 | As above. PR/B/969 | As above.	Adult was entangled by a surface gillnet in its head and pectoral fins and it was successfully untangled by the community.
PR/R/24719	PR/C/1584 | I.C. Avila (as above)	PR/B/968 | As above. PR/B/969 | As above.	A calf was reported with its dorsal fin entangled in a surface gillnet.
PR/R/24720	PR/C/1584 | I.C. Avila (as above)	PR/B/968 | As above. PR/B/969 | As above.	An adult registered with his back entangled in a surface gillnet, but it was not traced.
PR/R/24721	PR/C/1584 | I.C. Avila (as above)	PR/B/968 | As above. PR/B/969 | As above.	An adult with its tail tangled in a gillnet, the animal was released by the local community.
PR/R/24722	PR/C/1584 | I.C. Avila (as above)	PR/B/968 | As above. PR/B/969 | As above.	A calf in an advanced state of decomposition was found whose tail was entangled in a drifting longline.
PR/R/24723	PR/C/1584 | I.C. Avila (as above)	PR/B/968 | As above. PR/B/969 | As above.	A dead calf in a moderate state of decomposition was found stranded with a net fish, apparently a longline, tangled in its tail.
PR/R/24728	PR/C/1585 | Fundación Yubarta (as above)	-	It was a calf. It was watched alive with the net in previous days. It was reported by the National Park director to the Foundation.
PR/R/24729	PR/C/1585 | Fundación Yubarta (as above)	-	It was observed both mother and calf entangled
PR/R/24730	PR/C/1585 | Fundación Yubarta (as above)	-	Two adults were observed with a net for two days. Some divers and the naval army got to remove part of the net and buoys. One of them was very tired and kept calm while the net was removed.
PR/R/24731	PR/C/1585 | Fundación Yubarta (as above)	-	It was observed an adult swimming with the net.

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	Individuals data are available?	Targeted fishery species	Fishing gear	Other fishing gear	How observed
Mexico 2020-21																								
PR/R/25461	2020	2022	Pacific Ocean - North	Humpback whale	Los Cabos, Baja California Sur	Ballena jorobada	23°01'44 N 109°31'02 W	-	-	-	-	-	-	-	-	-	-	-	-	Yes	Unknown	Unknown	-	Public
PR/R/25462	2020	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	20°33'59.5 N 105°15'43.4W	-	-	-	-	-	-	-	-	1	1	-	1	Yes	Unknown	GN	-	-
PR/R/25463	2020	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	20°46'40 N 105°32'35.8 W	-	-	-	1	-	-	-	-	-	-	-	1	Yes	Unknown	LL	-	-
PR/R/25464	2020	2022	Pacific Ocean - North	Humpback whale	San Blas, Nayarit	Ballena jorobada	-	-	-	-	1	-	-	-	-	-	-	-	-	Yes	Unknown	FIX	-	-
PR/R/25465	2020	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	20°44'932N 105°33'689W	-	-	-	1	-	-	-	-	-	-	-	-	Yes	Cod	FIX	-	-
PR/R/25466	2020	2022	Pacific Ocean - North	Humpback whale	Oaxaca	Ballena jorobada	15°39'082N 96°33'287W	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	-	Ghost net	-
PR/R/25467	2020	2022	Pacific Ocean - North	Humpback whale	Manzanillo	Ballena jorobada	19°18'500N 105°00'512W	-	-	-	1	-	-	-	-	-	-	-	1	Yes	Sierra	GN	-	-

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	Individuals data are available?	Targeted fishery species	Fishing gear	Other fishing gear	How observed
Mexico 2020-21 cont.																								
PR/R/25468	2021	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	20°44’297 N 105°23’070W	-	-	-	-	-	-	-	-	-	-	1	-	Yes	Unknown	FIX	-	-
PR/R/25469	2021	2022	Pacific Ocean - North	Humpback whale	Los Cabos, Baja California Sur	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	-	Ghost net	-
PR/R/25470	2021	2022	Pacific Ocean - North	Humpback whale	Los Cabos, Baja California Sur	Ballena jorobada	22°53’435 N 109°50’212 W	-	-	-	-	-	-	-	-	-	-	1	-	Yes	Unknown	Unknown	Pieces of rope/ buoy	-
PR/R/25471	2021	2022	Pacific Ocean - North	Gray whale	Ensenada, Baja California	Ballena gris	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	GN	-	-
PR/R/25472	2021	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	-	Ghost nets	-
PR/R/25473	2021	2022	Pacific Ocean - North	Humpback whale	Los Cabos, Baja California Sur	Ballena jorobada	22°85’259 N 109°96’431 W	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	GN	-	-
PR/R/25474	2021	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	20°44’236 N 105°29’615 W	-	-	-	1	-	-	-	-	-	-	-	-	Yes	Unknown	GN	-	-
PR/R/25475	2021	2022	Pacific Ocean - North	Gray whale	Vizcaíno, Baja California Sur	Ballena gris	26°82’348N 113°19’647W	-	-	-	-	-	-	-	-	-	-	1	-	Yes	Lobster	FIX	-	-
PR/R/25476	2021	2022	Pacific Ocean - North	Humpback whale	Los Cabos	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	Unknown	-	-
PR/R/25477	2021	2022	Pacific Ocean - North	Humpback whale	Los Cabos	Ballena jorobada	22°64’869 N 109°48’247 W	-	-	-	1	-	-	-	-	-	-	-	-	Yes	Unknown	Unknown	Ghost net	-
PR/R/25478	2021	2022	Pacific Ocean - North	Humpback whale	Los Cabos	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	Unknown	Ghost net	-
PR/R/25479	2021	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	Unknown	-	-
PR/R/25480	2021	2022	Pacific Ocean - North	Humpback whale	Oaxaca	Ballena jorobada	-	-	-	-	1	-	-	-	-	-	-	-	-	Yes	Unknown	Unknown	Ghost net	-
PR/R/25481	2021	2022	Pacific Ocean - North	Humpback whale	Bahía de Los Ángeles	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	Unknown	Piece of rope/ buoy	-
PR/R/25482	2021	2022	Pacific Ocean - North	Humpback whale	La Paz, Baja California Sur	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Totoaba	GN	-	-
PR/R/25483	2021	2022	Pacific Ocean - North	Humpback whale	La Paz	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	GN	-	-
PR/R/25484	2021	2022	Pacific Ocean - North	Humpback whale	La Paz	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	-	-	Yes	Unknown	Unknown	-	-
PR/R/25485	2021	2022	Pacific Ocean - North	Humpback whale	Los Cabos	Ballena jorobada	22°51’340 N 109°53’376 W	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	GN	-	-
PR/R/25486	2021	2022	Pacific Ocean - North	Humpback whale	La Paz	Ballena jorobada	24°47’107 N 110°28’137 W	-	-	-	-	-	-	-	-	-	-	1	-	Yes	Unknown	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	Individuals data are available?	Targeted fishery species	Fishing gear	Other fishing gear	How observed
Mexico 2020-21 cont.																								
PR/R/25487	2021	2022	Pacific Ocean - North	Humpback whale	La Paz	Ballena jorobada	24°42'305 N 110°55'388 W	-	-	-	-	-	-	-	-	-	-	1	-	Yes	Unknown	GN	-	-
PR/R/25488	2021	2022	Pacific Ocean - North	Humpback whale	San Felipe, Baja California	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Corvina or shark	GN	-	-
PR/R/25489	2021	2022	Pacific Ocean - North	Humpback whale	Los Cabos	Ballena jorobada	22°53'485 N 109°51'158 W	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Crab trap	FIX	-	-
PR/R/25490	2021	2022	Pacific Ocean - North	Humpback whale	Between Loreto and Bahía Con-cepción, Baja California Sur	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	1	-	Yes	Unknown	Unknown	Rope and buoy	-
PR/R/25491	2021	2022	Pacific Ocean - North	Humpback whale	Bahía Magdalena, Baja California Sur	Ballena jorobada	24°32'230N 112°61'113	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	Unknown	Piece and buoys	Public
PR/R/25492	2021	2022	Pacific Ocean - North	Humpback whale	Ensenada, Baja California	Ballena jorobada	31°73'811 N 116°69'472W	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	GN	-	-
PR/R/25493	2021	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	20°55'055 N 105°29'049 W	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	Unknown	Rope/ buoy	-
PR/R/25494	2021	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	20°40'489 N 105°19'943W	-	-	-	-	-	-	-	-	-	-	1	-	Yes	Crab	-	Rope/ buoy	-
PR/R/25495	2021	2022	Pacific Ocean - North	Humpback whale	Oaxaca	Ballena jorobada	15°40'178N 96°25'430W	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	-	Rope/ buoy	-
PR/R/25496	2021	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	Unknown	Ghost net	-
PR/R/25497	2022	2022	Pacific Ocean - North	Humpback whale	Los Cabos	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	1	-	Yes	Unknown	Unknown	Rope/ buoy	-
PR/R/25498	2022	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	20°33'990 N 105°16'303 W	-	-	-	1	-	-	-	-	-	-	-	-	Yes	Unknown	GN	-	-
PR/R/25499	2022	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	-	-	-	-	1	-	-	-	-	-	-	-	-	Yes	Unknown	-	Rope	-
PR/R/25500	2022	2022	Pacific Ocean - North	Humpback whale	Guayabitos, Jaliso	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	GN	-	-
PR/R/25501	2022	2022	Pacific Ocean - North	Humpback whale	Los Cabos	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	-	Rope/ buoys	-
PR/R/25502	2022	2022	Pacific Ocean - North	Gray whale	Vizcaino	Ballena gris	26°73'245N 113°25'015W	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Lobster	FIX	-	-
PR/R/25503	2022	2022	Pacific Ocean - North	Humpback whale	Los Cabos	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	LL	-	-
PR/R/25504	2022	2022	Pacific Ocean - North	Humpback whale	Los Cabos	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	1	-	Yes	Unknown	-	Rope/ buoy	-

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	Individuals data are available?	Targeted fishery species	Fishing gear	Other fishing gear	How observed
Mexico 2020-21 cont.																								
PR/R/25505	2022	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	20°40'411 N 105°185'36 W	-	-	1	-	-	-	-	-	-	-	-	-	Yes	Unknown	-	Rope	-
PR/R/25506	2022	2022	Pacific Ocean - North	Humpback whale	Los Cabos	Ballena jorobada	23°42'202 N 109°415'09 W	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	GN	-	-
PR/R/25507	2022	2022	Pacific Ocean - North	Humpback whale	San Francisco, Baja California Sur	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	GN	-	-
PR/R/25508	2022	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	-	-	-	-	1	-	-	-	-	-	-	-	-	Yes	Unknown	GN	Ghost net	-
PR/R/25509	2022	2022	Pacific Ocean - North	Humpback whale	Bahía de Banderas	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unknown	GN	-	-
PR/R/25510	2022	2022	Pacific Ocean - North	Humpback whale	Cabo Pulmo, 2022	Ballena jorobada	23°24'160 N 109°24'766 W	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	-	Rope and buoy	-
PR/R/25511	2022	2022	Pacific Ocean - North	Humpback whale	Los Cabos	Ballena jorobada	-	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Unknown	GN	-	-

ID	Data year	Year sub-mitted	Large Area	Species	Local area	Local tax-onomy	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	Individuals data are available?	Targeted fishery species	Fishing gear	How observed	Contacts	Explanation
New Zealand 2020-21																									
PR/R/25853	2021	2022	Pacific Ocean - South	Humpback whale	Kai-koura	-	-42.43055, 173.68011	-	-	-	-	-	-	-	-	-	-	-	1	Yes	CRA - Spiny red rock lobster	FPO	Public	PR/C/537 | H. Hendriks (*hhendriks@doc.govt.nz*)	Humpback whale entangled in craypot line released alive, May 2021
PR/R/25854	2021	2022	Pacific Ocean - South	Humpback whale	-	-	-42.0622, 169.582	-	-	-	-	-	-	-	-	-	-	-	1	Yes	Southern bluefin tuna	LL	Fisherman	PR/C/895 | Fisheries New Zealand	Humpback whale entangled in surface long line on 5 Jul. 21, released alive uninjured
PR/R/25855	2020	2022	Pacific Ocean - South	Unidentified large baleen whale	-	-	-44.6919, 172.7445	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Hoki	TBB	Fisherman	PR/C/895 | Fisheries New Zealand	Bones of large baleen whale brought up in bottom trawl on 20/08/20

ID	Data year	Year sub-mitted	Large Area	Species	Local area	Local tax-onomy	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	Individuals data are available?	Fishing gear	How observed	Contacts	References	Explanation
UK 2021																									
PR/R/26035	2021	2022	Atlantic Ocean - North	Common minke whale	-	-	-	0	0	0	0	1	0	0	0	0	0	0	0	Yes	NK	Scientist	PR/C/248 | A. Brownlow (*andrew.brownlow@sac.co.uk*)	PR/B/985 | SMASS Annual Report to Scottish Government for 2021 | Brownlow, A. (compiler). Unpubl.	Diagnosed as entanglement from necropsies within UK strandings programme.
PR/R/26036	2021	2022	Atlantic Ocean - North	Humpback whale	-	-	-	0	0	0	0	0	0	0	0	2	0	0	0	Yes	NK	Public	PR/C/247 | R. Deaville (*rob.deaville@ioz.ac.uk*) PR/C/248 | A. Brownlow (*andrew.brownlow@sac.co.uk*)	PR/B/984 | CSIP Annual Report to UK Government for 2021. Deaville, R. (compiler). Unpubl. PR/B/985 | SMASS Annual Report to Scottish Government for 2021 | Brownlow, A. (compiler). Unpub.	Observed dead entangled in fishing gear at sea and reported within the UK strandings programmes.

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	Individuals data are available?	Targeted fishery species	Fishing gear	How observed	References
USA 2019-20																							
PR/R/24765	2019	2022	Atlantic Ocean - North	Fin whale	-	-	-	-	-	-	-	-	-	-	2	0	0	0	Yes	-	FPO		PR/B/975 | *US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments 2021.* Hayes *et al.*, eds. Unpubl.
PR/R/24766	2019	2022	Atlantic Ocean - North	North Atlantic right whale	-	-	0	0	0	0	1	1	0	0	0	0	0	0	Yes	-	FPO	Scientist, fisherman, observer/ inspector, public	PR/B/975 as above
PR/R/24767	2019	2022	Atlantic Ocean - North	Common minke whale	-	-	-	-	-	-	-	-	-	-	3	5	0	0	Yes	-	NK	-	PR/B/975 as above
PR/R/25329	2020	2022	Pacific Ocean - North	Blue whale	Santa Barbara County, CA	Eastern N Pacific	-	-	-	-	-	-	-	-	-	-	1	-	Yes	Unidentified fishery interaction	NK	Scientist	-
PR/R/25330	2020	2022	Pacific Ocean - North	Gray whale	Ventura County, CA	Eastern N Pacific	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unidentified fishery interaction	NK	Scientist	-
PR/R/25331	2020	2022	Pacific Ocean - North	Gray whale	San Diego County, CA	Eastern N Pacific	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Gillnet fishery	GN	Scientist	-
PR/R/25332	2020	2022	Pacific Ocean - North	Gray whale	Clallam County, WA	Eastern N Pacific	-	-	-	-	-	-	-	-	-	-	1	-	Yes	Dungeness crab pot fishery (Washington)	FPO	Scientist	-

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	Individuals data are available?	Targeted fishery species	Fishing gear	How observed	References
USA 2019-20 cont.																							
PR/R/25333	2020	2022	Pacific Ocean - North	Gray whale	Pacific County, WA	Eastern N Pacific	-	-	-	-	1	-	-	-	-	-	-	-	Yes	Unidentified fishery interaction	NK	Scientist	-
PR/R/25334	2020	2022	Pacific Ocean - North	Gray whale	Clallam County, WA	Eastern N Pacific - PCFG	-	-	-	-	1	-	-	-	-	-	-	-	Yes	Tribal salmon gillnet	GN	Fisherman	-
PR/R/25335	2020	2022	Pacific Ocean - South	Gray whale	Mendocino County, CA	Eastern N Pacific - PCFG	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Gillnet fishery	GN	Scientist	-
PR/R/25336	2020	2022	Pacific Ocean - North	Gray whale	Monterey County, CA	Eastern N Pacific	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unidentified fishery interaction	NK	Scientist	-
PR/R/25337	2020	2022	Pacific Ocean - North	Gray whale	Orange County, CA	Eastern N Pacific	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unidentified fishery interaction	NK	Scientist	-
PR/R/25338	2020	2022	Pacific Ocean - North	Humpback whale	San Diego County, CA	CA-OR-WA	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Gillnet fishery	GN	Scientist	-
PR/R/25339	2020	2022	Pacific Ocean - North	Humpback whale	Monterey County, CA	CA-OR-WA	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unidentified fishery interaction	NK	Scientist	-
PR/R/25340	2020	2022	Pacific Ocean - North	Humpback whale	Santa Barbara County, CA	CA-OR-WA	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Ca spot prawn trap fishery	FPO	Scientist	-
PR/R/25341	2020	2022	Pacific Ocean - North	Humpback whale	Orange County, CA	CA-OR-WA	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unidentified fishery interaction	NK	Scientist	-
PR/R/25342	2020	2022	Pacific Ocean - North	Humpback whale	Monterey County, CA	CA-OR-WA	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Dungeness crab pot fishery (California)	FPO	Scientist	-
PR/R/25343	2020	2022	Pacific Ocean - North	Humpback whale	Marin County, CA	CA-OR-WA	1	-	-	-	-	-	-	-	-	-	-	-	Yes	Dungeness crab pot fishery (Washington)	FPO	Scientist	-
PR/R/25344	2020	2022	Pacific Ocean - North	Humpback whale	Monterey County, CA	CA-OR-WA	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unidentified fishery interaction	NK	Scientist	-
PR/R/25345	2020	2022	Pacific Ocean - North	Humpback whale	Lincoln County, OR	CA-OR-WA	-	-	-	-	-	-	-	-	1	-	-	-	Yes	Unidentified fishery interaction	NK	Scientist	-
PR/R/25346	2020	2022	Pacific Ocean - North	Humpback whale	Clallam County, WA	CA-OR-WA	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unidentified fishery interaction	NK	Scientist	-

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	Individuals data are available?	Targeted fishery species	Fishing gear	How observed	References
USA 2019-20 cont.																							
PR/R/25347	2020	2022	Pacific Ocean - North	Humpback whale	Mendocino County, CA	CA-OR-WA	-	-	-	-	1	-	-	-	-	-	-	-	Yes	Unidentified fishery interaction	NK	Scientist	-
PR/R/25348	2020	2022	Pacific Ocean - North	Humpback whale	San Diego County, CA	CA-OR-WA	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unidentified fishery interaction	NK	Scientist	-
PR/R/25349	2020	2022	Pacific Ocean - North	Humpback whale	Monterey County, CA	CA-OR-WA	-	-	-	-	-	-	-	-	-	-	1	-	Yes	Unidentified fishery interaction	NK	Scientist	-
PR/R/25350	2020	2022	Pacific Ocean - North	Humpback whale	Jefferson County, WA	CA-OR-WA	-	-	-	-	1	-	-	-	-	-	-	-	Yes	Unidentified fishery interaction	NK	Scientist	-
PR/R/25351	2020	2022	Pacific Ocean - North	Sperm whale	Ventura County, CA	CA-OR-WA	-	-	-	-	-	-	-	-	-	1	-	-	Yes	Unidentified fishery interaction	NK	Scientist	-
PR/R/25625	2019	2022	Atlantic Ocean - North	Humpback whale			-	-	-	-	-	-	-	-	5	5	9	-	Yes		MIS	Scientist, fisherman, observer, inspector, public	PR/B/979 | *Serious Injury and Mortality Determinations for Baleen Whale Stocks along the Gulf of Mexico, United States East Coast, and Atlantic Canadian Provinces, 2015-2019.* Henry, Allison *et.al.* Unpubl.

ID	Explanation
USA 2019-20 cont.	
PR/R/24765	One was trap/pot gear, the other gear unknown/not recovered.
PR/R/24766	One trap/pot (the SI) and one gear unknown/not recovered.
PR/R/24767	-
PR/R/25329	09/03/2020: Blue whale with healing linear scar posterior to dorsal fin that appears to have been caused by large diameter rope or other entangling material. There are also raw abrasions the length of the caudal peduncle and on the anterior margin of the dorsal fin, indicating that entangling material shifted towards the back of the whale at some point. Another, larger diameter indentation is visible mid-body from UAV footage, presumably from the same entanglement. Whale was free-swimming with no gear attached, in apparent good health, despite evidence of a previous constricting entanglement. Assigned non-serious injury as the whale is gear free and in apparent good health.
PR/R/25330	01/12/2020: Approximately 75 feet of line trailing from tail area on whale. At the end of the line is a single light green or yellowish green buoy. Full gear configuration and amount unknown.
PR/R/25331	01/20/2020: Rope in front of blowhole and wrapped around the rostrum and trailing downward; blueish/purple monofilament netting draped over the blowhole, wrapped on itself into a 'cord' trailing over back. Gear configuration and amount unknown.
PR/R/25332	04/24/2020: Free-swimming gray whale with closed bridle through mouth. Other end of gear trailing with buoys and descending to depth. Line runs through mouth; out of left mouth across the head to meet up with the line coming from the right mouth in a multiple twists. The line from the left mouth continues after the twists towards the seafloor / trap. The line from the right mouth continues past the twists to the buoys near the peduncle. Pot line - 10 fathoms of 3/8ths sinking line from buoy, running to 2 fms of 7/16th floating line to pot had blue square WDFW tag from 2019-20 season (300 pot limit from coastal WA); 10 fathoms of 3/8ths sinking line from buoy. Rescue team was able to cut gear free/full release.

ID	Explanation
USA 2019-20 cont.	
PR/R/25333	05/10/2020: Moderately decomposed and in poor nutritional condition with healing entanglement injury at tip of lower jaw. One set of photos posted on Facebook on May 10 showed a loose entanglement on left pectoral flipper, but the gear was gone by morning of May 11. Whale also showed evidence of prior entanglement.
PR/R/25334	08/06/2020: Net and rope this whale was reported by fisherman (tribal salmon gillnet fishery) that had caught the whale in his net. It was dead on arrival at 9:40am after having drowned in the net. It is not known when the whale was entangled, or when it died, but it was clear that the whale had very little decomposition suggesting that it had not been dead in the net for too long. Carcass was brought ashore for a full examination due to the ongoing gray whale UME investigation and the fresh condition of the animal. Pretty clear where the large ropes of net had interacted with the whale - but if rope had not been seen at that location it would have been hard to pick out as compared to normal suite of scars and scratches on gray whales. We did not see any of the characteristic hash marking caused by a net.
PR/R/25335	08/07/2020: Blue steel line with 2 buoys (1/2 white/ 1/2 orange) wrapped around head and flipper. We believe it could be wrapped around the left pectoral and there is some small remnants of gillnet. Unauthorized RP said they grabbed the line very close to the whale and when the whale felt them on the line it spooked and dove and they didn't see it again. Final outcome and gear configuration and amount unknown.
PR/R/25336	08/19/2020: Orange buoy with marine growth attached to left side of whale, attachment point assumed to be pectoral flipper based on photo. Reporting party states there was a small amount of blue gillnet attached to the buoy, but it is not visible in photos. Gear amount and configuration unknown. Whale appears healthy and is free-swimming. Assumed to be same unidentified whale initially seen off Gualala in Mendocino on 8/7 and identified as a gray whale in same area on 8/13 with similar gear and placement.
PR/R/25337	11/18/2020: Confirmed entangled from unmanned aerial vehicle photos: bundle of line at base of peduncle and mid fluke. Constricting line at fluke insertion. Long single line trailing the whale that may exceed length of whale. Full gear configuration and amount unknown.
PR/R/25338	02/14/2020: Gillnet wrapped around bottom jaw, caught on front right tubercle draped over body, wrapped tightly around body and trailing over flukes. Left pectoral possibly pinned. Based on amount of gear and tight wrap, considered an extensive constricting entanglement.
PR/R/25339	02/28/2020: Black line through mouth running down both sides of the body, line appears to be weighted given the injuries/rubbing off of long linear patch of skin along the sides behind the pectoral fins. The inner leading edge adjacent to the tail stock of the flukes is rubbed raw. Gear configuration and amount unknown.
PR/R/25340	04/13/2020: Juvenile humpback confirmed entangled entangled and anchored in place to a spot prawn set; at least 4 wraps of light yellow twisted line tightly around caudal peduncle (multiple scars along tailstock); then line goes straight down (twisting on itself) to trap; other end of line is trailing oblong orange poly ball about 5 ft behind. Fisherman interviewed and confirmed 10 traps, with 120 pound weights; set on 04/10/2020; 400ft of sinking line running from the buoy down, 800ft of floating line running from there to the anchor. Partial gear removal by rescue team. Final gear amount and configuration unknown.
PR/R/25341	04/15/2020: Dependent calf (swimming with larger animal, presumed mother) near Catalina Island entangled in dark colored mesh netting (looked fairly fresh) wrapped on right fluke blade and tailstock, trailing dark line with at least very small 4 red/orange floats. Entanglement likely to become constricting as animal grows.
PR/R/25342	05/16/2020: California Dungeness crab pot commercial gear confirmed from tags. Photo shows two buoys and multiple twisted lines wrapped around flukes and caudal peduncle and cutting into whale with areas of pink/white flesh exposed. Constricting entanglement. Whale rescue team disentangled whale and cut away all gear. Outcome unknown.
PR/R/25343	06/13/2020: Carcass with constricting peduncle wrap almost completely amputating fluke. Left blade missing and right blade necrotic. Commercial Dungeness crab pot (Oregon). The entanglement was tightly wrapped around peduncle at the insertion point. The entanglement had cut entirely through the peduncle with the fluke and entanglement attached by only the cord in her peduncle. Consisted of 2 different color braided ropes (3/8 inch floating orange line with a blue tracer and white sinking line with blue tracer). Four bullet buoys attached (one large white-main buoy; two buoys with orange tip with yellow butt; one smaller orange buoy). The entire left side of the fluke was missing and unknown if the cause was the entanglement or scavenging. Based on interview with fisherman, gear was set sometime between mid April and late May.
PR/R/25344	07/03/2020: Single line across the top of the body cutting into flesh anterior to dorsal fin connected to a mass of tangled lines on the right side of body. Constricting entanglement. Nothing trailing the whale so either there is something still on the line below that is causing the drag to pull through the whales flesh; perhaps left pectoral flipper is involved. Able to relocate the whale just as it started chin slapping which gave us good looks at the different parts of the body. Then it began tail slapping. It appeared as if it was trying to throw the gear.
PR/R/25345	07/30/2020: Hake trawl vessel pulled up a dead humpback in their net. Bloated animal with large missing and sloughing patches of skin, obviously dead before pulled up. Vessel reported that carcass had buoys attached to and there are two orange buoys shown from the deck camera photos.
PR/R/25346	08/31/2020: Reporting party saw a line wrapping the whole body between the dorsal fin and flippers and it surfaced again after the breach and he saw the line again - which he described the entangling material as yellow 5/8 line. Observation occurred within 60 ft. of vessel. Full configuration and amount of gear unknown. No photos.
PR/R/25347	09/07/2020: Fresh dead with fair body condition. Photos showed probable entanglement injuries including (a) amputated flukes, (b) lacerations, abrasions, and penetrating wounds to the dorsal ridge as well as (c) a possible line impression on the dorsal surface posterior to the blowholes directly over the scapulae, (d) possible abrasions on the right pectoral fin, and (e) possible lateral bruising on the right abdomen. Chronic entanglement resulting in amputation of flukes.
PR/R/25348	10/11/2020: Whale with obvious entanglement injury at fluke insertion point and scars/apparent rub marks along the dorsal midline posterior to dorsal fin indicating gear had moved along that part of the whale. Whale is also not using its flukes while traveling (=limited mobility). Heavy cyamid load and discolored skin indicating a health decline. No gear actually present on whale (=gear free), but photos and UAV video are unequivocal that this whale was previously-entangled and has undergone a health decline. Configuration and amount of gear unknown.
PR/R/25349	10/13/2020: Two green lines on left side of rostrum and line across the animals back, which is hard to see in the photo. Gear configuration and amount unknown. Presumed full self release, seen gear free by Happy Whale in November.

ID	Explanation
USA 2019-20 cont.	
PR/R/25350	10/15/2020: Whale stranded alive but died by the following morning. Necropsy identified numerous scrapes, scratches, and circular or oblong skin lesions with wide margins and depressed centers. The whale lice (cyamid) burden was heavy along the back and sides and extending ventrally along the head and mouth. Deep constricting wrap injury encircled the tailstock with associated tissue necrosis and abraded skin. Similar abrasions were on the right pectoral fin, and the left pectoral fin appeared swollen. Healed cookie cutter bites were on both pectoral fins, and a large healed notch was on the distal end of the trailing left pectoral fin.
PR/R/25351	10/01/2020: Juvenile sperm whale photographed off Santa Cruz Island. Entanglement appears to mainly involve the peduncle and tail but it is possible that there is more line on the whale. Amount and configuration of gear unknown. The gear appears to be some thicker gauge poly pro line like blue spectra and is wrapped around the peduncle and dragging behind approx. 10 ft or so. Photo of peduncle underwater shows line cutting into peduncle below the skin, with whitish wounds visible and multiple scars surrounding the wound. Constricting entanglement based on line cutting into whale.
PR/R/25625	-

FAO Gear Codes listed

[FIX] TRAPS - Traps (not specified)
[FPO] TRAPS - Pots
[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)
[GTN] GILLNETS AND ENTANGLING GEAR - Combined gillnet-trammel nets
[GTR] GILLNETS AND ENTANGLING GEAR - Trammel nets
[LL] HOOKS AND LINES - Longlines (not specified)
[LLD] HOOKS AND LINES - Drifting longlines
[LX] HOOKS AND LINES - Hooks and lines (not specified)
[MIS] MISCELLANEOUS GEAR
[NK] GEAR NOT KNOWN OR NOT SPECIFIED
[NSC] SHARK CONTROL NETS
[RG] RECREATIONAL FISHING GEAR
[TBB] TRAWLS - Bottom trawls

Ship Strikes

ID	Data year	Year sub-mitted	Large Area	Species	Local area	Local area (Long/Lat)	TI: Dead	TI: Ser. Inj	TI: Inj.	TI: Unk	Indiv. data are available	Submitted to National Ship Strike Database	Sub-mitted to IWC	Explanation	Contacts	Refs
Australia 2021																
PR/R/23600	2020	2022	Pacific Ocean - South	Humpback whale	Woody Head	-29.359627, 153.359211	1	-	-		Yes	No	No	Dead humpback on beach. Post mortem by vet (Dr Duan March) suggests blunt force trauma including significant infection on right hand pectoral flipper consistent with collision.	PR/C/1011 | S. Crocetti (*susan.crocetti@ environment.nsw.gov.au*)	-
PR/R/24822	2021	2022	Southern Ocean	Humpback whale	Port Phillip Bay	Mt Martha	1	-	-		No	Unknown	Unk.	Observed alive and swimming in Port Phillip Bay day before. Large injury on left side lower jaw. Presumed vessel strike. Appeared otherwise healthy.	PR/C/465 | M. Watson (*mandy.watson @delwp.vic.gov.au*)	(1)
PR/R/24871	2021	2022	Indian Ocean	Unidentified large whale	Onslow, Western Australia	-	-	-	-	1	No	Unknown	Unk.	15/08/2021	PR/C/1588 | Wildlife Protection (*wildlife.protection @dbca.wa.gov.au*)	-
PR/R/25064	2021	2022	Southern Ocean	Sei whale	St Kilda, Gulf St Vincent	34 44 35 S, 138 31 56 E	1	-	-	-	Yes	No	No	Found on ship's bow after berthing in Port Adelaide on 21 Aug 2021. Carcasss floated out and washed up in St Kilda (N of Port Adelaide) where dissected and collected. Broken vertebrae with pre-mortem haemorrhaging observed.	PR/C/857 | C. Kemper (*catherine.kemper @samuseum.sa.gov.au*)	-
PR/R/25168	2021	2022	Pacific Ocean - South	Humpback whale	Hervey Bay	153.10281; -25.04958	-	-	-	1	No	No	No	Reported by vessel skipper.	PR/C/832 | StrandNet (*strand.data@ des.qld.gov.au*)	-
PR/R/25361	2021	2022	Pacific Ocean - South	Humpback whale	Sydney Heads	Lat:-33°50'27 .485, Lng: 151°17'1.838	-	-	1	-	No	No	Yes	Adult humpback with healed propeller vessel strike injury seen, same animal as was originally seen with rope entanglement.	PR/C/1598 | S. Lorigan (*shona.lorigan@ environment.nsw.gov.*	-

ID	Data year	Year sub-mitted	Large Area	Species	Local area	Local area (Long/Lat)	TI: Dead	TI: Ser. Inj	TI: Inj.	TI: Unk	Indiv. data are available	Submitted to National Ship Strike Database	Sub-mitted to IWC	Explanation	Contacts	Refs
Australia 2021 cont.																
PR/R/25362	2021	2022	Pacific Ocean - South	Humpback whale	Jervis Bay	Lat: -35°4'39.494, Lng: 150° 44' 1.451	-	-	1	-	No	No	Yes	Staff from Jervis Bay Wild Pty Ltd called last night to report their vessel struck an adult whale. The incident occurred around 12.30pm yesterday within Jervis Bay. The vessel was moving a two-thirds speed to towards a distant whale when this whale surfaced under the vessel. The whale was not seen before it was struck. They were able to follow the whale thereafter to determine it had minor injuries.	PR/C/1598 | S. Lorigan (as above)	-
PR/R/25363	2021	2022	Pacific Ocean - South	Humpback whale	Tweed Heads	Lat: -28°11' 57.562, Lng: 153°34'13.969	-	-	1	-	No	No	Yes	Call from ORRCA to report an adult Humpback Whale with visible propeller strike. Location off Cook Island Nature Reserve (south of Tweed Heads) and heading north. Photos provided and wound appears minor and animal will likely recover.	PR/C/1598 | S. Lorigan (as above)	-
PR/R/25364	2021	2022	Pacific Ocean - South	Humpback whale	Narooma	Lat: -36° 14' 49.848, Lng: 150°13'34.896			1		No	No	Yes	Vessel strike - recreational vessel had a whale breach onto it. 2 people injured. Whale not seen to determine injury to whale but no reports in following days of an injured whale.	PR/C/1598 | S. Lorigan (as above)	-
PR/R/25365	2021	2022	Pacific Ocean - South	Humpback whale	Bilgola Headland	Lat: -33° 38' 36.06, Lng: 151° 20' 0.384		1			No	No	Yes	02/07/21. Whale observed at Bilgola Headland (Sydney's Northern Beaches). 03/07/21. Whale observed off Birubi Beach up near Anna Bay (Port Stephens). This animal appears to have a significant injury, forward of its dorsal fin that has healed (old vessel strike scar).	PR/C/1598 | S. Lorigan (as above)	-

(1) PR/B/929 | Victorian Biodiversity Atlas. DELPW. Unpublished.

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	Sub-mitted to IWC	Explanation
Columbia 2021														
PR/R/24724	2020	2022	Pacific Ocean - South	Humpback whale	Uramba Bahia Malaga National Park	-77.419470, 3.907890	-	-	1	-	Yes	Unknown	Yes	An adult humpback whale alive, identified as a mother as it was with its calf, registered with a recent scar caused by a propeller or a collision with a boat.
PR/R/24725	2010	2022	Pacific Ocean - South	Humpback whale	Gorgona Island National Park	77°20'21W, 3°55'23N	-	-	1	-	No	Unknown	Yes	An 8m vessel powered by a 200hp outboard engine collided with a calf in waters of Gorgona Island.
PR/R/24762	2018	2022	Pacific Ocean - South	Humpback whale	Bahía Solano	-77.48251, 6.31863	-	-	-	-	Yes	Yes	Unknown	Adult with propeller marks. The wounds were already healed. Animal photographed and registered by Madre Agua Colombia.

ID	Contacts	References
Columbia 2021 cont.		
PR/R/24724	PR/C/1584 | I.C. Avila (*isabel_c_avila@yahoo.com*)	PR/B/971 | *Áreas en riesgo para los mamíferos marinos en Colombia.* Avila, I.C., & A. Giraldo. Published. PR/B/972 | *A decade of whale watching in an important tourist destination in the Pacific coast of Colombia: Challenges for proper management*. Avila, I.C., Ortega, L.F., Pretel, C. and Mayor, G. Published
PR/R/24725	PR/C/1584 | I.C. Avila (as above)	PR/B/971 | *Áreas en riesgo para los mamíferos marinos en Colombia*. Avila, I.C., & A. Giraldo. Published PR/B/973 | *Crustaceans ectoparasites and epibionts of humpback whales, Megaptera novaeangliae (Cetacea: Balaenopteridae), in the Colombian Pacific*. Avila I.C., L.M. Cuellar and J.R. Cantera. Published. PR/B/974 | *Where humpback whales and vessel traffic coincide, a Colombian Pacific case study*. Avila, I.C., L. M. Correa & K. Van Waerebeek. Published.
PR/R/24762	PR/C/1587 | Madre Agua Colombia (*madreaguaeco@gmail.com*)	-

ID	Data year	Year sub-mitted	Large Area	Species	Local area	Local taxonomy	Total Indiv.: Dead	Total Indiv.: Seriously Injured	Total Indiv.: Injured	Total Indiv.: Unknown	Indiv. data are available	Submitted to National Ship Strike Database	Submitted to IWC	Contacts	Explanation
Mexico 2021															
PR/R/25515	2021	2022	Pacific Ocean - North	Humpback whale	-	Ballena jorobada	-	1	-	-	Yes	No	No	PR/C/1600 | A. Frisch Jordan (*fibbcatalogo@yahoo.com*)	Date: March 02, 2021. Boat propeller. Calf. The collision was located on the left side of the whale on the anterior of the dorsal fin.
PR/R/25516	2021	2022	Pacific Ocean - North	Humpback whale	-	Ballena jorobada	-	-	1	-	Yes	No	No	PR/C/1600 | A. Frisch Jordan (as above)	Date: May 21, 2021. Adult. Boat propeller. The collision was located on the right side of the whale.
PR/R/25517	2021	2022	Pacific Ocean - North	Sperm whale	Sonora	Cachalote	1	-	-	-	Yes	No	No	PR/C/1602 | H. Pérez Puig (*hector.perez@prescott.edu*)	Date: March 03, 2021. Male. Possible injuries due to boat collision.
PR/R/25518	2021	2022	Pacific Ocean - North	Bryde's whale	Colima	Rorcual tropical	1	-	-	-	No	No	No	PR/C/1601 | C. Ortega (*christian_ortega@ucol.mx*)	Date: October 24, 2021. Possible injuries or strikes due to boat collision. Male.
PR/R/25519	2022	2022	Pacific Ocean - North	Humpback whale	Sinaloa	Ballena jorobada	1	-	-	-	No	Unknown	Unknown	PR/C/135 | Mexican Network of Marine Mammals Strandings of SOMEMMA (*somemmavaram01@gmail.com*)	Date: February 07, 2022. Female. Possible injuries due to boat collision.
PR/R/25520	2022	2022	Pacific Ocean - North	Humpback whale	Colima	Ballena jorobada	1	-	-	-	Yes	No	No	PR/C/1601 | C. Ortega (as above)	Date: March 03, 2022. Female. Possible injuries due to boat collision.

ID	Data year	Year sub-mitted	Large Area	Species	Local area	Local tax-onomy	Local area (Long/Lat)	Total Indiv.: Dead	Total Indiv.: Ser. Inj.	Total Indiv.: Inj.	Total Indiv.: Unk	Indiv. data are available	Submitted to National Ship Strike Database	Sub-mitted to IWC	Contacts	Refs	Explanation
USA 2019-20																	
PR/R/24741	2020	2022	Atlantic Ocean - North	Sperm whale	-	-	-	1	0	0	0	No	Unknown	Unk.	PR/C/54 | B. Mase (*Blair.Mase@noaa.gov*)	-	SER20-00674
PR/R/24764	2019	2022	Atlantic Ocean - North	N Atl. right whale	-	-	-	4	0	0	0	Yes	Unknown	Unk.	PR/C/123 | T. Cole (*tim.cole@noaa.gov*)	PR/B/975 (1)	-
PR/R/25317	2020	2022	Pacific Ocean - North	Gray whale	Pacific County, WA	EN Pacific	-	1	-	-	-	Yes	Yes	Unk.	PR/C/1385 | J. Greenman (*justin.greenman@noaa.gov*)	-	05/31/2020: blunt force trauma to left side rostrum. Haemorrhage, edema, hematoma, force strong enough to cause latitudinal cracks in baleen and bend the fringe outward over the lower lip. No broken bones seen. At least contributed to the mortality. Healed entanglement wounds on leading edge of flukes and on tailstock--not related to mortality. Indent across tongue (healed), approx. 1/3 posterior to the tip, appears to have been wrapped/constricted at some point-not related to mortality. Vessel size and speed unknown.
PR/R/25318	2020	2022	Pacific Ocean - North	Gray whale	Grays Harbor County, WA	EN Pacific - PCFG	-	1	-	-	-	Yes	Yes	Unk.	PR/C/1385 | J. Greenman (as above)	-	07/05/2020: blunt force trauma to top of head, pre-mortem. Haemorrhage and edema at top of head. Bone near ear canal chipped, evidence of draining haemorrhage in area. Tiny bone fragments could be felt in edematous bone tissue. Vessel size and speed unknown.
PR/R/25319	2020	2022	Pacific Ocean - North	Hump-back whale	King County, WA	CA-OR-WA	-	-	1	-	-	Yes	Yes	Unk.	PR/C/1385 | J. Greenman (as above)	-	07/06/2020: ferry strike. Vessel size is 362 feet and speed was 13 kts. Photo immediately after strike shows injury to right side of animal not present in photos taken at sightings in days prior. Video just after strike showed whale acting abnormally and animal last seen 24 minutes after impact. Passengers aboard Puget Sound Express were watching 2 humpback whales and witnessed a ferry strike to the smaller of the two whales at 12:15. Whale presumed dead after exhaustive searches on 06 Jul and 07 Jul during which the larger of 2 whales was sighted but smaller one was not. National database reference nw-2020-1226706.
PR/R/25320	2020	2022	Pacific Ocean - North	Hump-back whale	Grays Harbor County, WA	CA-OR-WA	-	1	-	-	-	Yes	Yes	Unk.	PR/C/1385 | J. Greenman (as above)	-	07/26/2020: cause of mortality blunt force trauma consistent with ship strike. Vessel size and speed unknown. Several broken ribs on left side near veterbral connection. Massive internal bleeding in chest cavity, hematoma in blubber/muscle near l pectoral fin. Healed impressions consistent with entanglement on tailstock (wrap) and leading edges of flukes at insertions and a line of imp-ressions along the throat pleats between the pec fins (appeared to have been wrapped) these are not suspected to be related to mortality. Vessel size and speed unknown.

ID	Data year	Year sub-mitted	Large Area	Species	Local area	Local tax-onomy	Local area (Long/Lat)	Total Indiv.: Dead	Total Indiv.: Ser. Inj.	Total Indiv.: Inj.	Total Indiv.: Unk	Indiv. data are available	Submitted to National Ship Strike Database	Sub-mitted to IWC	Contacts	Refs	Explanation
USA 2019-20 cont.																	
PR/R/25321	2020	2022	Pacific Ocean - North	Hump-back whale	Clallam County, WA	CA-OR-WA	-	1	-	-	-	Yes	Yes	Unk.	PR/C/1385 | J. Greenman (as above)	-	09/27/2020: animal had been seen alive by local whale watch company on 9-22. Evidence of blunt force trauma, consistent with ship strike. Field of subcutaneous hemorrhage on lateral right mandible, concentrated in front 1/3 of mandible and radiating to insertion of pectoral fin. Trauma may extend toward left side mandible. No broken bones observed but cannot rule out the possibility of small fractures that were missed. Laying on back and unable to examine top of head. Extent of traumatic injuries undetermined but likely significantly contributed to morbidity and mortality. Vessel size and speed unknown.
PR/R/25322	2020	2022	Pacific Ocean - North	Unid. large baleen whale	Los Angeles County, CA	-	-	1	-	-	-	Yes	Yes	Unk.	PR/C/1385 | J. Greenman (as above)	-	08/11/2020: container vessel reported they had struck a whale in position 33-14n 119-12.3w. At 0800 the *m/v Horizon Pacific* updated that the whale has fallen off the bulb of the ship in position 33-33-.50n 118-25.50w. Fresh dead. Vessel size=247 feet, cruising speed=20 kts (65 ft and 10 kts). Speed is assumed, not known, based on location of reported strike and vessel profile listed online.
PR/R/25624	2019	2022	Atlantic Ocean - North	Hump-back whale	-	-	-	5	1	-	-	Yes	Unknown	Unk.	PR/C/123 | T. Cole (*tim.cole@noaa.gov*)	PR/B/979 (2)	-

(1) PR/B/975. *US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments 2021* | Hayes *et al.*, eds. Unpublished.

(2) PR/B/979. *Serious Injury and Mortality Determinations for Baleen Whale Stocks along the Gulf of Mexico, United States East Coast, and Atlantic Canadian Provinces, 2015-2019* | Henry, Allison *et.al.* Unpublished.

Annex I

Bycatch of Small Cetaceans Recorded in the Progress Reports Database

Compiled by Marion Hughes, IWC Secretariat

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	Explanation
Australia 2021																						
PR/R/24867	2021	2022	Indian Ocean	Unid. dolphin	Swan River, South Perth, WA	-	-	-	-	-	-	-	-	-	-	1	-	-	-	LX; FPO	Observer, inspector, public	08/05/2021. Dolphin located near Narrows Bridge, South Perth, entangled with crab pot, fishing line, injuries resulted in euthanasia.
PR/R/24868	2021	2022	Indian Ocean	Unid. dolphin	Point Gray, Mandurah, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	LX	Observer, inspector	29/09/2021. Dolphin sighted entangled in yellow braided line, was reported/assisted by Marine Officers and dolphin rescue volunteers and resulted in the dolphin managing to free itself.
PR/R/24869	2021	2022	Indian Ocean	Unid. dolphin	Peel Inlet, Mandurah, WA	-	-	-	-	1	-	-	-	-	-	-	-	-	-	LX	Observer, inspector	06/10/2021. Female dolphin entangled in fishing line reported/assisted by dolphin rescues volunteers.
PR/R/24870	2021	2022	Indian Ocean	Unid. dolphin	Doddies Beach, Mandurah, WA	-	-	-	-	-	-	-	-	-	-	-	-	1	-	LX	Public	22/10/2021. Dolphin sighted by a member of the public entangled in fishing line.
PR/R/24874	2021	2022	Southern Ocean	Common bottlenose dolphin	Fortescue Bay	-43.1413, 147.9658	-	-	-	-	-	-	-	-	1	-	-	-	Scalefish	RG; GNS	Public	Adult drowned in recreational gillnet, found on 27/12/2021.
PR/R/24970	2021	2022	Pacific Ocean - South	Killer whale	Victoria	-38.2,149.8	-	-	-	-	-	-	-	-	1	-	-	-	SESS	TBB	Fisherman	Around 8 to 10 feet long and juvenile, looked like been dead at least a 2 week.
PR/R/24971	2021	2022	Pacific Ocean - South	Long-finned pilot whale	Kiama, NSW	-34.7,151.4	-	-	-	-	-	-	-	-	-	-	-	-	ETBF	LLD	Fisherman	1 released alive and vigorous
PR/R/24972	2021	2022	Pacific Ocean - South	Long-finned pilot whale	Sunshine Coast, QLD	-26,155.20	-	-	-	-	-	-	-	-	-	-	-	-	ETBF	LLD	Fisherman	1 released alive and vigorous
PR/R/24973	2021	2022	Pacific Ocean - South	Short-finned pilot whale	Sydney, NSW	-34,152.20	-	-	-	-	-	-	-	-	-	-	-	-	ETBF	LLD	Fisherman	Caught a pilot whale first shot and released alive.
PR/R/24974	2021	2022	Pacific Ocean - South	Short-finned pilot whale	Sunshine Coast, QLD	-25,155.30	-	-	-	-	-	-	-	-	-	-	-	-	ETBF	LLD	Fisherman	1 released alive and sluggish
PR/R/24976	2021	2022	Pacific Ocean - South	Short-finned pilot whale	Gladstone, QLD	-24,154.50	-	-	-	-	-	-	-	-	-	-	-	-	ETBF	LLD	Fisherman	1 released alive and vigorous
PR/R/24977	2021	2022	Pacific Ocean - South	Short-finned pilot whale	QLD	-25,154	-	-	-	-	-	-	-	-	1	-	-	-	ETBF	LLD	Fisherman	1 dead
PR/R/24978	2021	2022	Pacific Ocean - South	Common dolphin	Victoria	-38,149.20	-	-	-	-	-	-	-	-	1	-	-	-	CTS SESS	TBB	Fisherman	-
PR/R/24979	2021	2022	Pacific Ocean - South	Common dolphin	Victoria	-38,149	-	-	-	-	-	-	-	-	1	-	-	-	CTS SESS	TBB	Fisherman	-
PR/R/24980	2021	2022	Pacific Ocean - South	Common bottlenose dolphin	NSW	-29,154.60	-	-	-	-	-	-	-	-	-	-	-	-	ETBF	LLD	Fisherman	1 animal released alive and vigorous. Hook on its top beak we cut the line and the hook came off.
PR/R/24981	2021	2022	Pacific Ocean - South	Unidentified dolphin	Nowra, NSW	-35,151.40	-	-	-	-	-	-	-	-	-	-	-	-	ETBF	LLD	Fisherman	1 released alive and vigorous

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	Explanation
Australia 2021 cont.																						
PR/R/24982	2021	2022	Pacific Ocean - South	Common bottlenose dolphin	Victoria	-38,148.10	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	Meshed in middle of net, juvenile. No marks or damage
PR/R/24983	2021	2022	Pacific Ocean - South	Unid. dolphin	Tasmania	-41,148.30	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	Juvenile, meshed middle of net
PR/R/24984	2021	2022	Pacific Ocean - South	Common dolphin	Bass Strait	-40,145.50	-	-	-	-	-	-	-	-	2	-	-	-	GHAT SESS	GNS	Fisherman	2 dead
PR/R/24985	2021	2022	Pacific Ocean - South	Common dolphin	Victoria	-38,148.20	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/24986	2021	2022	Pacific Ocean - South	Common dolphin	Bass Strait	-40,145.50	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/24987	2021	2022	Pacific Ocean - South	Common dolphin	Victoria	-38,148.40	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/24988	2021	2022	Pacific Ocean - South	Common dolphin	King Island	-40,143.60	-	-	-	-	-	-	-	-	2	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/24989	2021	2022	Indian Ocean	Common dolphin	South Australia	-38,140.80	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/24990	2021	2022	Pacific Ocean - South	Common dolphin	Victoria	-38,148.30	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/24991	2021	2022	Pacific Ocean - South	Common dolphin	Tasmania	-41,146.40	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	Fell out at bow roller
PR/R/24992	2021	2022	Pacific Ocean - South	Common dolphin	Bass Strait	-41,146.20	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/24993	2021	2022	Pacific Ocean - South	Common dolphin	Bass Strait	-41,146.70	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	Fell out at bow roller. unable to confirm species or status
PR/R/24994	2021	2022	Pacific Ocean - South	Unid. dolphin	Tasmania	-44,147.60	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	Caught during setting or whilst on the bottom as was being eaten by lice and dog sharks, shot into tide.
PR/R/24995	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-38,148.70	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/24996	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-39,143.10	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/24997	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-39,143	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	Well dead, chasing sardines as we shot. Dolphin was well meshed.
PR/R/24998	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-39,142.70	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/24999	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-38,144.40	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25000	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-38,148.40	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25001	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-39,141.50	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-

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	Explanation
Australia 2021 cont.																						
PR/R/25002	2021	2022	Pacific Ocean - South	Unid. dolphin	Bass Strait	-41,146.70	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25003	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-39,143	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	Well dead chasing sardines as we shot. Dolphin was well meshed.
PR/R/25004	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-38,149.30	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25005	2021	2022	Pacific Ocean - South	Unid. dolphin	Bass Strait	-39,145.90	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25006	2021	2022	Pacific Ocean - South	Unid. dolphin	Bass strait	-41,146.40	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25007	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-39,144.20	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	--
PR/R/25008	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-39,145.90	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25009	2021	2022	Indian Ocean	Unid. dolphin	South Australia	-37,139.70	-	-	-	-	-	-	-	-	2	-	-	-	GHAT SESS	GNS	Fisherman	2 dolphin in one shot
PR/R/25010	2021	2022	Pacific Ocean - South	Unid. dolphin	Tasmania	-43,147.40	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	Lots of bait fish, guessing was feeding and chasing bait.
PR/R/25011	2021	2022	Pacific Ocean - South	Unid. dolphin	Bass Strait	-40,145.50	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25012	2021	2022	Indian Ocean	Unid. dolphin	South Australia	-37,139.70	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25013	2021	2022	Pacific Ocean - South	Unid. dolphin	Bass Strait	-40,146.90	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25014	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-39,148.20	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25015	2021	2022	Pacific Ocean - South	Common dolphin	Victoria	-38,148.20	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25016	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-38,148.50	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25017	2021	2022	Pacific Ocean - South	Unid. dolphin	Tasmania	-42,148.40	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25018	2021	2022	Pacific Ocean - South	Unid. dolphin	Tasmania	-41,148.30	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25019	2021	2022	Pacific Ocean - South	Common dolphin	Victoria	-39,148.80	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25020	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-39,144.80	-	-	-	-	-	-	-	-	3	-	-	-	GHAT SESS	GNS	Fisherman	Refer to Dolphin Report
PR/R/25021	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-39,142.80	-	-	-	-	-	-	-	-	1	-	-	-	GHAT SESS	GNS	Fisherman	-
PR/R/25023	2021	2022	Pacific Ocean - South	Unid. dolphin	Victoria	-39,144.80	-	-	-	-	-	-	-	-	-	-	-	1	GHAT SESS	GNS	Fisherman	-

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	Explanation
Australia 2021 cont.																						
PR/R/25026	2021	2022	Pacific Ocean - South	Unid. dolphin	Gulf Of Carpentaria	-17,139.80	-	-	-	-	-	-	-	-	-	-	-	-	NPF	TM	Fisherman	1 released alive and sluggish, caught in TED
PR/R/25028	2021	2022	Pacific Ocean - South	Common dolphin	Eden, NSW	-37,150.30	-	-	-	-	-	-	-	-	-	-	-	-	STHN SPF	OTM	Fisherman	1 released alive just
PR/R/25031	2021	2022	Pacific Ocean - South	Common dolphin	Eden, NSW	-37,150.30	-	-	-	-	-	-	-	-	3	-	-	-	STHN SPF	OTM	Fisherman	Caught during tow. Observer on board
PR/R/25032	2021	2022	Pacific Ocean - South	Common dolphin	Ulladulla, NSW	-35,150.80	-	-	-	-	-	-	-	-	3	-	-	-	STHN SPF	OTM	Fisherman	Observer on board
PR/R/25033	2021	2022	Pacific Ocean - South	Common dolphin	NSW	-37,150.30	-	-	-	-	-	-	-	-	5	-	-	-	STHN SPF	OTM	Fisherman	All in barrier net
PR/R/25035	2021	2022	Pacific Ocean - South	Common dolphin	NSW	-37,150.30	-	-	-	-	-	-	-	-	3	-	-	-	STHN SPF	OTM	Fisherman	3 common dolphin caught while towing. Had Dr John Wakford onboard to confirm
PR/R/25036	2021	2022	Pacific Ocean - South	Common dolphin	NSW	-37,150.30	-	-	-	-	-	-	-	-	1	-	-	-	STHN SPF	OTM	Fisherman	-
PR/R/25038	2021	2022	Pacific Ocean - South	Common dolphin	NSW	-34,151.30	-	-	-	-	-	-	-	-	1	-	-	-	STHN SPF	OTM	Fisherman	-
PR/R/25041	2021	2022	Pacific Ocean - South	Common dolphin	Ulladulla, NSW	-35,150.80	-	-	-	-	-	-	-	-	5	-	-	-	STHN SPF	OTM	Fisherman	I saw 4 some crew said maybe 5 1 may've have slipped out while I was off deck. Confirmed with client, definitely 5.
PR/R/25042	2021	2022	Pacific Ocean - South	Common dolphin	NSW	-35,150.90	-	-	-	-	-	-	-	-	1	-	-	-	STH N SPF	OTM	Fisherman	Caught in the excluder
PR/R/25043	2021	2022	Pacific Ocean - South	Common dolphin	NSW	-36,150.40	-	-	-	-	-	-	-	-	2	-	-	-	STHN SPF	OTM	Fisherman	-
PR/R/25080	2021	2022	Southern Ocean	Common dolphin	South Australia		2	-	-	-	2	-	-	-	1	-	-	-	*Sardinops sagax*	PS1; PS2	Scientist, fisherman	5 events involving 5 indiv. - all collected by the SA Sardine Fishery and 4 post-mortemed by the SA Museum. One still to be examined 05/04/22.
PR/R/25081	2021	2022	Southern Ocean	Indo-Pacific bottlenose dolphin	Adelaide Dolphin Sanctuary, Port Adelaide River, Gulf St Vincent	34 48 15 S 138 31 45 E	-	-	-	-	-	-	1	-	-	-	-	-	Unknown	RG	Scientist, observer, inspector	Animal known as 'Doc' - 8 y.o. male. First observed with poor body conditions in Oct 2020 then seen with multiple skin lesions throughout Oct 2020 to Jan 2021. Improved body condition (less emaciated) noted in April 2021. Reported entangled with fishing lines and hooks on 19 June 2021, captured and disentangled on 25 June. The animal was seen spending lots of time around fishing boats and fishermen after the incident and has disappeared since. Last seen alive on 27 June 2021.
PR/R/25183	2021	2022	Pacific Ocean - South	Unid. dolphin	Sunshine Coast to Gold Coast	Various	1	-	-	-	2	-	-	-	1	-	-	-	White, tiger and bull sharks	NSC	Fisherman	-
PR/R/25184	2021	2022	Pacific Ocean - South	Common dolphin	Rainbow Beach to Gold Coast	-	2	-	-	-	-	-	-	-	2	-	-	-	White, tiger and bull sharks	NSC	Fisherman	-

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	Explanation
Australia 2021 cont.																						
PR/R/25185	2021	2022	Pacific Ocean - South	Indo-Pacific humpback dolphin	Sunshine Coast to Moreton Bay	Various	-	-	-	-	-	-	-	1	-	-	-	2	White, tiger and bull sharks	LX	-	Drumlines
PR/R/25186	2021	2022	Pacific Ocean - South	Indo-Pacific bottlenose dolphin	Moreton Bay	Various	-	-	-	-	-	-	-	-	-	-	-	3	Various teleosts	RG	Fisherman - public	
PR/R/25357	2021	2022	Indian Ocean	Unid. dolphin	Swan Estuary Marine Park, Western Australia	-	-	-	-	-	-	-	-	-	1	-	-	-	-	RG	Observer or inspector	05/10/2021. Dolphin calf with fishing line entanglement reported on weekend, and observed by government officers and vets over the weekend. Team assembled for disentanglement. Outcome due to fishing line injuries, unfortunately euthanasia.
PR/R/25399	2021	2022	Pacific Ocean - South	Indo-Pacific bottlenose dolphin	Gogleys Creek laurieton	-31°38' 43.722; 152°48' 58.452	1	-	-	-	-	-	-	-	-	-	-	-	-	MIS	Public	Council advised NPWS of a dead dolphin tangled in the swimming enclosure net at Gogleys Creek, Dunbogan in the Camden Haven River. Carcass poor (advanced decomposition).
PR/R/25400	2021	2022	Pacific Ocean - South	Common dolphin	Curl Curl Beach	33°46'26.3 S, 151°17'46.5 E	-	-	-	-	-	-	-	-	1	-	-	-	-	NSC	Observer, inspector	-
PR/R/25401	2021	2022	Pacific Ocean - South	Common dolphin	Narrabeen Beach	33°42'36.1 S, 151°18'36.2 E	-	-	-	-	-	-	-	-	1	-	-	-	-	NSC	Observer, inspector	-
PR/R/25402	2021	2022	Pacific Ocean - South	Common dolphin	Mona Vale Beach	33°40'55.3 S, 151°19'02.9 E	-	-	-	-	-	-	-	-	1	-	-	-	-	NSC	Observer, inspector	-
PR/R/25403	2021	2022	Pacific Ocean - South	Indo-Pacific bottlenose dolphin	Boat ramp North Haven	-31° 38' 18.817746; 152° 49' 9.3822708	-	-	-	-	-	-	1	-	-	-	-	-	-	RG	Public	An adult dolphin from resident pod named 'Lucky' with length of line/rope embedded in the dorsal fin, first reported on 9 Aug 2020. The dolphin is mobile and sighted at North Haven boat ramp. Dolphin resighted and top of dorsal fin now fully amputated and entanglement gone. Dolphin sighted in SW part of Queens Lake near Stingray Creek. It has small section of rope (crab trap rope?) embedded in dorsal fin. Dorsal fin has partial amputation injury, and is significantly deformed by injury.
PR/R/25404	2021	2022	Pacific Ocean - South	Indo-Pacific bottlenose dolphin	Long Beach, Jervis Bay	-35°2' 10.406; 150° 46' 24.294	-	-	-	-	-	-	-	-	-	-	1	-	-	RG	Public	Report from Dolphin Watch Cruises. The young dolphin was sighted off Callala Bay around midday, still showing signs of fishing line wrapped around the tail stock and fishing line trailing behind with some seaweed entangled within the fishing line. Traveling with mother dolphin, the calf was sighted with fishing line around the tail. The dolphin calf was reportedly swimming freely.

ID	Data year	Year sub-mitted	Large Area	Species	Local Area	Local Tax-onomy	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	Individuals data are available?	Targeted fishery species	Fishing gear	Other fishing gear	How observed	References	Explanation
Germany 2021																										
PR/R/25405	2021	2022	Atlantic Ocean - North	Harbour porpoise	Baltic Sea, Coast of Federal State of Schleswig Holstein	-	-	2	-	-	-	3	-	-	-	-	-	-	-	-	Plaice, flounder	GN	-	Fisherman	-	-
PR/R/25406	2021	2022	Atlantic Ocean - North	Harbour porpoise	Baltic Sea, Coast of Federal State of Schleswig Holstein	-	-	5	-	-	-	6	-	-	-	-	-	-	-	-	-	NK	-	-	-	-

ID	Data year	Year sub-mitted	Large Area	Species	Local Area	Local tax-onomy	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	Individuals data are available?	Targeted fishery species	Fishing gear	Other fishing gear	How observed
Italy 2021																								
PR/R/24808	2021	2022	Atlantic Ocean - North	Common bottlenose dolphin	Mediterranean Sea- Ligurian Sea-San Fruttuoso (GE)	-	Long: 9:10.2 Lat: 44:18.6	-	-	-	-	1	-	-	-	-	-	-	-	-	-	Unknown	-	Scientist
PR/R/24809	2021	2022	Atlantic Ocean - North	Common bottlenose dolphin	Mediterranean Sea-Central Tyrrhenian Sea, Anzio (Roma)	-	Long: 12:37.735 Lat: 41:26.698	-	-	-	-	1	-	-	-	-	-	-	-	-	-	Unknown	-	Scientist
PR/R/24810	2021	2022	Atlantic Ocean - North	Common bottlenose dolphin	Mediterranean Sea- Central Tyrrhenian Sea, Anzio (Roma)	-	Long: 12:26.606 Lat: 41:8.616	-	-	-	-	1	-	-	-	-	-	-	-	-	-	Unknown	-	Scientist, fisherman
PR/R/24811	2021	2022	Atlantic Ocean - North	Common bottlenose dolphin	Mediterranean Sea- Ligurian Sea-San Fruttuoso (GE)	-	Long: 9:10.2 Lat: 44:18.6	-	-	-	-	1	-	-	-	-	-	-	-	-	-	Unknown	-	Scientist

ID	Explanation
Italy cont.	
PR/R/24808	Adult. Male. Total length: 241cm. DCC: 2. NCC: moderate. The animal showed gas bubbles in main vessels; presence of fresh gastric content; bulging /red eyes; pulmonary and vascular changes-and multiorgan congestion; diatoms evidence (bone marrow). Relevant diagnostic findings: paravertebral abscess; poxvirus cutaneous infection. Degree of certainty: by catch as a consequence of underlying pathologies.
PR/R/24809	Adult. Male. Total length: 236cm. DCC: 2. NCC: good. The animal showed good NCC, gas bubbles in main vessels and organs, presence of fresh gastric content, pulmonary and vascular changes and multiorgan congestion. Relevant diagnostic findings: multiorganic parasitosis; photobacterium damselae systemic infection. Degree of certainty: by catch as a consequence of underlying pathologies.
PR/R/24810	Newborn. Male. Total length: 133.5cm. DCC: 2. NCC: good. The animal showed fishery interaction in the animal history, net marks/linear signs (acute), good NCC, presence of fresh gastric content, pulmonary and vascular changes. Relevant diagnostic findings: Morbillivirus systemic infection. Degree of certainty: By-catch as a consequence of underlying pathologies.
PR/R/24811	Adult. Male. Total length: 241cm. DCC: 2. NCC: moderate. The animal showed gas bubbles in main vessels; presence of fresh gastric content; bulging/red eyes; pulmonary and vascular changes-and multiorgan congestion; diatoms evidence (bone marrow). Relevant diagnostic findings: paravertebral abscess; poxvirus cutaneous infection. Degree of certainty: by catch as a consequence of underlying pathologies.

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	Individuals data are available?	Targeted fishery species	Fishing gear	Other fishing gear	How observed
Mexico 2021																								
PR/R/25512	2021	2022	Pacific Ocean - North	Spinner dolphin	Colima	Delfín tornillo	18.89221 N; -104.02529 W	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
PR/R/25513	2021	2022	Pacific Ocean - North	Spinner dolphin	Colima	Delfín tornillo	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	Public
PR/R/25514	2021	2022	Pacific Ocean - North	Spinner dolphin	Colima	Delfín tornillo	18.9168 N; -104.0708 W	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	Public

ID	Contacts	References	Explanation
Mexico cont.			
PR/R/25512	PR/C/1601 | C. Ortega (*christian_ortega@ucol.mx*)		Date: July 27, 2021. The dolphin showed marks of possible entanglement in fishing nets around the head and under the lower jaw. In addition, the dorsal and caudal fins may have been severed by the same fishermen to facilitate release from the net.
PR/R/25513	PR/C/1601 | C. Ortega (as above)		Date: September 19, 2021. The dolphin has net-like markings on its body.
PR/R/25514	PR/C/1601 | C. Ortega (as above)		Date: October 16, 2021. Possible interaction with fishery. Civilians reported the dolphin to the authorities, who notified the Cuyutlán turtle camp to request support and bury the dolphin.

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	Individuals data are available?	Targeted fishery species	Fishing Gear	Other Fishing Gear	How Observed
Netherlands																								
PR/R/25407	2021	2022	Atlantic Ocean - North	Harbour porpoise	North Sea	Bruinvis	-	3	-	-	-	4	-	-	-	-	-	-	-	-	-	NK	-	Scientist

ID	Contacts	References	
Netherlands cont.			
PR/R/25407	PR/C/453 | L. IJsseldijk (*L.L.IJsseldijk@uu.nl*)	PR/B/978 | *Post-mortem research on porpoises (Phocoena phocoena) from Dutch waters, 2021. Biological data, health status and causes of death*. Statutory Research Tasks Unit for Nature, the Environment (WOT Natuur, Milieu), WOt-technical report xx. xx p.; xx Figs; x Tabs; xx Refs; x Annexes. | van Schalkwijk, L., Kik, M.J.L., Gröne, A and IJsseldijk, L.L. (2022). Unpubl.	This is data obtained from a sample of stranded animals that are subject to post-mortem examinations in which the cause of death is determined.In 2021 the cause of death of 7 of the 54 porpoises examined was likely bycatch. These were four males and three females. Three animals had clear signs of net markings and no significant health issues, therefore bycatch is considered the cause of death with a high likelihood. Two porpoises that were considered likely bycatch also had other findings, such as parasitic infection, pneumonia and emaciation. Two more porpoises were likely bycaught but also showed that they were attacked by birds while still alive, indicating a live stranding or live entanglement.

ID	Data year	Year sub-mitted	Large Area	Species	Local Area	Local tax-onomy	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	Individuals data are available?	Targeted fishery species*	Fishing gear	Other fishing gear*	How observed	Contacts	Refs	Explanation
New Zealand 2021																											
PR/R/25857	2021	2022	Pacific Ocean - South	Gray's beaked whale	-	-	-35.956, 173.7447	-	-	-	-	-	-	-	-	1	-	-	-	-	Unk.	LX	-	Public	PR/C/537 | H. Hendriks (*hhendriks@doc.govt.nz*)	-	Found on beach with evidence of line entanglement; July 2021
PR/R/25858	2021	2022	Pacific Ocean - South	Common dolphin	Kawau Island	-	-36.4292, 174.8188	-	-	-	-	-	-	-	-	-	-	-	1	-	Unk.	GN	-	Public	PR/C/537 | H. Hendriks (as above)	-	Caught in recreational net, re-leased alive uninjured; 03/01/21
PR/R/25859	2021	2022	Pacific Ocean - South	Common dolphin	Waitemata Harbour	-	-36.84391, 174.70150	-	-	-	-	-	-	-	-	1	-	-	-	-	Unk.	LX	-	Public	PR/C/537 | H. Hendriks (as above)	-	Reported dead by public entangled in line on 27/11/21
PR/R/25860	2021	2022	Pacific Ocean - South	Common bottlenose dolphin	-	-	-47.0026, 167.4168	-	-	-	-	-	-	-	-	1	-	-	-	-	SCH	GNS	-	Fisherman	PR/C/895 | Fisheries New Zealand	-	Reported by fisherman on 06/01/21
PR/R/25861	2021	2022	Pacific Ocean - South	Common bottlenose dolphin	-	-	-43.8811, 172.4928	-	-	-	-	-	-	-	-	1	-	-	-	-	ELE	TBB	-	Fisherman	PR/C/895 | Fisheries New Zealand	-	Reported by fisherman on 20/01/21
PR/R/25862	2021	2022	Pacific Ocean - South	Unid. dolphin	-	-	-44.988, 171.6342	-	-	-	-	-	-	-	-	1	-	-	-	-	BAR	TBB	-	Fisherman	PR/C/895 | Fisheries New Zealand	-	Reported by fisherman on 25/01/21
PR/R/25863	2021	2022	Pacific Ocean - South	Common dolphin	-	-	-38.1059, 178.4369	-	-	-	-	-	-	-	-	1	-	-	-	-	GUR	TBB	-	Fisherman	PR/C/895 | Fisheries New Zealand	-	Reported by fisherman on 27/02/21
PR/R/25864	2021	2022	Pacific Ocean - South	Common dolphin	-	-	-37.6912, 176.6415	-	-	-	-	-	-	-	-	-	-	-	4	-	EMA	PS1	-	Fisherman	PR/C/895 | Fisheries New Zealand	-	Dolphins reported by fisherman as released alive uninjured on 03/03/21
PR/R/25865	2021	2022	Pacific Ocean - South	Dusky dolphin	Unk. location	-	-39.16414, 175.25391	-	-	-	-	-	-	-	-	1	-	-	-	-	Unk.	NK	-	Fisherman	PR/C/895 | Fisheries New Zealand	-	Reported by fisherman on 04/03/21, unknown location and fishing gear/target species
PR/R/25866	2021	2022	Pacific Ocean - South	Common dolphin	-	-	-37.3925, 175.9751	-	-	-	-	-	-	-	-	1	-	-	-	-	SNA	LL	BLL	Fisherman	PR/C/895 | Fisheries New Zealand	-	Reported by fisherman on 25/03/21
PR/R/25867	2021	2022	Pacific Ocean - South	Common dolphin	-	-	-37.8723, 177.0264	-	-	-	-	-	-	-	-	1	-	-	-	-	SNA	TBB	-	Fisherman	PR/C/895 | Fisheries New Zealand	-	Reported by fisherman on 26/04/21
PR/R/25868	2021	2022	Pacific Ocean - South	Killer whale	-	-	-38.7115, 178.5591	-	-	-	-	-	-	-	-	-	-	-	1	-	BIG	LL	Surface/ midwater long line	Fisherman	PR/C/895 | Fisheries New Zealand	-	Reported by fisherman as released alive uninjured on 18/05/21
PR/R/25869	2021	2022	Pacific Ocean - South	Long-finned pilot whale	-	-	-48.1702, 178.8447	-	-	-	-	-	-	-	-	1	-	-	-	-	LIN	LL	Bottom long line	Fisherman	PR/C/895 | Fisheries New Zealand	-	Reported by fisherman on 11/07/21
PR/R/25870	2021	2022	Pacific Ocean - South	Dusky dolphin	-	-	-42.6748, 173.5398	-	-	-	-	-	-	-	-	-	-	-	1	-	HPB	GNS	-	Fisherman	PR/C/895 | Fisheries New Zealand		Reported by fisherman as released alive uninjured on 24/07/21
PR/R/25871	2021	2022	Pacific Ocean - South	Common bottlenose dolphin	-	-	-37.0227, 177.4197	-	-	-	-	-	-	-	-	-	-	-	1	-	STN	LL	Surface/ midwater long line	Fisherman	PR/C/895 | Fisheries New Zealand		Reported by fisherman as released alive uninjured on 24/07/21
PR/R/25872	2021	2022	Pacific Ocean - South	Common dolphin	-	-	-38.7483, 174.0618	-	-	-	-	-	-	-	-	1	-	-	-	-	WAR	GNS	-	Fisherman	PR/C/895 | Fisheries New Zealand		Reported by fisherman on 01/08/21
PR/R/25873	2021	2022	Pacific Ocean - South	Dusky dolphin	-	-	-42.55, 173.6633	-	-	-	-	-	-	-	-	1	-	-	-	-	BNS	GNS	-	Fisherman	PR/C/895 | Fisheries New Zealand		Reported by fisherman on 15/08/21
PR/R/25874	2021	2022	Pacific Ocean - South	Common dolphin	-	-	-41.5473, 174.5906	-	-	-	-	-	-	-	-	6	-	-	-	-	HOK	TM	-	Fisherman	PR/C/895 | Fisheries New Zealand		Reported by fisherman on 24/08/21
PR/R/25875	2021	2022	Pacific Ocean - South	Unid. dolphin	-	-	-50.8552, 166.9196	-	-	-	-	-	-	-	-	1	-	-	-	-	SCI	TBB	-	Fisherman	PR/C/895 | Fisheries New Zealand		Reported by fisherman on 15/09/21
PR/R/25876	2021	2022	Pacific Ocean - South	Common dolphin	-	-	-38.1158, 174.2684	-	-	-	-	-	-	-	-	1	-	-	-	-	SCH	GNS	-	Fisherman	PR/C/895 | Fisheries New Zealand		Reported by fisherman on 26/09/21

*BLL - Bottom long line. BAR – Barracouta. BIG - Bigeye tuna. BNS – Bluenose. ELE - Elephant fish. EMA - Blue mackerel. GUR – Gurnard. HPB - Hapuku and bass. HOK - Hoki. LIN – Ling. SCH - School shark. SCI – Scampi. SNA – Snapper. STN - Southern bluefin tuna. WAR - Common warehou.

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	Individuals data are available?	Targeted fishery species	Fishing gear	Other fishing gear	How observed	Contacts	References	Explanation
UK 2021																											
PR/R/26032	2021	2022	Atlantic Ocean - North	Common dolphin	-	-	-	3	0	0	0	6	0	0	0	0	0	0	0	-	-	NK	-	Scientist	PR/C/247 | R. Deaville (*rob.deaville@ioz.ac.uk*) PR/C/1547 | J. Barnett (*jamesbarnettvet@gmail.com*)	PR/B/984 | CSIP Annual Report to UK Government for 2021. Deaville, R. (compiler). Unpubl.	Diagnosed as bycatch from necropsies within UK strandings programme.
PR/R/26033	2021	2022	Atlantic Ocean - North	Harbour porpoise	-	-	-	3	0	0	0	3	0	0	0	0	0	0	0	-	-	NK	-	Scientist	PR/C/247 | R. Deaville (as above) PR/C/1547 | J. Barnett (as above)	PR/B/984 as above	As above
PR/R/26034	2021	2022	Atlantic Ocean - North	Killer whale	-	-	-	0	0	0	0	1	0	0	0	0	0	0	0	-	-	NK	-	Scientist	PR/C/248 | A. Brownlow (*andrew.brownlow@sac.co.uk*)	PR/B/985 | SMASS Annual Report to Scottish Govern-ment for 2021. Brownlow, A. (compiler). Unpub.	As above

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	Individuals data are available?	Targeted fishery species	Fishing gear	Other fishing gear	How observed
USA 2018-19																								
PR/R/22961	2018	2022	Atlantic Ocean - North	Common bottlenose dolphin	-	-	-	-	-	-	-	-	-	-	-	0	17.4	-	-	-	Pelagic swordfish, tunas and billfish	LLS	-	Observer or inspector
PR/R/22964	2018	2022	Atlantic Ocean - North	Short-finned pilot whale	-	-	-	-	-	-	-	-	-	-	-	0	102.2	-	-	-	Pelagic swordfish, tunas and billfish	LLS	-	Observer or inspector
PR/R/22967	2018	2022	Atlantic Ocean - North	Long-finned pilot whale	-	-	-	-	-	-	-	-	-	-	-	0	0.4	-	-	-	Pelagic swordfish, tunas and billfish	LLS	-	Observer or inspector
PR/R/22970	2018	2022	Atlantic Ocean - North	Common dolphin	-	-	-	-	-	-	-	-	-	-	-	0	1.4	-	-	-	Pelagic swordfish, tunas and billfish	LLS	-	Observer or inspector
PR/R/22973	2018	2022	Atlantic Ocean - North	Risso's dolphin	-	-	-	-	-	-	-	-	-	-	-	0	0.2	-	-	-	Pelagic swordfish, tunas and billfish	LLS	-	Observer or inspector
PR/R/22976	2018	2022	Atlantic Ocean - North	Unid. small cetacean	-	-	-	-	-	-	-	-	-	-	-	0	40.9	-	-	-	Pelagic swordfish, tunas and billfish	LLS	-	Observer or inspector
PR/R/24736	2019	2022	Atlantic Ocean - North	Pantropical spotted dol.	Gulf of Mexico	-	-	-	-	-	-	-	-	-	-	0	12.9	0	0	-	Swordfish, tunas, and billfish	LL	-	Observer or inspector
PR/R/24737	2019	2022	Atlantic Ocean - North	Short-finned pilot whale	Western North Atlantic	-	-	-	-	-	-	-	-	-	-	0	131.2	0	0	-	Pelagic swordfish, tunas, and billfish	LL	-	Observer or inspector
PR/R/24738	2019	2022	Atlantic Ocean - North	Long-finned pilot whale	Western North Atlantic	-	-	-	-	-	-	-	-	-	-	0	0.4	0	0	-	Pelagic swordfish, tunas, and billfish	LL	-	Observer or inspector
PR/R/24739	2019	2022	Atlantic Ocean - North	Common dolphin	Western North Atlantic	-	-	-	-	-	-	-	-	-	-	0	0.2	0	0	-	Pelagic swordfish, tunas, and billfish	LL	-	Observer or inspector

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	Individuals data are available?	Targeted fishery species	Fishing gear	Other fishing gear	How observed
USA 2018-19 cont.																								
PR/R/24740	2019	2022	Atlantic Ocean - North	Unidentified beaked whale	Western North Atlantic	-	-	-	-	-	-	-	-	-	-	0	0.3	0	0	-	Pelagic swordfish, tunas, and billfish	LL	-	Observer or inspector
PR/R/25324	2020	2022	Pacific Ocean - North	Common dolphin	Santa Barbara County, California	Long-beaked common dolphin	-	-	-	-	-	-	-	-	-	3	-	-	-	-	Gillnet fishery	GN	-	Scientist
PR/R/25325	2020	2022	Pacific Ocean - North	Harbour porpoise	Kitsap County, WA inland waters	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	Gillnet fishery	GN	-	Scientist
PR/R/25326	2020	2022	Pacific Ocean - North	Harbour porpoise	Whatcom County, WA inland waters	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	Gillnet fishery	GN	-	Scientist
PR/R/25327	2020	2022	Pacific Ocean - North	Harbour porpoise	Clallam County, WA, northern Oregon-WA coast	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	Gillnet fishery	GN	-	Scientist
PR/R/25328	2020	2022	Pacific Ocean - North	Striped dolphin	Clatsop County, Oregon CA-OR-WA	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	Gillnet fishery	GN	-	Scientist
PR/R/25628	2019	2022	Atlantic Ocean - North	Risso's dolphin	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	GN	-	Observer or inspector
PR/R/25630	2019	2022	Atlantic Ocean - North	Long-finned pilot whale	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	TBB	-	Observer or inspector
PR/R/25631	2019	2022	Atlantic Ocean - North	Atlantic white-sided dolphin	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	TBB	-	Observer or inspector
PR/R/25632	2019	2022	Atlantic Ocean - North	Common dolphin	-	-	-	-	-	-	-	-	-	-	-	58	-	-	-	-	-	MIS	-	Observer or inspector
PR/R/25633	2019	2022	Atlantic Ocean - North	Harbour porpoise	-	-	-	-	-	-	-	-	-	-	-	37	-	-	-	-	-	MIS	-	Observer or inspector

ID	Contacts	Explanation
USA 2018-19 cont.		
PR/R/22961	PR/C/53 | L. Garrison (*Lance.Garrison@noaa.gov*)	-
PR/R/22964	PR/C/53 | L. Garrison (as above)	-
PR/R/22967	PR/C/53 | L. Garrison (as above)	-
PR/R/22970	PR/C/53 | L. Garrison (as above)	-
PR/R/22973	PR/C/53 | L. Garrison (as above)	-
PR/R/22976	PR/C/53 | L. Garrison (as above)	-
PR/R/24736	PR/C/53 | L. Garrison (as above)	-
PR/R/24737	PR/C/53 | L. Garrison (as above)	-
PR/R/24738	PR/C/53 | L. Garrison (as above)	-
PR/R/24739	PR/C/53 | L. Garrison (as above)	-
PR/R/24740	PR/C/53 | L. Garrison (as above)	-
PR/R/25324	PR/C/1385 | J. Greenman (*justin.greenman@noaa.gov*)	05/03/2020, 05/18/2020, and 05/26/2020: 3 moderately decomposed animals with flukes cut off, characteristic of animals cut out of net.
PR/R/25325	PR/C/1385 | J. Greenman (as above)	09/30/2020: multiple deep impressions on both sides of tail fluke consistent with gillnet entanglement.
PR/R/25326	PR/C/1385 | J. Greenman (as above)	10/03/2020: fresh dead animal entangled in netting.

ID	Contacts	Explanation
USA 2018-19 cont.		
PR/R/25327	PR/C/1385 | J. Greenman (as above)	08/12/2020 and 08/13/2020: a total of six harbor porpoise were found dead with evidence of gillnet mortality over 2 days. Three porpoise came ashore on 08/12 in a net. The next day, three more porpoise stranded dead with evidence of net marks, considered to be part of same event or fishery.
PR/R/25328	PR/C/1385 | J. Greenman (as above)	07/08/2020: animal with compound fracture of jaw, net marks and gashes stranded alive. Euthanized.
PR/R/25628	PR/C/33 | D. Palka (*debra.palka@noaa.gov*)	One mortality observed - estimate = 5.3 (0.7 CV)
PR/R/25630	PR/C/33 | D. Palka (as above)	One mortality observed – estimate = 5.39 (0.88 CV)
PR/R/25631	PR/C/33 | D. Palka (as above)	14 observed dead – estimate = 79 (0.28 CV)
PR/R/25632	PR/C/33 | D. Palka (as above)	1 dead in New England sink gillnet - estimate=5.0 (0.66 CV). 3 dead in mid-Atlantic gillnet - estimate=20 (0.56CV). 2 dead in northeast bottom trawl – estimate - 10 (0.62 CV). 52 dead, 2 SI in mid-Atlantic bottom trawl - estimate=395 (0.23 CV).
PR/R/25633	PR/C/33 | D. Palka (as above)	33 observed dead in northeast gillnet - estimate=195 (0.23 CV). 2 observed dead in mid-Atlantic gillnet - estimate 13 (0.5 CV). 2 observed dead in northeast bottom trawl - estimate 11 (0.63 CV).

FAO Gear Codes used

[FPO] TRAPS - Pots	[LX] HOOKS AND LINES - Hooks and lines (not specified)	[PS1] SURROUNDING NETS - One-boat operated purse seines
[GN] GILLNETS AND ENTANGLING GEAR - Gillnets (not specified)	[MIS] MISCELLANEOUS GEAR	[PS2] SURROUNDING NETS - Two-boat operated purse seines
[GNS] GILLNETS AND ENTANGLING GEAR - Set gillnets (anchored)	[NK] GEAR NOT KNOWN OR NOT SPECIFIED	[RG] RECREATIONAL FISHING GEAR
[LL] HOOKS AND LINES - Longlines (not specified)	[NSC] SHARK CONTROL NETS	[TBB] TRAWLS - Bottom trawls
[LLD] HOOKS AND LINES - Drifting longlines	[OTM] MIDWATER TRAWLS - Otter trawls (side or stern)	[TM] MIDWATER TRAWLS - Midwater trawls (not specified)
[LLS] HOOKS AND LINES - Set longlines		[TM] TRAWLS - Shrimp trawls (not specified)

Annex J

Written Statement from the UK Government Condemning Russia

(New Zealand, Australia and the United States also wish to be associated with this Statement)

While we do not want to derail a technical, Scientific Committee meeting, we feel it is essential to state, on the record, the UK's strong condemnation of the unprovoked, illegal war Russia has launched, and our unwavering support of Ukraine.

Putin's unprovoked, illegal war is a reprehensible, premeditated attack on Ukraine, and on the principles of self-determination and the rule of law. Ukraine continues to suffer barbaric attacks, but their resolve remains unbroken. The Russian government is engaged in an information war – seeking to distort their inability to achieve their original aims, and to attempt to cover up the atrocities committed in their name. Our aim remains clear: Putin must lose in Ukraine. And we will do everything we can to ensure that happens.

Russia's assault on Ukraine is an unprovoked, premeditated attack against a sovereign democratic state. The UK and our international partners stand united in condemning the Russian government's reprehensible actions, which are an egregious violation of international law and the UN Charter. As a Permanent Member of the UN Security Council, Russia has a particular responsibility to uphold international peace and security. Instead, it is violating the borders of another country and its actions are causing widespread suffering.

As the UN Secretary-General has said, such unilateral measures conflict directly with the United Nations Charter - the use of force by one country against another is the repudiation of the principles that every country has committed to uphold. We strongly support Ukraine's sovereignty, its territorial integrity and its people, and we call on Russia to immediately cease attack and withdraw its forces from Ukrainian territory. Russia must be held accountable and stop undermining democracy, global stability, and international law.

Together with our allies the UK will step up our efforts to stop Putin's appalling war. We stand with Ukraine and their right to choose their own destiny.

Annex K

Statement on the Agenda

Annex K1

STATEMENT BY THE GOVERNMENTS OF ICELAND AND NORWAY CONCERNING DNA REGISTER SYSTEMS

The IWC member Governments of Iceland and Norway, have implemented national DNA register systems for effective monitoring of whale meat products in the market and for many years have provided information on those DNA register systems to the IWC-SC, on a voluntary basis.

This year the Governments of Iceland and Norway reiterate their position that the monitoring of markets is outside the jurisdiction and competence of the IWC. Therefore we consider that the inclusion of items related to DNA identification of market products on the agenda of the IWC-SC and its Working Groups is inappropriate. As in previous years, our national delegates will not participate in any such discussions. We note that, whilst a non-IWC member, the Government of Japan shares this position.

However, again as in previous years, our two Governments will continue to voluntarily provide additional information on their DNA register systems as they deem appropriate for achieving conservation and sustainable use of large whales including information on technical aspects of those systems[1].

We urge that future work of the IWC-SC on matters related to the use of DNA technologies and analyses should take our position into account. In this regard, we consider that documents dealing with the marketing of whale products should not be submitted to nor discussed at the IWC-SC.

[1]Whilst a member of the IWC, Japan also provided such information voluntarily. We note that Japan has indicated that it will continue to do so as a non-member government and also that it will not participate in discussions related to the identification of market products.

Annex L

State of the Cetacean Environment Report (SOCER) 2022

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 2022 SOCER features the Arctic and Antarctic Oceans, summarising key papers and articles published from *ca*. 2020 through 2022 to date. This year's regional SOCER represents the third year of the current cycle, which will be combined in a second 5-year compendium (2020: Atlantic Ocean through 2024: Mediterranean and Black Seas; see first 5-year compendium at *https://iwc.int/socer-report*) to present to the Commissioners at IWC/70.

ARCTIC AND ANTARCTIC OCEANS

General

Most Recent Ocean Health Index Includes Arctic Countries But Omits Antarctic Region

The OHI provides quantitative assessments of progress towards healthy and sustainable oceans on a scale from 0-100. It is based on 10 goals encompassing current status, trend, external pressures and resilience measures. The average score of the 2020 OHI was 72 out of 100. The Index is currently available for 220 regions (coastal nations and territories). Although the average OHI scores have not dramatically changed over eight years, some individual goals and regions have changed significantly. The Arctic is not listed separately, but based on the OHI's country/territory approach, certain countries bordering Arctic waters are at or above the average global value (Greenland 86, Norway 83, Finland 79, Iceland 78, Canada, 76, Russia 71). Antarctica, although listed, is evaluated throughout with 'NA', meaning that many of the OHI goals do not apply to Antarctica and that it has therefore been excluded in recent assessments. Longo *et al.* (2017) provided the most recent OHI-based assessment of the Southern Ocean.

(SOURCES: Anon. Ocean Health Index. 2020, http://ohi-science.org/ohi-global/scores.html; Longo, C.S., Frazier, M., Doney, S.C., Rheuban, J.E., Humberstone, J.M. and Halpern, B.S. 2017. Using the Ocean Health Index to identify opportunities and challenges to improving Southern Ocean ecosystem health. Front. Mar. Sci. 4: 20, https://doi.org/10.3389/fmars.2017.00020).

Cetacean Distribution Shifting in the Arctic

Spatial trends were examined in Svalbard for three Arctic endemic cetacean species (white whales, narwhals and bowhead whales), sperm whales, white-beaked dolphins and four summer-resident baleen whales (blue whales, fin whales, humpback whales and common minke whales). The authors compared earlier (2005-19) and more recent periods (2015-19) to identify potential shifts in distribution in this area, which is experiencing rapid warming and concomitant sea-ice losses. The summer residents shifted their distributions from the continental shelf break west of Spitsbergen during the earlier period into fjords and coastal areas during the recent period. These changes coincided with increased inflows of warmer, nutrient- and plankton-rich Atlantic Water into the fjords and troughs around this high-Arctic archipelago. Two of the three Arctic endemic species increased in number north of Svalbard and decreased in coastal areas and fjords, reflecting the retreating sea-ice edge, with which they are associated. There was also an increase in the number of Atlantic species, which may indicate an uncertain future for endemic Arctic species.

(SOURCE: Bengtsson, O., Lydersen, C. and Kovacs, K.M. 2022. Cetacean spatial trends from 2005 to 2019 in Svalbard, Norway. Polar Res. 41: 7773, https://doi.org/10.33265/polar.v41.7773).

[1]Department of Functional and Evolutionary Ecology, Bio-Oceanography and Marine Biology Unit, University of Vienna, Austria and Department of Paleontology, University of Vienna, Austria.

[2]Animal Welfare Institute, Washington, DC, USA.

[3]The Center for Ecology and Conservation, University of Exeter, Penryn Campus, Cornwall, UK.

White Whales in St Lawrence Estuary Subject to Multiple Stressors

Endangered St Lawrence Estuary white whales have failed to recover from overharvest (population size reduction by ~90% by 1979), despite combined management measures. This has been attributed to the sub-lethal effects of noise, toxic contaminants and prey reduction (with rare lethal ship strikes and entanglement in fishing gear). Chion *et al.* (2021) used a model to simulate the effect of vessel underwater noise. They concluded that the projected ship traffic increase in the Saguenay River will negate the role of this river as a quiet zone or acoustic refuge in critical habitat for females and calves. Williams *et al.* (2021) conducted a population viability analysis and concluded that the predicted effects of climate change could determine the future of this population more than other threats. This 'population is unlikely to recover to pre-exploitation levels or meet interim recovery targets, even under our most optimistic scenarios, because the reproductive capacity has been reduced both by sublethal threats and by climate changes since cessation of harvest'. This population is thus a case study for the cumulative effects of multiple stressors, as well as for polar species at the southernmost limits of their distribution, where climate change exacerbates the mix of other threats. Finally, Ménard *et al.* (2022) reported on an effort to mitigate acoustic disturbance of these whales based on using different marine spatial planning-based approaches in the Saguenay-St Lawrence Marine Park. These approaches included preserving the area as an acoustic refuge by not diverting ship traffic into an already quiet sector of critical habitat and restricting the growth of commercial whale watching activities.

(SOURCES: Chion, C., Bonnell, T.R., Lagrois, D., Michaud, R., Lesage, V., Dupuch, A., McQuinn, I.H. and Turgeon, S. 2021. Agent-based modelling reveals a disproportionate exposure of females and calves to a local increase in shipping and associated noise in an endangered beluga population. Mar. Pollut. Bull. 173: 112977, https://doi.org/10.1016/j.marpolbul.2021.112977; Williams, R., Lacy, R.C., Ashe, E., Hall, A., Plourde, S. McQuinn, I.H. and Lesage, V. 2021. Climate change complicates efforts to ensure survival and recovery of St. Lawrence Estuary beluga. Mar. Pollut. Bull. 173: 113096, https://doi.org/10.1016/j.marpolbul.2021.113096; Ménard, N., Turgeon, S., Conversano, M. and Martins, C.C.A. 2022. Sharing the waters: Application of a marine spatial planning approach to conserve and restore the acoustic habitat of endangered beluga whales (Delphinapterus leucas) in and around the Saguenay-St. Lawrence Marine Park. Mar. Pollut. Bull. 175: 113325, https://doi.org/10.1016/marpolbul.2022.113325).

Most Antarctic Biotas Are Exposed to Multiple Stressors and Considered Vulnerable to Environmental Change

A literature survey by 26 international experts provided 10 key messages regarding the impact of environmental change on biological processes in the Antarctic. Life in the Southern Ocean and Antarctica is highly sensitive to environmental changes, and these experts concluded that climate change was the greatest anthropogenic threat. In contrast, the IPBES Global Assessment considered exploitation to present the greatest risk to global marine and terrestrial ecosystems. This difference reflects the currently low economic importance of exploitable Antarctic resources. Pollution in Antarctic habitats has recently attracted particular attention, especially microplastics. Antarctic concerns include multiple stressors, biotas vulnerable to environmental change due to narrow tolerance ranges, rapid change, projected circumpolar impacts, low potential for timely genetic adaptation and migration barriers. The authors noted that the Southern Ocean makes a remarkable contribution to global biodiversity and ecosystem services and that conservation strategies should consider Antarctic biotas and their functioning to be more connected to the rest of the world than previously understood.

(SOURCE: Gutt, J., Isla, E., Xavier. J.C., Adams, B.J., Ahn, I.-Y., Cheng, C.-H.C., Colesic, C., Cummings, V.J. et al. 2021. Antarctic ecosystems in transition - life between stresses and opportunities. Biol. Rev. 96: 798-821, https://doi.org/10.1111/brv.12679).

Krill as a Foundation of the Southern Ocean Food Chain in the Framework of Ecosystem-Based Management

Krill is a key dietary item for whales, seals, seabirds and fish. Its biomass is the largest of any multicellular species of wildlife on the planet. Seventy percent of the krill population inhabits the Southwest Atlantic sector of the Southern Ocean and is the target of a valuable commercial fishery managed by CCAMLR. Based on the restricted distribution of successfully spawning krill and the high inter-annual variability in its biomass, Meyer *et al.* (2020) argued that the risk of direct fishery impacts might be higher than previously thought. They contended that improved knowledge and remaining mindful of uncertainties about krill ecology would benefit management decisions by enabling improved models to be used in a more holistic approach to ecosystem change. This would promote the overall goal of conservation of the Antarctic ecosystem as a whole. One such ecosystem model (Karakuş *et al.* [2021]) incorporated krill as large zooplankton. The model's results showed that these crustaceans and their metabolic products actually support a stable phytoplankton population and that this has implications for the transfer of carbon to the deep ocean. A projected decline of krill or a shift to a salp-dominated ecosystem could weaken this role.

(SOURCES: Meyer, B., Atkinson,A., Bernard, K.S., Brierley, A.S., Driscoll, R., Hill, S.L., Marschoff, E., Maschette, D., Perry, F.A., Reiss, C.S., Rombolá, E., Tarling, G.A., Thorpe, S.E., Trathan, P.N., Guoping, Z. and Kawaguchi, S. 2020. Successful ecosystem-based management of Antarctic krill should address uncertainties in krill recruitment, behaviour and ecological adaptation. Commun. Earth Environ. 1: 28, https://doi.org/10.1038/s43247-020-00026-1; Karakuş, O., Völker, C., Iversen, M., Hagen, W., Wolf-Gladrow, D., Fach, B. and Hauck, J. 2021. Modeling the impact of macrozooplankton on carbon export production in the Southern Ocean. J. Geophys. Res-Oceans 126 e2021JC017315, https://doi.org/10.1029/2021JC017315).

Aquatic Critical Zones: Fjords Are Particularly Sensitive to Threats

Fjords, many in subarctic and Arctic regions and frequented by cetaceans, have been classified as Aquatic Critical Zones (ACZs). This reflects their 'high vulnerability to anthropogenic pressure and increasing evidence of Holocene climate fluctuations'. The authors predicted shipping to increase considerably in the Arctic Ocean and subarctic, a reflection of climate change and declining sea ice cover. This increase would be associated with higher levels of vessel-related contaminants, including antifouling paints, metals and airborne articles (PAHs), as well as pharmaceuticals and sanitary wastes (e.g. PPCPs). The authors also predicted shipping accidents to increase. They called for intensified monitoring and research, e.g. into whether the toxicity of pollutants might be different in cold-water organisms or in species that have previously hardly encountered pollution, focusing particularly on emerging pollutants of concern. Additional threats to these ACZs include considerably expanding mariculture and waste disposal, including suggestions to use deep anoxic fjord basins as dumping grounds for fresh forestry waste to help reduce the quantity of CO_2 released to the atmosphere. Glaciated high-latitude fjords are the 'canary in the coalmine', i.e. particularly vulnerable to climate change because the rate of warming is three times faster in the Arctic than the global average. The authors concluded by stating that 'Climate change affecting rainfall and river discharge into fjords will impact the thickness and extent of the low- salinity layer in the upper reaches of the fjord, slowing the rate of the overturning circulation and deep-water renewal— thereby impacting bottom water oxygen concentrations'.

(SOURCE: Svavarsson, J., Guls, H.D., Sham, R.C., Leung, K.M.Y. and Halldórsson, H.P. 2021. Pollutants from shipping - new environmental challenges in the subarctic and the Arctic Ocean. Mar. Pollut. Bull. 164: 112004, https://doi.org/10.1016/j.marpolbul.2021.112004).

HABITAT DEGRADATION

General

Increasing Carbon Dioxide, Trace Element and Nutrient Levels in Arctic Ocean Waters

Due to melting Arctic sea ice, more ocean surface water is being exposed to the atmosphere, which in turn leads to greater absorption of carbon dioxide in polar waters (Ouyang *et al.,* 2020). As the uptake of carbon dioxide is actually greater in colder water, this has elevated the rates of carbon dioxide uptake in the region. Some of this increased carbon uptake may lead to increase biological productivity in some areas; however, it may also lead to an increase in ocean acidification in the Arctic environment. Melting sea ice also increases the levels of freshwater runoff (Charette *et al.,* 2020), bringing higher levels of trace elements into Arctic waters. Because this runoff is bound to organic matter from the land surface and rivers, it is allowing carbon and trace elements to be transported over 1,000km from their source into the central Arctic Ocean. Some of these trace elements, such as Fe, are a limiting nutrient in the ocean, and elevated levels lead to an increase in ocean productivity and algal growth. However, some trace elements, such as Hg, are toxic to marine ecosystems. In addition, as permafrost melts, the flow of water will change, from melting ice at the surface flowing into the oceans to a groundwater-dominated system (Rawlins *et al.,* 2019). Deeper water will flow through newly thawed soils, bringing more nutrients to coastal waters and altering food webs and ecosystems. These increases in carbon, acidification and trace elements could have major impacts on Arctic ecosystems.

(SOURCES: Ouyang, Z., Qi, D., Chen, L., Takahashi, T., Zhong, W., DeGrandpre, M.P., Chen, B., Gao, Z., Nishino, S., Murata, A., Sun, H., Robbins, L.L., Jin, M. and Cai, W.-J. 2020. Sea-ice loss amplifies summertime decadal CO2 increase in the western Arctic Ocean. Nat. Clim. Change 10: 678-684, https://doi.org/10.1038/s41558-020-0784-2; Charette, M.A., Kipp, L.E., Jensen, L.T. et al. 2020. The transpolar drift as a source of riverine and shelf-derived trace elements to the central Arctic Ocean. J. Geophys. Res- Oceans 125: e2019JC015920, https://doi.org/10.1029/2019JC015920; Rawlins, M.A., Cai, L., Stuefer, S.L. and Nicolsk, D. 2019. Changing characteristics of runoff and freshwater export from watersheds draining northern Alaska. Cryosphere 13: 3337-3352, https://doi.org/10.5194/tc-13-3337-2019).

Fisheries interactions

Fisheries Interactions with Alaskan Killer Whales

Between 2001 and 2016, Alaskan fisheries observer records were examined for instances of killer whale injuries and mortalities associated with fishing operations. The highest number of incidents occurred in the southeast Bering Sea and most incidents were when killer whales fed on caught fish or discarded catches, or fishermen used whale deterrent measures (96% of 3,245 interactions). Longline fisheries accounted for 87% of incidents. A total of 27 mortalities were reported (3 of which were mammal eaters and the rest fish eaters), but the actual number was assumed to be higher. At least 12 animals were entangled and/or killed in fishing gear and 9 were killed by propeller injuries. This level of mortality could have major impacts on relatively small killer whale populations.

(SOURCE: Dahlheim, M.E., Cahalan, J. and Breiwick, J.M. 2022. Interactions, injuries, and mortalities of killer whales (Orcinus orca) observed during fishing operations in Alaska. Fish. Bull. 120: 79-94).

Marine Debris

Is A Predicted Future Increase In Plastic Ingestion By Seabirds Also Valid For Cetaceans?

In the Canadian Arctic, 72% of northern fulmars and 15% of black-legged kittiwakes ingested plastics (two other seabird species did not). The authors concluded that, with increased shipping activities and as climate change releases plastics frozen in sea ice, 'seabirds may be increasingly susceptible to plastic ingestion in the Arctic'. The ingestion threat posed by plastics introduced by these two mechanisms would no doubt be equally applicable to cetaceans.

(SOURCE: Baak, J.E., Provencher, J.F. and Mallory, M.L. 2020. Plastic ingestion by four seabird species in the Canadian Arctic: Comparisons across species and time. Mar. Pollut. Bull. 158: 112386, https://doi.org/10.1016/j.marpolbul.2021.111386).

Low Levels of Seabed Litter in the Siberian Arctic Stem Mostly from the Fishing Industry

In the first study of its kind in this region, 174 bottom trawl hauls in the Chukchi, East Siberian, Laptev and Kara Seas yielded seabed litter only in the Chukchi and Kara Seas, with the values being highest in the latter. Plastic was the most common type of debris. The main source was fisheries related (e.g. net pieces, rope fragments), followed by solid municipal wastes (e.g. textiles, wrappings, packaging). Navigation on this Northern Sea Route is limited by time of year, but the amount of cargo transported is expected to double between 2024 and 2035. Much of the litter that enters the Kara Sea is from fishing fleets in the Barents Sea, with long-range transport via currents and, to some degree, by ice. The geography is such that large amounts of garbage accumulate on beaches. Four species of cetaceans occur regularly in the Kara Sea, with three more as vagrants in the ice-free season. Such studies are important because much of the marine debris in the oceans is thought to ultimately sink to the sea floor and thus escape detection.

(SOURCES: Benzik, A.N., Orlov, A.M. and Novikov, M.A. 2021. Marine seabed litter in Siberian Arctic: A first attempt to assess. Mar. Pollut. Bull. 172: 112836, https://doi.org/10.1016/j.marpolbul.2021.112836; https://www.pame.is/images/03_Projects/EA/LMEs/Factsheets/6_Kara_Sea_LME.pdf).

Microplastics in Arctic Fjord Probably Transported Long-Range by West Spitsbergen Current

The abundance of microplastics in the sediments of two fjords in Svalbard was high, 721 and 783 pieces/kg, respectively. Polyethylene and polypropylene were the most common polymers and fibres the most common shape. The Krossfjord-Kongsfjord system is thus heavily polluted by microplastics, despite its low population density and remote location. The authors identified long-range transport by the west Spitsbergen current, sea ice, glacial melt and atmospheric transport by wind as possible sources of these microplastics. Moreover, the contribution of local sources such as wastewater effluents, packaging material and fishing gear is increasing, because anthropogenic activities have expanded in recent years due to a reduction in sea ice.

(SOURCE: Choudhary, S., Neelavanan, K. and Saalim, S.M. 2022. Microplastics in the surface sediments of Krossfjord-Kongsfjord system, Svalbard, Arctic. Mar. Pollut. Bull. 176: 113452, https://doi.org/10.1016/j.marpolbul.2022.113452).

Antarctic Specially Protected Area Status Insufficient to Prevent Anthropogenic Debris

Antarctica is typically considered to be one of the most pristine environments on Earth. Nevertheless, even the highest form of environmental protection here - the status as an Antarctic Specially Protected Area - is insufficient to ensure protection from anthropogenic debris. A study on Nelson Island, South Shetland Islands, revealed a wide range of debris from local terrestrial sources and marine transportation. The authors outlined the threats that this poses to wildlife and stated 'an international treaty for the conservation and sustainable use of the high seas could decrease the release of debris in these remote areas by enforcing the already existing regulations (e.g. MARPOL 73/78 Annex V)'.

(SOURCE: Grohman Finger, J.V., Corá, D.H., Covey, P., Santa Cruz, F., Petry, M.V. and Krüger, L. 2021. Anthropogenic debris in an Antarctic Specially protected Area in the maritime Antarctic. Mar. Pollut. Bull. 172: 112921, https://doi.org/10.1016/j.marpolbul.2021.112921).

Antarctic Sea Ice is a Reservoir for Microplastic Debris

A core taken in coastal land-fast sea ice in the East Antarctic yielded ca. 12 microplastic particles/litre. The most common polymers were polyethylene, polypropylene and polyamide, corresponding to most studies on marine microplastics. Based on the literature and polymer composition, the authors considered that one source is fishing debris. They also noted that 'western Antarctica may experience higher levels of [microplastics] pollution due to the presence of more scientific research stations, heavier marine traffic and the majority of Antarctic tourism operations'. Importantly, the authors concluded that sea ice serves as a potential reservoir for microplastics debris, which 'may have consequences for Southern Ocean food webs'.

(SOURCE: Kelly, A., Lannuzel, D., Rodemann, T., Meiners, K.M. and Auman, H.J. 2020. Microplastic contamination in east Antarctic sea ice. Mar. Pollut. Bull. 154: 111130, https://doi.org/10.1016/j.marpolbul.2020.111130).

Potential Combined Effects of Nanoplastics, the Smallest Marine Debris, and Ocean Acidification

Marine debris is ubiquitous in the world's oceans. Although not yet documented in the Southern Ocean, the smallest category, nanoplastics, is expected to be as pervasive as the larger categories. For example, Arctic krill can fragment microplastics down to nanoplastic size. In a laboratory study, polystyrene nanoparticles compromised the ability of sub- Antarctic pteropods to counteract the stress of ocean acidification, which hampers shell formation and thus survival. Nanoplankton on and in both

pteropods and krill can potentially pose a threat because pteropods are an important link between phytoplankton and higher trophic levels, including whales. This is a good example of the potential combined effects of more than one stressor or threat. The authors highlighted the importance of studying plastic pollution in the context of climate change.

(SOURCE: Manno, C., Peck, L.V., Corsi, I. and Bergami, E.L. 2022. Under pressure: Nanoplastics as a further stressor for sub- Antarctic pteropods already tackling ocean acidification. Mar. Pollut. Bull. 174: 113176, https://doi.org/10.1016/j.marpolbul.2021.113176).

Marine Debris in Arctic Seas Originates Primarily in the Atlantic

Pogojeva *et al.* (2021) found that the average density of large items of marine debris floating on the surface of Russian Arctic seas was a comparatively low 0.92 items/km². The eastern part of the study area - the Kara, Laptev and East Siberian seas - was practically free of such litter. The authors believed North Atlantic surface water, which flows along the Norwegian coastline and enters through the Norwegian and Barents seas, to be primarily responsible for introducing floating plastic litter to the study area, with little input from Siberian rivers, at least during the autumn study period. These results serve as a baseline and can help to prioritise efforts to manage Arctic marine litter. Hänninen *et al.* (2021) also reported relatively small amounts of plastic debris in the Arctic Ocean. The mean particle size was 2.7mm; the most abundant polymer was polyethylene. Although the drifting times of particles could not be determined, long-range drifting was likely. Accordingly, the Atlantic Ocean, via the Fram Strait, was again the main source of marine debris in the Arctic Ocean. The authors discussed the Greenland gyre and a potential accumulation somewhere, 'whether in surface waters, the water column, the sea ice, in deep-sea sediments or in the biota'.

(SOURCES: Pogojeva, M., Zhdanov, I., Berezina, A., Lapenkov, A., Kosmatch, D., Osadchiev, A., Hanke, G., Semiletov, I. and Yakushev, E. 2021. Distribution of floating marine macro-litter in relation to oceanographic characteristics in the Russian Arctic Seas. Mar. Pollut. Bull. 166: 112201, https://doi.org/10.1016/j.marpolbul.2021.112201; Hänninen, J., Weckström, M., Pawlowska, J., Szymanska, N., Uurasjärvi, E., Zajaczkowski, M., Hartikainen, S. and Vuoinen, I. 2021. Plastic debris composition and concentration on the Arctic Ocean, the North Sea and the Baltic Sea. Mar. Pollut. Bull. 166: 112150, https://doi.org/10.1016/j.j.marpolbul.2021.112150).

MICROPLASTICS POLLUTION VERY HIGH IN THE ARCTIC REGION

Despite its remoteness, the Arctic region has amongst the highest microplastics concentrations worldwide. Based on sampling at four depths (near-surface, ~300m, ~1,000m, above seafloor), Tekman *et al.* (2020) reported water column values between 0 and 1287 items/m³ and sediment values from 239 to 13,331 items/kg. Polyamide (39%) and ethylene-propylene-diene rubber (23%) were the most abundant polymers within the water column, while polyethylene- chlorinated (31%) was most abundant in the sediments. The authors concluded that biological processes in the water interact with microplastics and found support for the hypotheses that 'the Arctic is an accumulation area for [microplastics] particles transported: (i) from the North Atlantic via the thermohaline circulation; ii) from the north of the Fram Strait entrained in sea ice and released during melting; (iii) from the Barents Sea; (iv) via local emissions from increasing shipping activities; (v) from different directions through the atmosphere and precipitation; and (vi) from the discharge of rivers'. In a later review, Bergmann *et al.* (2022) noted that, even if plastics emissions were halted today, fragmentation of legacy plastics would lead to an increasing microplastics burden in Arctic ecosystems.

(SOURCE: Tekman, M.B., Wekerle, C., Lorenz, C., Primpke, S., Hasemann, C., Gerdts, G. and Bergmann, M. 2020. Tying up loose ends of microplastic pollution in the Arctic: Distribution from the sea surface through the water column to deep-sea sediments at the HAUSGARTEN Observatory. Environ. Sci. Technol. 54: 4079-4090, https://doi.org/10.1021/acs.est.9b06981; Bergmann, M., Collard, F., Fabres, J. Gabrielsen, G.W., Provencher, J.F., Rochman, C.M., van Sebille, E. and Tekman, M.B. 2022. Plastic pollution in the Arctic. Nat. Rev. Earth Environ., https://doi.org/10.1038/s43017-022-00279-8).

Marine Debris on the Shores of Novaya Zemlya, Barents Sea

The density of beach litter on four shores of an uninhabited island of the Novaya Zemlya archipelago (Russian Federation) was 1.5 x 10³ items/km². Eighty-five percent of the 375 items collected (>2.5cm) were plastic. This density is relatively low compared to other remote and uninhabited areas. The Barents-Kara region is the most developed in the Russian Arctic sector and features significant industrial fishing and pressure by marine traffic due to industrial development. The authors found support for the hypothesis that marine litter is mainly transported here by oceanic currents from more populated areas and is connected to the fisheries in the Barents Sea.

(SOURCE: Vesman, A., Moulin, E., Egorova, A. and Zaikov, K. 2020. Marine litter pollution on the Northern Island of the Novaya Zemlya archipelago. Mar. Pollut. Bull. 150: 110671, https://doi.org/10.1016/j.marpolbul.2019.110671).

Northern Dvina River a Main Source of Microplastics Pollution for the White and Barents seas

The Northern Dvina River, one of the largest rivers in the European Arctic flowing into the White Sea, passes through populated regions with developed industry. The microplastics export rate was highest during the spring flood period in May (58 items/s) and lowest in September (9 items/s). The calculated loads of microplastics and total plastics in May reached 250mg/s for microplastics and 800mg/s for total plastics. As in other studies, the main polymers were polyethylene and

polypropylene. Although the Northern Dvina River is less polluted by about 1-2 orders of magnitude when compared with other rivers, the average weight concentration was higher than in the Barents Sea and several times higher than in the Eurasian Arctic on average. These results indicate that the Northern Dvina River is one of the main sources of microplastics pollution for the White and Barents seas.

(SOURCE: Zhdanov, I., Lokhov. A., Belesov, A., Kozhevnikov, A., Pakhomova, S., Berezina, A., Frolova, N., Kotova, E., Leshchev. A., Wang, X., Zavialov, P. and Yakushev, E. 2022. Assessment of seasonal variability of input of microplastics from the Northern Dvina River to the Arctic Ocean. Mar. Pollut. Bull. 175: 113370, https://doi.org/10.1016/j.marpolbul.2022.113370).

Ship Strikes

Potential Increased Ship Strike Risk for Arctic Baleen Whales

The IUCN Cetacean Specialist Group examined trans-Arctic shipping via the Northern Sea Route (NSR) and determined that shipping there increased from 10.7 million tons in 2017 to 32 million tons in 2020. With continued loss of sea ice due to global warming, commercial shipping will increase in terms of both rates of passage and season length. The first- ever voyages of liquid natural gas tankers along the NSR took place in January 2021. All shipping routes here converge in the narrow and shallow Bering Strait, 'making these waters especially perilous for large whales that migrate through and feed in the area'. This was particularly relevant for sub-arctic species, including gray, humpback, fin and common minke whales, which are now common in the Bering Strait region during the summer. The report pointed to the Arctic Marine Shipping Assessment of the Arctic Council PAME Working Group as the most relevant international effort to mitigate risks to baleen whales from ship strike. It also highlighted the cooperation with the Conservation and Scientific Committees of the IWC. The report argued for introducing multi-faceted ship strike mitigation efforts to the Bering Strait gateway as soon as possible.

(SOURCE: https://iucn-csg.org/baleen-whales-in-the-cross-hairs-potential-for-increased-ship-strike-risk-in-and-near-bering- strait).

CHEMICAL POLLUTION

Mercury Levels in the East Siberian Sea Are Moderate But Expected to Increase Due to Warming

Hg accumulation in the sediments of the East Siberian Sea have increased over the past 150 years, reflecting global carbon emissions. The current values, however, are deemed to be slight to moderate and are comparable to other Arctic sediments. Nonetheless, the authors predicted that ongoing and future increases would be partly governed by biological factors affected by global warming, namely the influx of Pacific water with its higher productivity and new plankton species (e.g. diatoms) that accumulate Hg. Thus, beyond releasing toxic substances currently accumulated in ice (see Kannan *et al.* [2022] and Pouch *et al.* [2021]), climate change could also promote an increase in Hg in Arctic waters by altering biological productivity.

(SOURCE: Aksentov, K.I., Astakhov, A.S., Ivanov, M.V., Shi, X., Hu, L., Alatortsev, A.V., Sattarova, V.V., Mariash, A.A. and Melgunov, M.S. 2021. Assessment of mercury levels in modern sediments of the East Siberian Sea. Mar. Pollut. Bull. 168: 112426, https://doi.org/10.1016/j.j.marpolbul.2021.112426).

First Results on Mercury Levels in Southern Ocean Humpback Whales

Hg is a toxic heavy metal that biomagnifies along the food chain and is therefore a priority focus in most ecotoxicological investigations on marine organisms and seafood. In the Arctic and Antarctic, Hg enters the ocean via Atmospheric Mercury Depletion Events. Due to their relatively high trophic position, humpback whales were considered to be ideal biomonitoring species for Hg and other persistent elements and compounds. Among the seven megafauna species examined, humpback whales had the lowest Hg levels in blubber and skin, with values similar to those of its chief prey, Antarctic krill. The values were 5 times lower than from an earlier study on Antarctic minke whales from this area, pointing to potential niche partitioning between the two species. Interestingly, however, the second highest values were recorded in the muscle tissue of a stranded humpback whale. The authors therefore called for more detailed studies on how Hg accumulates in different tissues, to improve routine biopsy-based humpback whale Hg monitoring.

(SOURCE: Bengtson Nash, S.M., Casa, M.V., Kawaguchi, S., Staniland, I. and Bjerregaard. 2021. Mercury levels in humpback whales and other Southern Ocean marine megafauna. Mar. Pollut. Bull. 173: 113096, https://doi.org/10.1016/j.marpolbul.2021.112774).

Decreasing Levels of Persistent Organic Pollutants in Alaskan Bowhead Whales

The concentrations of POPs in blubber and muscle from Western Arctic bowhead whales were measured from 2006-2015. While the levels of PCBs and HCB did not decrease significantly during the 10-year study period, they were lower than corresponding values from the 1990s. The authors concluded that the POPs in whale tissues are declining at rates comparable to those of other Arctic biota, with current levels in the examined whale tissues being one-half to one- quarter what they had been in the 1990s. They attributed this to international agreements (e.g. Stockholm Convention) restricting the use and production of many POPs, which have apparently outweighed current climate change-related drivers of potential POP increases (e.g. melting ice, transport by migratory species).

(SOURCE: Bolton, J.L., Ylitalo, G.M., Chittaro, P., George, J. C., Suydam, R., Person, B.T., Gates, J.B., Baugh, K.A., Sformo, T. and Stimmelmayr, R. 2020. Multi-year assessment (2006-2015) of persistent organic pollutant concentrations in blubber and muscle from Western Arctic bowhead whales (Balaena mysticetus), North Slope, Alaska. Mar. Pollut. Bull. 151: 110857, https://doi.org/10.1016/j.marpolbul.2019.110857).

Mercury Levels and Toxicological Risk in Arctic Cetaceans

Levels of Hg tended to be higher in marine mammals than in terrestrial mammals in the Arctic. Long-finned pilot whales and killer whales from the Faeroe Islands and white whales in the Southern Beaufort Sea were the most contaminated cetaceans. For adult pilot whales, 18.4% were considered to be at moderate risk from Hg effects, 19.6% were at high risk and 27.4% were at severe risk. In addition, 20% of sub-adults were at severe risk. For adult killer whales, 33% were at high risk and 33% at severe risk. For adult narwhals, 7% were at moderate risk, 13% were at high risk and 7% were at severe risk. For adult white whales, 5.1% were at moderate risk, 3.9% at high risk and 1.2% at severe risk. Sub-adult white whales were at 4% and 1.3% moderate and high risk, respectively. Harbour porpoises had lower Hg levels in comparison, with only one adult male porpoise from the Danish straits being at moderate risk and one at high risk.

(Maximum liver mercury levels, $\mu g.g^{-1}$ wet wt: harbour porpoise, 92; white whale, 143.7; narwhal, 132; Long-finned pilot whale, 574; killer whale, 199.8)

(SOURCE: Dietz, R., Letcher, R.J., Aars, J. et al. 2022. A risk assessment review of mercury exposure in Arctic marine and terrestrial mammals. Sci. Total. Environ. 829: 154445, https://doi.org/10.1016/j.scitotenv.2022.154445).

Melting Glaciers Are an Important Source of Toxic Organic Compounds in the High Arctic

Kannan *et al.* (2022) found that the concentrations of highly toxic PCDFs and DL-PCBs in the sediment of selected fjords of the Svalbard archipelago, Norway, were higher than those reported for other polar regions. Such compounds reach the Arctic primarily through long-range atmospheric transport and local sources such as tourism activities. The authors also noted that '[a]n increase in glacial melt has released trapped PCDD/Fs, contributing to their introduction to the Arctic Sea'. Pouch *et al.* (2021) examined another set of pollutants in seawater of the same archipelago and determined that most are combustion products transported to the Arctic by the atmosphere. The seawater levels are seen as 'background and good', except for toxic levels associated with a few suspended particulate matter samples. With regard to PAHs and HCBs, the authors pointed to melting glaciers as 'additional, important suppliers of pollutants to Arctic fjords'. Finally, Zaborska *et al.* (2020) reported extremely high Cd values in a fjord in Spitsbergen. The highest concentrations of Pb, Zn and Cu were recorded in late June, when snow cover melts. The authors concluded that the most important sources of heavy metals in summer are glacier meltwater and surface run-off discharges. The middle of the water column is influenced by heavy metals from glacial meltwaters and possible transport from the Atlantic. This means that the remobilisation and accumulation of a large variety of toxic compounds must also be seen in relation to climate change.

(SOURCES: Kannan, V.M., Gopikrishna, V.G., Saritha, V.K., Krishnan, K.P. and Mohan, M. 2022. PCDD/Fs, dioxin-like, and non-dioxin like PCBs in the sediments of high Arctic fjords, Svalbard. Mar. Pollut. Bull. 172: 113277, https://doi.org/10.1016/j.marpolbul.2021.113277; Pouch, A., Zaborska, A., Mazurkiewicz, M., Winogradow, A. and Pazdro, K. 2021. PCBs, HCB, and PAHs in the seawater of Arctic fjords - Distribution, sources and risk assessments. Mar. Pollut. Bull. 164: 111980, https://doi.org/10.1016/j.marpolbul.2021.111980; Zaborska, A., Strzelewicz, A. Rudnicka, P. and Moskalik, M. 2020. Processes driving heavy metal distribution in the seawater of an Arctic fjord (Hornsund, southern Spitsbergen). Mar. Pollut. Bull. 161: 111719, https://doi.org/10.1016/j.marpolbul.2020.111719).

Persistent Organic Pollutants in the Tissues of Antarctic Marine Mammals

Persistent organic pollutants were evaluated in the blubber of Ross Sea killer whales (Type C) and compared with seals (Weddell, Ross and crabeater seals) collected from the Southern Ocean, Antarctica. DDTs, PCBs and chlordanes were the most abundant POPs, with killer whales displaying levels of pollutants several times greater than seals, except for PBDEs. Levels of the emerging contaminant Dechlorane plus (DP) were also detected in the killer whale blubber. (Maximum values, $\mu g.g^{-1}$ lipid wt: DDTs 4.6, PCBs 1.6, HCB 1.42, Chlordanes 1.7, Heptachlors 0.065, PBDEs 0.017 (Khairy *et al.,* 2021))

(Maximum values, $\mu g.g^{-1}$ lipid wt: DDTs 3.55, PCBs 3.97, HCB 0.2, HCHs 0.056, PBDEs 0.138; $ng.g^{-1}$ lipid wt: DP 0.074 (Panti *et al.* 2022))

(SOURCES: Khairy, M., Brault, E., Dickhut, R., Harding, K.C., Harkonen, T., Karlsson, O., Lehnert, K., Teilmann, J. and Lohmann, R. 2021. Bioaccumulation of PCBs, OCPs and PBDEs in marine mammals from West Antarctica. Front. Mar. Sci. 8: 768715, https://doi.org/10.3389/fmars.2021.768715; Panti C., Muñoz-Arnanz, J., Marsili, L., Panigada, S., Baini, M., Jiménez, B., Fossi, M.C. and Lauriano, G. 2022. Ecotoxicological characterization of Type C killer whales from Terra Nova Bay (Ross Sea, Antarctica): Molecular biomarkers, legacy, and emerging persistent organic contaminants. Front. Mar. Sci. 9: 818370, https://doi.org/10.3389/fmars.2022.818370).

Polar Regions a Sink for Organophosphate Esters

Eleven OPEs were documented in the air and seawater from the northwest Pacific to the Arctic Ocean. Temperature is apparently a driving factor for the long-range atmospheric transport of these compounds northward. The Arctic Ocean and the Bering Strait are considered to be a global sink for OPEs. The authors expected global warming to remobilise OPEs, deposited in sinks such as snow and ice, into the atmosphere and ocean water.

(SOURCE: Na, G., Hou, C., Li, R., Gao, H., Jin, S., Gao, Y., Jiao, L. and Cai, Y. 2020. Occurrence, distribution, air-seawater exchange and atmospheric deposition or organophosphate esters (OPEs) from the Northwestern Pacific to the Arctic Ocean. Mar. Pollut. Bull. 157: 111243, https://doi.org/10.1016/j.marpolbul.2020.111243).

Predicted Shipping Increase in the Arctic Ocean Calls for Monitoring Programmes and Research on Contaminants

The authors predicted shipping to increase considerably in the Arctic Ocean and subarctic, a reflection of climate change and declining sea ice cover. This increase would be associated with higher levels of vessel-related contaminants, including antifouling paints, metals and airborne articles (PAHs), as well as pharmaceuticals and sanitary wastes. The authors also predicted shipping accidents to increase. They called for intensified monitoring and research, e.g. into whether the toxicity of pollutants might be different in cold-water organisms or on species that have previously hardly encountered pollution. They noted that one focus should be on emerging pollutants of concern.

(SOURCE: Svavarsson, J., Guls, H.D., Sham, R.C., Leung, K.M.Y. and Halldórsson, H.P. 2021. Pollutants from shipping - new environmental challenges in the subarctic and the Arctic Ocean. Mar. Pollut. Bull. 164: 112004, https://doi.org/10.1016/j.marpolbul.2021.112004).

DISEASE AND MORTALITY EVENTS

Disease

Arctic Sea Ice Reduction may Promote Viral Infections in Marine Mammals

Climate change in the Arctic is predicted to affect marine ecosystems in many ways. The authors questioned whether reductions in sea ice could increase contact between Arctic and sub-arctic marine mammals, in turn leading to viral transmission. Based on positive cases of phocine distemper virus (PDV) in North Pacific sea otters, Steller sea lions, northern fur seals and ice-associated seals - after extensive mortalities in Atlantic harbour seals - the authors pointed to viral exchanges among such diverse North Pacific marine mammals as potentially being linked to changes in the extent of Arctic sea ice. Coupled with rapid long-distance movements of many marine mammals, they suggested that the opportunities for PDV and other pathogens to cross between North Atlantic and North Pacific marine mammal populations along open water routes through Arctic sea ice may become more common in 'this new normal in the Arctic,' with as yet unknown health impacts, including to cetacean populations.

(SOURCE: VanWormer, E., Mazet, J.A.K., Hall, A., Gill, V.A., Boveng, P.L., London, J.M, Gelatt, T., Fadely, B.S., Lander, M.E., Sterling, J., Burkanov, V.N., Ream, R.R., Brock, P.M., Rea, L.D., Smith, B.R., Jeffers, A., Henstock, M., Rehberg, M.J., Burek-Huntington, K.A. Cosby S. L., Hammond J. A. and Goldstein, T. 2019. Viral emergence in marine mammals in the North Pacific may be linked to Arctic sea ice reduction. Sci. Rep. 9: 15569, https://doi.org/10.1038/s41598-019-51699-4).

Harmful Algal Blooms (HABs)

Global Warming Could Cause an Increase in Toxic Algal Blooms in the Arctic

A warming climate could lead to increasing numbers of HABs of the alga *Alexandrium catenella* in the northern Bering, Chukchi and Beaufort seas. The authors mapped the life cycle of the alga and examined the factors affecting this life cycle. *A. catenella* lies dormant on the seabed as a seed-like organism for most of the year, coming to the surface and reproducing when certain nutrient levels and temperatures are reached. Warming Arctic waters will increase the frequency of this process, leading to more blooms, and consequently more algal toxins, in surface waters, potentially affecting cetaceans and their prey species.

(SOURCE: Anderson, D.M., Fachon, E, Pickart, R.S. and Fukai, Y. 2021. Evidence for massive and recurrent toxic blooms of Alexandrium catenella in the Alaskan Arctic. Proc. Natl. Acad. Sci. 118: e2107387118: 1-11, https://doi.org/10.1073/ pnas.2107387118).

Oil spills

Oil Spills in the Arctic: Risk Assessments and Response Options

Oil spills in polar waters are of special concern due to the threat to pristine environments, the poor accessibility of accident sites and the behaviour of oil in cold water and ice. The Arctic, for example, is increasingly vulnerable to oil spills involving commercial vessels utilising newly open shipping lanes. Lubetkin (2020) used three case studies near and on Arctic seas - drilling on the Alaskan Coastal Plain, the Pebble Mine project and Arctic offshore drilling - to criticise the process of environmental impact statements (EIS) and their evaluation. This includes the used spill risk models, the grey literature in which they are often cited and the potential for scientific results to be overridden by political concerns. Better peer review of EIS documents would be a good first step to improving the process. In recognition of the potential threat of oil spills in Arctic waters, a number of additional authors modelled risk, considering 42 risk factors (Sajid *et al.*, 2020); described the degradation and behaviour of oil in relation to sea ice (Lofthus *et al.*, 2020; Nordam *et al.*, 2020; Singsaas *et al.*, 2020; de Aguiar *et al.*, 2022); and discussed strategies to select appropriate response measures to ongoing oil spills, depending on oil type and conditions (Hu *et al.*, 2020).

(SOURCES: Lubetkin, S.C. 2020. The tip of the iceberg: Three case studies of spill risk assessments used in environmental impact statements. Mar. Pollut. Bull. 152: 110613, https://doi.org/10.1016/j.marpolbul.2019.110613; Sajid, Z., Khan, F-. and Veitch, B. 2020. Dynamic ecological risk modelling of hydrocarbon release scenarios in Arctic waters. Mar. Pollut. Bull. 153: 110100, https://doi.org/10.1016/j.marpolbul.2020.110001; Lofthus, S., Bakke, I., Trembley, J., Greer, C.W. and Brakstad, O.G. 2020. Biodegradation of weathered crude oil in seawater with frazil ice. Mar. Pollut. Bull. 154: 111090, https://doi.org/10.1016/j.marpolbul.2020.111090; Nordam, T., Litzler, E., Skancke, J., Singsaas, I., Leirvik, F. and Johansen, Ø. 2020. Modelling of oil thickness in the presence of an ice edge. Mar. Pollut. Bull. 156: 111229, https://doi.org/10.1016/j.marpolbul.2020.111229; Singsaas, I., Leirvik, F., Daling, P.S., Guénette, C. and Sørheim, K.R.. 2020. Fate and behaviour of weathered oil drifting into sea ice, using a novel wave and current flume. Mar. Pollut. Bull. 159: 111485, https://doi.org/10.1016/j.marpolbul.2020.111485; de Aguiar, V., Dagestad, K.-F., Hole, L.R. and Barthel, K. 2022. Quantitative assessment of two oil-in-ice surface drift algorithms. Mar. Pollut. Bull. 175: 113393, https://doi.org/10.1016/j.marpolbul.2022.113393; Hu, G., Mohammadiun, S., Gharahbagh, A.A., Li, J., Hewage, K. and Sadiq, R. 2020. Selection of oil spill response method in Arctic offshore waters: A fuzzy decision tree based framework. Mar. Pollut. Bull. 161(A): 111705, https://doi.org/10.1016/j.marpolbul.2020.111705).

Climate Change

Record Melting of Antarctica's George VI Ice Shelf

During the 2019-20 summer season, record melting was observed in the Antarctic's George VI Ice Shelf when compared with the previous three decades. The George VI Ice Shelf is the second largest on the Antarctic Peninsula. This extreme melting period also coincided with record periods of time when surface air temperatures were at, or above, freezing. The authors utilised satellite observations of 'ponds' and 'lakes' of meltwater on top of the ice. Meltwater ponds were observed covering 23% of the ice shelf surface. These meltwater ponds and lakes can cause ice sheets to fracture and hasten the rate of ice shelf collapse. Moreover, the George VI Ice Shelf acts as a dam for the largest volume of ice on the Antarctic Peninsula, and, should this ice shelf completely break off, this additional volume of land-based ice would flow into the ocean, adding considerably to sea level rise.

(SOURCE: Banwell, A.F., Datta, R.T. and Dell, R.L. 2021. The 32-year record-high surface melt in 2019/2020 on the northern George VI Ice Shelf, Antarctic Peninsula. Cryosphere 15: 909-925, https://doi.org/10.5194/tc-15-909-2021).

Why the Arctic Is Warming so Fast

A new theory, aided by computer simulations and observations, was published to explain why the Arctic is warming so much faster than other regions. Due to the unique oceanography of the Arctic Ocean, the surface is usually covered with ice, with cold, low salinity water at the surface and warmer water at depth. These deeper waters are fed by the relatively warm Pacific and Atlantic oceans. Heat flows upward from the warmer water to the colder water at the surface. Because of climate change, deeper water is getting even warmer, but near surface water remains close to freezing temperatures. The increasing temperature difference is leading to a greater upwards flow of heat. The authors estimated that this oceanographic effect is responsible for 20% of the amplification of warming impacts in the Arctic.

(SOURCE: Beer, E. Eisenman, I. and Wagner, T.J.W. 2020. Polar amplification due to enhanced heat flux across the halocline. J. Geophys. Res-Lett. 47: e2019GL086706, https://doi.org/10.1029/2019GL086706).

Greenland Ice Sheet on Brink of No Return

A new analysis (Boers and Rypdal, 2021), based on a 140-year record of ice-sheet height and melting rates, warned that Jakobshavn Basin, one of the five biggest ice-filled basins in Greenland and the fastest-melting, is reaching a tipping point. Accelerated melting would become inevitable, even if global warming was halted, should this point be passed. The authors stated that ice equivalent to 1-2m of sea level rise is probably already doomed to melt. The increase in melting was attributed to a positive feedback loop, in which melting reduces the height of the ice sheet, exposing it to the warmer air found at lower altitudes, which causes further melting. In addition, melting might be accelerated by thinning of coastal glaciers, allowing more ice to flow into the sea, and reduced snowfall, leading to greater exposure of the darker surface of the ice sheet, which would then absorb more heat from the sun. Due to the level of uncertainty in the data, this 'tipping point' may already have passed, or it could pass within a matter of decades. It is also possible that, although the majority of the ice sheet would likely melt, a stable, but much smaller ice sheet could result. The current and near future melting of the ice sheet is irreversible, and to restore the original height of the Greenland ice sheet would require temperatures to be driven down to pre-industrial levels. The melting of the Greenland ice sheet could also stop the flow of the Gulf Stream, leading to major changes in oceanography and climate. Added to these concerns, Maier *et al.* (2019) noted that loss of ice in Greenland is accelerated by ice sliding over underlying bedrock much faster than previously predicted. It had been assumed that ice would flow fastest over underlying soft sediments, like mud, but in fact rates of sliding over bedrock were high. Thus, ice is moving faster to the coasts, or to lower, warmer altitudes, and melting.

(SOURCES: Boers, N. and Rypdal, M. 2021. Critical slowing down suggests that the western Greenland Ice Sheet is close to a tipping point. Proc. Nat. Acad. Sci. 118: e2024192118, https://doi.org/10.1073/pnas.2024192118; Maier, N., Humphrey, N., Harper, J. and Meierbachtol, T. 2019. Sliding dominates slow-flowing margin regions, Greenland Ice Sheet. Sci. Adv. 5(7): eaaw5406, https://www.science.org/doi/pdf/10.1126/sciadv.aaw5406).

Massive Ice Shelf Collapse in East Antarctica

An ice shelf 1,200km^2 in area, approximately the size of New York City, has collapsed in East Antarctica. The collapse was observed by satellite images and occurred on 14-16 March 2022. This part of Antarctica was thought to be relatively stable and not affected substantively by climate change; this was the first time in human history that ice in this area has collapsed. The collapse may have been due to a major heat wave in this region, where temperatures were 40°C warmer than usual. Because of this collapse, scientists are concerned that they have been been overestimating East Antarctica's stability. The shelf had been holding back ice from the Conger and Glenzer glaciers, which now may flow rapidly into the ocean, increasing Antarctic ice loss and adding to sea level rises.

(SOURCE: Borenstein, S. 2022. Ice shelf collapses in previously stable East Antarctica. AP News, 25 March, https://apnews.com/article/climate-science-new-york-new-york-city-antarctica-4f5f1817bffd632e48e845d4638cc237).

Greenland Will Lose Ice Faster this Century than During the Past 12,000 Years

A new model reconstructed a 12,000 year history of Greenland's ice sheet, which has been validated by field measurements and data from proxies that have allowed the estimation of ice sheet size. The predicted ice sheet losses for the 21st century are on track to be higher than anything observed over the past 12,000 years. If dramatic reductions in greenhouse gas emissions are not made, the rate of ice loss with be four times the highest level experienced in the past 120 centuries. The authors focused on southwest Greenland; however, the rates of ice loss in this region match those seen across all of the Greenland ice sheet.

(SOURCE: Briner, J.P., Cuzzone, J.K., Badgeley, J.A. et al. 2020. Rate of mass loss from the Greenland Ice Sheet will exceed Holocene values this century. Nature 586: 70-74, https://doi.org/10.1038/s41586-020-2742-6).

Antarctic Warming and Decline in Sea Ice Connected with Decline in Key Forage Fish

A study in the Southern Ocean found a correlation between warming waters, decreased sea ice and reduced abundance of Antarctic silverfish. These small fish are important prey for penguins and marine mammals. The study was conducted on the west coast of the Antarctic Peninsula, one of the fastest warming areas of the ocean. The authors warned that, with continued warming in this region, these fish could disappear from the region entirely, triggering major changes in the marine ecosystem.

(SOURCE: Corso, A.D., Steinberg, D.K., Stammerjohn, S.E. and Hilton, E.J. 2022. Climate drives long-term change in Antarctic silverfish along the western Antarctic Peninsula. Commun. Biol. 5: 104, https://doi.org/10.1038/s42003-022-03042-3).

Distribution of Copepod Species Shifting Northwards with Retreating Sea Ice

Sea ice coverage, thickness and extent are declining in the central Arctic Ocean. Based on a comparison between past (1993-98) and recent (2007-16) zooplankton collections and satellite-based sea ice observations, the authors found strong correlations between two species of copepods and several sea ice parameters. Accordingly, the distribution patterns of these zooplankton species are expected to shift northwards with retreating sea ice and changing climate conditions. Copepods commonly dominate the biomass of zooplankton in polar seas and serve as a link to higher trophic levels such as fish, birds and marine mammals.

(SOURCE: Ershova, E.A., Kosobokova, K.N., Banas, N.S., Ellingsen, I., Niehoff, B., Hildebrandt, N. and Hirche, H.-J. 2021. Sea ice decline drives biogeographical shifts of key Calanus species in the central Arctic Ocean, Glob. Change Biol. 27: 2128-2143, https://doi.org/10.1111/gcb.15562).

Recent Changes In Antarctic Sea Ice Are Unique For The 20th Century

Before satellites started gathering sea ice data, measurements were collected via direct human observations of the ice sheet edge, a small number of weather stations and ice core samples. Data were therefore limited to a restricted location or a specific season. The authors used data from a network of 30 long-term temperature and pressure observations to develop a model that reconstructed conditions throughout the 20th century, during all four seasons. They found significant decreases in sea ice in the early part of the 20th century, which were linked to increasing temperatures and wind strength, and then a significant increase in the century's latter two decades (through 2015), to levels that exceeded the greatest sea ice extent at the start of measurements in 1905. However, in 2016, Antarctic sea ice extent declined sharply, well below the average throughout the early 20th century decline, possibly part of long-term sea ice variability.

(SOURCE: Fogt, R.L., Sleinkofer, A.M., Raphael, M.N. and Handcock, M.S. 2022. A regime shift in seasonal total Antarctic sea ice extent in the twentieth century. Nat. Clim. Change 12: 54-62, https://doi.org/10.1038/s41558-021-01254-9).

Antarctic Minke Whale Ice Edge Habitat Threatened by Warming

Ship-based surveys for cetaceans are impossible in ice-covered regions, so helicopter surveys were used to estimate Antarctic minke whale abundance in relation to sea ice (2006-13) and the data were then used to develop distribution models. The highest whale densities were at the ice edge and in medium ice concentrations. Medium densities were found up to 500km into the ice edge. Few whales occurred in ice-free waters; thus, minke whales seem dependent upon ice edge habitat. With the loss of sea ice in Antarctica, there may already be major impacts on important minke whale habitat.

(SOURCE: Herr, H., Kelly, N., Dorschel, B., Huntemann, M., Kock, K.-H., Lehnert, L.S., Siebert, U., Viquerat, S., Williams, R. and Scheidat, M. 2019. Aerial surveys for Antarctic minke whales (Balaenoptera bonaerensis) reveal sea ice dependent distribution patterns. Ecol. Evol. 9: 5664-5682, https://doi.org/10.1002/ece3.5149).

Pine Island Glacier's Ice Sheet Disintegrating, Speeding up Glacier Flow

The Pine Island Glacier contains approximately 180 trillion tons of ice, equivalent to 0.5m of global sea level rise if it melted. Loss of the glacier already contributes to one-sixth of a millimetre of sea-level rise each year - a rate that is expected to increase. If this and other glaciers speed up their flow into the oceans, then sea level rise could increase drastically over the next few centuries. From the 1990s to 2009, the speed of the glacier increased from 2.5km/year to 4km/year. The speed was relatively steady from 2009 to 2017. However, between 2017 and 2020, several large icebergs at the edge of the shelf broke off, leading to a 19km retreat of the shelf's edge. This ice shelf had been holding back the Pine Island glacier, and this loss of the ice sheet's edge caused the speed of the glacier to increase again, by >12% over three years. The glacier's acceleration raised the concern that the ice shelf appears to be 'ripping apart'. The glacier has been relatively stable for millennia, and there is major concern about the rate of change being observed, and what this might mean for global sea levels.

(SOURCE: Joughin, I., Shapero, D., Smith, B., Dutrieux, P. and Barham, M. 2021. Ice-shelf retreat drives recent Pine Island Glacier speedup. Sci. Adv. 7: eabg3080, https://doi.org/10.1126/sciadv.abg3080).

A Third of Winter Arctic Ice Volume Lost over Nearly Two Decades

Over three winters (2018-21) in the Arctic, mean April snow depth decreased by *c*.2.50cm and ice thickness by *c*.0.28m, which is equivalent to an ice volume loss of approximately 12.5%. Satellite images showed that the decrease mainly involved thick multi-year ice, which typically remains frozen through the summer, being replaced by thinner seasonal ice that forms only in the colder months. Over an 18-year satellite record, the loss of winter ice was approximately 6,000km^3, or a third of the winter ice volume.

(SOURCE: Kacimi, S. and Kwok, R. 2022. Arctic snow depth, ice thickness, and volume from ICESat-2 and CryoSat-2: 2018-2021. Geophys. Res-Lett. 49: e2021GL097448. https://doi.org/10.1029/2021GL097448).

The Arctic Is Transitioning to New Climate State

Due to warming, experts believe that the Arctic has transitioned to a new climatic state. The US National Center for Atmospheric Research has concluded that the Arctic has warmed so much that inter-annual variability has shifted beyond previous climatic ranges to a 'new Arctic' climate regime. For example, Arctic sea ice has melted to the point where even an unusually cold year will not have the same amount of summer sea ice as was observed in the mid-20th century. The authors predicted that soon, instead of snow, rain will fall for several months of the year. This has major implications for Arctic ecosystems and marine mammals.

(SOURCE: Landrum, L. and Holland, M.M. 2020. Extremes become routine in an emerging new Arctic. Nat. Clim. Chang. 10: 1,108-1,115, https://doi.org/10.1038/s41558-020-0892-z).

Antarctic Core Samples Suggest that the West Antarctic Ice Sheet Could Be Even More Vulnerable to Warming

Core samples from various depths of 1.5km of seabed sediment were used to reconstruct the evolution of Antarctic ice sheets over the past 20 million years. In the early Miocene, atmospheric concentrations of carbon dioxide were similar to those that are expected by 2100, if greenhouse gas emissions are not substantially reduced. During the warm Miocene period, sea level rose by up to 60m. This is the sea level rise predicted if all the ice currently on the Antarctic continent melts. The authors suggested that the West Antarctic Ice Sheet contributed significantly to global sea level rises 8 million years earlier than previously known, implying that the ice sheet is more vulnerable to warming than thought. This could be due to the land mass below this ice sheet being below sea level, causing the bottom of the ice sheet to be warmed and eroded by seawater. Currently, melting of the West Antarctic Ice Sheet is contributing significantly to global sea level rise, and as temperatures rise, this contribution will increase. If this ice sheet completely melts, it could cause a 4.5m rise in sea level, affecting coastal environments globally.

(SOURCE: Marschalek, J.W., Zurli, L., Talarico, F. et al. (2021). A large West Antarctic Ice Sheet explains early Neogene sea-level amplitude. Nature 600: 450-455, https://doi.org/10.1038/s41586-021-04148-0).

Storms Increase Ice Breakup in Arctic Through Oceanographic Processes

In 2016, a massive cyclone equivalent in force to a Category 2 hurricane was observed in the Arctic Ocean by a nearby icebreaker. During the cyclone, sea ice extent declined at a rate that was 5.7 times faster than normal, driven by cyclone-related oceanographic processes. Winds pushed low density surface water away from the ice, causing denser but warmer water to well up, warming the ice sheet. Surface winds then caused surface water turbulence; the combination of warming and turbulence helped to break up the ice more quickly. These data suggest that storms, which are likely to increase, could cause the breakup of Arctic ice faster than predicted.

(SOURCE: Peng, L., Zhang, X. Kim, J.-H., Cho, K.-H., Kim, B.-M., Wang, Z. and Tang, H. 2021. Role of intense Arctic storm in accelerating summer sea ice melt: An in situ observational study. Geophys. Res-Lett. 48: e2021GL092714:1-10, https://doi.org/10.1029/2021GL092714).

The Eastern Antarctic Ice Sheet Achieves Record Temperatures

Normally one of the coldest locations on the planet, parts of the Eastern Antarctic ice sheet recently experienced temperatures 40°C above normal for multiple days. Instead of temperatures ranging from -45°C to -51°C, they were -12°C to -18°C - still cold, but the equivalent of a massive heat wave by Antarctic standards. Vostok - 808 miles from the south pole, at the centre of the eastern ice sheet and one of the coldest places in Antarctica - recorded -17.7°C in March, the warmest temperature at that time of year since recording began 65 years ago. Computer models suggested temperatures up to 50°C higher than normal may have been reached at several locations on the ice sheet.

(SOURCE: Samenow, J. and Patel, K. 2022. It's 70 degrees warmer than normal in eastern Antarctica. Scientists are flabbergasted. Washington Post, 19 March, https://www.washingtonpost.com/weather/2022/03/18/antarctica-heat-wave-climate-change/).

Climate Oscillations Can Influence Humpback Whale Migrations

Based on passive acoustic monitoring between 2011 and 2018 in the Atlantic sector of the Southern Ocean, humpback whales were present in their feeding grounds for five years, but virtually absent in two (2015, 2016). The latter two corresponded to El Niño years. Climate oscillations have large effects on sea surface temperature and local ice concentrations in the Southern Ocean. The ice concentration directly affects whale access to open water areas and indirectly affects primary productivity, which in turn drives the distribution of krill, the whale's primary prey. The authors considered that future climate change could change the overall occupancy of certain feeding areas by humpback whales or their prey resources on a hemisphere-wide spatial scale. They argue for employing acoustic detection to evaluate the sensitivity of keystone species to climate variability to help better understand the effects of climate-induced changes on the Southern Ocean ecosystem.

(SOURCE: Schall, E., Thomisch, K., Boebel, O., Gerlach, G., Woods, S.M., El-Gabbas, A. and Opzeeland, I.V. 2021. Multi-year presence of humpback whales in the Atlantic sector of the Southern Ocean but not during El Niño. Commun. Biol. 4: 790, https://doi.org/10.1038/s42003-021-02332-6).

Twhaites Glacier, West Antarctica, Melting Faster than Previously Thought

Digitised Antarctic radar data, originally recorded between 1971 and 1979 on optical film, were compared with modern data. Schroeder *et al.* (2019) calculated that the eastern ice shelf of Thwaites Glacier, West Antarctica, was shrinking faster than previously thought, between 10% and 33% during the period 1978-2009. This is consistent with other closely observed Antarctic glaciers, which have doubled their rate of ice loss in the past six years. Robel *et al.* (2019) modelled ice flow simulations with a state-of-the-art ice sheet model for Thwaites Glacier, which is thought to be unstable. The model predicted that the glacier is likely to succumb to this instability, increasing the flow of its ice into the ocean. Even if global warming were to cease, the instability of the glacier would still cause ice to flow into the sea at an accelerated rate for centuries. This high flow of ice into the ocean will lead to a higher level of sea level rise, and the researchers conclude 'that the collapse of marine ice sheets makes worst-case scenarios of rapid sea-level rise more likely in future projections'.

(SOURCES: Schroeder, D.M., Dowdeswell, J.A. and Siegert, M.J. 2019. Multidecadal observations of the Antarctic ice sheet from restored analog radar records. Proc. Nat. Acad. Sci. 116: 18867-18873, https://doi.org/10.1073/pnas.1821646116; Robel, A.A., Seroussi, H. and Roe, G.H. 2019. Marine ice sheet instability amplifies and skews uncertainty in projections of future sea-level rise. Proc. Nat. Acad. Sci. 116: 14887-14892, https://doi.org/10.1073/pnas.1904822116).

Seabed Geology Has Slowed Down the Thinning of the Ross Ice Sheet, Until Now

Ocean melting has thinned Antarctica's ice shelves at an increasing rate over the past two decades, leading to loss of ice above the continent's land area. At present, the Ross Ice Shelf is at a relatively steady state and holds back approximately 20% of Antarctica's ice from flowing into the ocean. However, geological records suggest that it could disintegrate rapidly, freeing ice on land to flow rapidly into the ocean, which could add up to 11.6m to global sea level rise. Surveys underneath the Ross Ice Shelf showed that the seabed's bathymetry constrains the circulation of ocean water, which in turn reduces the amount of warm water reaching the underside of the ice sheet. In contrast, local warming of surface water near the front of the ice sheet has led to rapid ice shelf melting east of Ross Island. The reduction of the ice sheet in this area could lead to a faster loss into the ocean of land-based ice from both the Eastern and Western Antarctic ice sheets.

(SOURCE: Tinto, K.J., Padman, L., Siddoway, C.S. et al. 2019. Ross Ice Shelf response to climate driven by the tectonic imprint on seafloor bathymetry. Nat. Geosci. 12: 441-449, https://doi.org/10.1038/s41561-019-0370-2).

Climate Change Expected To Alter The Arctic's Role In Absorbing Carbon

Certain regions of the Arctic seas (North Atlantic west and east) absorb the most anthropogenic carbon globally; the biological carbon pump contributes substantially to this absorption. As Arctic sea ice melts, this pump changes, affecting global climate and other important ocean attributes (e.g. biodiversity). The authors observed that, compared to conditions where ice was not affected, sea-ice derived meltwater stratification slowed the pump by four months, causing a shift from an export to a retention system. The details of sea ice export, distribution and melt remain to be studied in detail, but will determine the net impact of climate change on Arctic food webs, including benthic ecosystems.

(SOURCE: von Appen, W.-J., Waite, A.M., Bergmann, M., Bienhol, C., Boebel, O., Bracher, A., Cisewski, B., Hagemann, JH., Hoppema, M., Iversen, M.H. et al. 2021. Sea-ice derived meltwater stratification slows the biological carbon pump: results from continuous observations. Nat. Commun. 12: 7309, https://doi.org/10.1038/s41467-021-26943-z).

Record-High Levels of Arctic Freshwater Are Impacting the Marine Environment and Atlantic Ocean Currents

Due to melting ice, the Beaufort Sea has increased its freshwater content by 40% over the past two decades. This water tends to flow through the Canadian Archipelago to reach the Labrador Sea, rather than through the wider marine passageways that connect to seas in Northern Europe. As this water is not only less saline, but also rich in nutrients, its behaviour has implications for the Labrador Sea ecosystem and food web. In addition, greater amounts of less saline, and therefore less dense, water flowing into the Labrador Sea could have an impact on ocean circulation in the North Atlantic. If the flow into the North Atlantic should increase, the less dense, less saline water would flow over the top of the important northward flowing current in the North Atlantic, slowing down oceanic circulation in this region and also reducing heat transfer to the atmosphere. This could have major impacts on both the oceanography and climate of the North Atlantic.

(SOURCE: Zhang, J., Weijer, W., Steele, M., Cheng, W., Verma, T. and Veneziani, M. 2021. Labrador Sea freshening linked to Beaufort Gyre freshwater release. Nat. Commun. 12: 1229, https://doi.org/10.1038/s41467-021-21470-3).

Noise Impacts

The Effect of Warming Oceans on Underwater Sound Speed and Propagation

Warmer oceans will cause sound underwater to travel faster and farther, which will impact many species of sound-reliant cetaceans. The authors modelled the impacts of a warming ocean on sound propagation and highlighted areas that would most be affected by changes in sound transmission. The largest effect on the underwater speed of sound can be expected east of Greenland and off Newfoundland in the Atlantic. The average speed of sound here is likely to increase by more than 1.5%, or approximately 25m/s, from the surface to a depth of 500m. This will occur by the end of the century if the current rate of greenhouse gas emissions continues. In addition, there will be a 1% sound speed increase, more than 15m/s, at 50m depth in the Barents Sea, the northwest Pacific and the Southern Ocean, as well as at 500m depth in the Arctic Ocean, Gulf of Mexico and southern Caribbean Sea. The authors also modelled the effect of temperature change on the calls of the North Atlantic right whale, a critically endangered species that inhabits an area that would be affected, predicting that the species' calls (at 50Hz) would travel farther in these warmer waters.

(SOURCE: Affatati, A., Scaini, C. and Salon, S. 2022. Ocean sound propagation in a changing climate: global sound speed changes and identification of acoustic hotspots. Earths Future 10: e2021EF002099, https://doi.org/10.1029/2021EF002099).

Underwater Noise in the Canadian Arctic Increasing and Predicted to Increase Further

An analysis of 30 passive acoustic datasets collected between 2014 and 2019 from 15 sites revealed that sound pressure levels in the Canadian Arctic decreased with ice cover but increased with the number of ships per day. The authors predicted that the noise levels would increase further due to two factors: (1) earlier melt and later freeze-up; and (2) increased shipping in the extended ice-free months. These results provided a useful baseline for future studies, and the authors called for continued acoustic monitoring, including in the geographic gaps for which no published studies of underwater sound levels are currently available.

(SOURCE: Halliday, W.D., Barclay, D., Berkley, A.N., Cook, E., Dawson, J., Hilliard, R.C., Hussey, N.E. et al. 2021. Underwater sound levels in the Canadian Arctic, 2014-2019. Mar. Pollut. Bull. 168: 112437, https://doi.org/10.1016/j.marpolbul.2021.112437).

Underwater Noise In The Arctic Ocean Is Undergoing Ice- And Temperature-Related Change

The Arctic Ocean is a special case with regard to underwater noise. Its acoustic properties are primarily affected by sea ice, which is a source, shield and diffuser of underwater sound. Global warming, however, is causing a decrease in sea ice coverage, thickness and duration. Sound propagation is also affected by water temperature and salinity. Lancaster *et al.* (2021) highlighted the increasing shipping in Arctic waters and its distinctive features, such as icebreaking. The authors called for 'a proactive approach by Arctic coastal states that addresses key knowledge gaps about noise- sensitive species, systematically monitors underwater soundscapes and holds noise at safe levels for biodiversity'. Bonnel *et al.* (2021) examined the effects of temperature and sea ice on ambient noise on the Chukchi Shelf. The Shelf shows traditional polar features, such as being quieter when the sea is ice-covered. Noise levels are also influenced by the Beaufort Duct, a recurring Pacific warm water intrusion first observed in the early 1970s. The authors reported that ambient noise dropped by up to 10dB/Hz when the Beaufort Duct disappeared. At the same time, the Duct apparently increased acoustic propagation, which could increase the communication space of bowhead whales but also could magnify the effect of anthropogenic noise. The persistence and increasing geographic spread of the Beaufort Duct therefore has major implications for ocean noise in this region.

(SOURCES: Lancaster, M.L., Winsor, P. and Dumbrille, A. 2021. Underwater noise from shipping: A special case for the Arctic. In: Carpenter A., Johansson T.M. and Skinner J.A. (eds). Sustainability in the Maritime Domain. Strategies for Sustainability. Springer, Cham, Switzerland, https://doi.org/10.1007/978-3-030-69325-1_14; Bonnel, J., Kinda, G.B. and Zitterbart, D.P. 2021. Low- frequency ocean ambient noise on the Chukchi Shelf in the changing Arctic. J. Acoust. Soc. Am. 49: 4,061-4,072, https://doi.org/10.1121/10.0005135).

Cetaceans React to Sonar as They Do to Predators, with Major Implications in an Increasingly Noisy Arctic

Suction cup tags were attached to sperm, humpback, long-finned pilot and northern bottlenose whales in northern Norwegian waters, on the Arctic Circle (Miller *et al.,* 2022). These tags recorded the whales' behaviour when exposed to three types of sounds: sonar similar to naval sonar (1-4kHz) and fish-eating and marine mammal-eating killer whale clicks. Three species reduced their foraging activity by 50-97% when exposed to navy sonar or mammal-eating killer whale sounds, while northern bottlenose whales showed the strongest reaction, completely ceasing feeding behaviour. The authors concluded that the cetaceans react to sonar as a major threat, akin to a killer whale attack. They warned that with more shipping, oil and gas exploration and naval activity in an increasingly ice-free Arctic, the reactions of naïve populations to anthropogenic noise could lead to negative impacts on populations. Confirming these concerns, Ladegaard *et al.* (2021) recorded underwater sound around Greenland from 2011 to 2020. Ice-covered waters were roughly 20dB quieter than open ocean waters, and rapidly melting ice can increase sound levels by 20dB. Noise levels in Melville Bay, Baffin Bay and the Greenland Sea peaked in the late summer and autumn, correlating with open water periods. Seismic surveys conducted by the oil and gas industry raised sound levels by a constant 2-8dB, with reverberation raising sound levels even between seismic pulses. A decrease in ice cover coupled with an increase in anthropogenic activity is likely to increase the sound levels in the Arctic several orders of magnitude.

(SOURCES: Miller, P.J.O., Isojunno, S., Siegal, E. and Curé, C. 2022. Behavioral responses to predatory sounds predict sensitivity of cetaceans to anthropogenic noise within a soundscape of fear. Proc. Nat. Acad. Sci. 119: e2114932119, https://doi.org/10.1073/pnas.2114932119; Morell, V. 2022. Why whales flee from sonar - sometimes to their death. Science, 21 March 2022, https://doi.org/10.1126/science.abq1516; Ladegaard, M., Macauley, J., Simon, M., Laidre, K.L., Mitseva, A., Videsen, S., Pedersen, M.B., Tougaard, J. and Madsen, P.T. 2021. Soundscape and ambient noise levels of the Arctic waters around Greenland. Sci. Rep. 11: 23360, https://doi.org/10.1038/s41598-021-02255-6).

Marine Traffic Produces the Loudest Noise in an Arctic Fjord

Summer noise measurements in Kongsfjorden (Spitsbergen, Svalbard, Norway) confirmed predicted noise maps that yielded marine traffic values from 85 to 145dB at 125Hz. Frequencies of 10-200Hz could be heard thousands of kilometres away. Values were expected to increase as the Arctic warms. The authors suggested that their results could be used to develop strategies to mitigate the impact of marine traffic noise on marine species. This study could serve as a reference for underwater shipping noise.

(SOURCE: Sanjana, M.C., Latha, G. and Raguraman, G. 2021. Anthropogenic sound field and noise mapping in an Arctic fjord during summer. Mar. Pollut. Bull. 173: 113035, https://doi.org/10.1016/j.marpolbul.2021.113035).

Narwhals Display Major Reactions to Anthropogenic Sound at Levels Far Below Levels Considered 'Safe'

A group of six tagged narwhals in the Scoresby Sound fjord system, East Greenland, were exposed to anthropogenic sound - both from a ship's engine and a seismic airgun. Their echolocation rate was halved at 12km from the ship, and they ceased echolocating (and thus foraging) at 7-8km. Behavioural changes occurred at distances greater than 40km from the sound source. The narwhals also stopped diving deeply and increased their fluking rate, which is similar to their behavioural response to killer whales. The cessation of foraging and increased fluking rate may have energetic implications for this species. The authors noted that the frequencies to which narwhals should be most sensitive were only just above ambient levels a few kilometres from the vessel. When narwhals completely stopped foraging, these frequencies were more than 10dB re 1 μPa^2 -s lower than the background noise level. This suggests that narwhals are able to detect signals, and react to them, even if they are embedded in background noise. This considerably changes our understanding of how cetaceans perceive sound. Current methods of estimating impacts of anthropogenic sound may largely be underestimating these impacts, which has major marine noise management implications, especially regarding Arctic cetaceans.

(SOURCE: Tervo, O.M., Blackwell, S.B., Ditlevsen, S., Conrad, A.S., Samson, A.L., Garde, E., Hansen, R.G. and Heide-Jorgensen, M.P. 2021. Narwhals react to ship noise and airgun pulses embedded in background noise. Biol. Lett. 17: 20210220, https://doi.org/10.1098/rsbl.2021.0220).

GLOBAL

General

Room for Improvement in Assessing the Cumulative Impacts of Maritime Industries

The impacts of cumulative stressors upon marine mammals is a field of high interest, as any stressor typically occurs in conjunction with multiple other stressors. A Cumulative Effects Assessment (CEA) is a mandatory component of the Environmental Impact Assessment process of many countries. However, for marine mammals, critical thresholds for impacts of many stressors are unknown, and the synergistic effects of multiple stressors are often unknown, which makes assessing the consequences, to individuals and populations, of multiple stressors problematic. A review of 93 CEAs across 11 maritime industries in the UK rated the aquaculture industry's CEAs the poorest and the large offshore windfarm industry (≥20 turbines) most favourably. The authors noted that CEAs improved between 2009 and 2019, although this was largely

due to five industries (cable, large and small offshore wind farms and tidal and wave energy). There was 'inconsistency in the language used to define and describe cumulative effects' and 'a lack of routinely applied methodology'. There is clear room to improve CEA processes, such as standardising practices, with some industries likely underestimating their impacts due to poor CEAs.

(SOURCE: Hague, E.L., Sparling, C.E., Morris, C., Vaughan, D., Walker, R., Culloch, R.M., Lyndon, A.R., Fernandes, T.F. and McWhinnie, L.H. 2022. Same space, different standards: A review of Cumulative Effects Assessment practice for marine mammals. Front. Mar. Sci. 9: 822467, https://doi.org/10.3389/fmars.2022.822467).

Current Efforts to Tackle Marine Pollution Are Insufficient

Despite global efforts, marine pollution is increasing. A review of 2417 scientific papers addressing coastal and marine pollution, published from 2000-18, revealed that chemical pollution was the most studied, followed by heavy metals and nutrients. The most frequently mentioned sources were oil spills, industry and wastewater. Most reports considered the issue to be a technical problem and focused on reactive interventions (e.g. clean-ups). The authors argued that bringing about a trend change would require examining the deeper drivers of pollution. This would mean treating the issue as a systemic social-ecological problem, involving proactive, pre-emptive interventions at 'deep leverage points'. They recommended pursuing inter- and transdisciplinary efforts encompassing a diversity of stakeholders. Such systemic changes would be the only strategy capable of meeting stated goals such as those given in the UN's Agenda 2030 for Sustainable Development, which aims to prevent and significantly reduce marine pollution of all kinds by 2025. This approach would also support the agenda for the UN Decade of Ocean Science for Sustainable Development (2021-30).

(SOURCE: Riechers, M., Brunner, B.P., Dajka, J.-C., Duse, I.A., Lübker, H.M., Manlosa, A.O., Sala, J.E., Schaal, T. and Weidlich, S. 2021. Leverage points for addressing marine and coastal pollution: A review. Mar. Pollut. Bull. 167: 112263, https://doi.org/10.1016/j.marpolbul.2021.112263).

HABITAT DEGRADATION

Marine Debris

Microplastics in Marine Biota: An Increasing Focus of Marine Pollution Studies

Microplastics have become a major focus not only of marine debris studies but of marine pollution studies in general, with the journal *Marine Pollution Bulletin* a good example of this trend. A recent review of 132 articles from 2010-20 indicated that the predominant type of microplastics in marine biota is fibres, the predominant polymer is polyethylene, and the size is under 2mm. The most studied regions are the Atlantic, the Pacific and the Mediterranean. The Arctic and Antarctic Oceans are among the least studied. Sea turtles were the taxon with the highest percentage of individuals affected (88%), followed by marine mammals (60%). Most studies examined the gastrointestinal tract, while others focused on other organs or faeces. A 2019 IWC workshop on marine debris summarised the latest information regarding cetaceans, including plastic-associated chemical contaminants. The workshop suggested that humpback and fin whales would be the best candidates for monitoring microplastics pollution in cetaceans.

(SOURCES: Ugwu, K., Herrera, Al. and Gomez, M. 2021. Microplastics in marine biota: A review. Mar. Pollut. Bull. 166: 112540, https://doi.org/10.1016/j.marpolbul.2021.112540; Report of the IWC Workshop on Marine Debris: The Way Forward, 3-5 December 2019, La Garriga, Catalonia, Spain, SC/68B/REP/03).

Binding International Agreement on Plastics Pollution Is in the Making

Plastics pollution is one of the most rapidly worsening environmental challenges in the early 21st century. Walker (2022) expressed concern that, despite decades of effort (MARPOL 73/78, Annex V; UN SDGs target 14.1; several UNEA resolutions; G7 Ocean Plastics Charter and G20 Action Plans), no binding global agreement to reduce marine plastics pollution has been reached. A new global treaty has been proposed, but the author estimated that negotiations and implementation could take up to 8-10 years. However, UNEP issued a press release on 2 March 2022, reporting that 'representatives from 175 nations endorsed a historic resolution to end plastic pollution and forge an international legally binding treaty by 2024. The resolution addresses the full lifecycle of plastic, including its production, design and disposal'. The newly established Intergovernmental Negotiating Committee will begin its work in 2022. UNEP considered this to be the most significant environmental multilateral deal since the Paris Accords.

(SOURCES: Walker, T.R. 2022. Calling for a decision to launch negotiations on a new global agreement on plastic pollution at UNEA5.2. Mar. Pollut. Bull. 176. https://doi.org/10.1016/marpolbul.2022.113447; https://www.unep.org/news-and-stories/press-release/historic-day-campaign-beat-plastic-pollution-nations-commit-develop).

Baleen Whales Near a Coastal City Consumed Millions of Microplastic Particles Every Day

The faeces of Bryde's and sei whales from the Hauraki Gulf, New Zealand, were examined from a study site close to Auckland, New Zealand's largest city. The authors identified prey species from genetic analyses of the faeces. They also found 32+/-24 (SD) particles of microplastics per 6g of faeces. The main route of microplastics uptake would be through consuming prey.

Calculating microplastics uptake from levels in water would have underestimated uptake by four orders of magnitude. The authors estimated the whales consume about 25,000 particles of microplastics every time they capture prey, for a total of 3.4 million particles of microplastics per day.

(SOURCE: Zantis, L.J., Bosker, T., Lawler, F., Nelms, S.E., O'Rorke, R., Constantine, R., Sewell, M. and Carroll, E.L. 2021. Assessing microplastic exposure of large marine filter-feeders. Sci. Total Environ. 818: 151815, https://doi.org/10.1016/j.scitotenv.2021.151815).

Ship Strikes

Low Levels of Compliance with Voluntary Speed Restrictions to Protect Whales

Ship strikes are a major threat to whales. A voluntary speed restriction zone (10 knots or less) for vessels over 300 tons was established in Californian waters (USA) to reduce the risk of ship strikes. Previous studies have shown low compliance levels (0-13%) in such zones. Ship position data were used to investigate compliance levels within the California zone between 2010 and 2019. While average ship speeds were reduced, the level of compliance was lower than the level needed to ensure ship strikes would be sustainable. A compliance level of 80% or higher was needed to reduce ship-strike mortality by 20-30%, but even a financial incentive-based speed reduction programme (with incentives ranging from $500-$50,000) did not lead to sufficient compliance. It was introduced in 2014 - Protecting Blue Whales and Blue Skies - and scaled up in 2018, leading to a small (15%) increase in compliance, but it levelled out at approximately 50%. The authors suggested that purely voluntary speed restrictions are ineffective at reducing speeds to the level needed to protect whales. Legal speed limits, regulations and enforcement may be required.

(SOURCE: Morten, J., Freedman, R., Adams, J.D., Wilson, J., Rubinstein, A. and Hastings, S. 2022. Evaluating adherence with voluntary slow speed initiatives to protect endangered whales. Front. Mar. Sci. 9: 833206. https://doi.org/10.3389/fmars.2022.833206).

Chemical Pollution

A Review of Polycyclic Aromatic Hydrocarbons in Marine Mammals, including Cetaceans

PAHs stem largely from anthropogenic activities, mostly from crude oil. Some are toxic and therefore incorporated in environmental monitoring programmes. A study found naphthalene was the predominant PAH in marine mammal tissue, but knowledge about the effects of PAHs on cetaceans is scarce. In general, the levels were not correlated with sex or age but were 'associated with the influence of urban and industrialised areas in which the organisms lived, or eventually with an oil spill or oil products'. The authors compiled a summary of PAH measurements in marine mammal tissue samples, but also noted that diverging methodological approaches affected these results.

(SOURCE: Lourenco, R.A., Taniguchi, S., da Silva, J., Costa Gallota, F.D. and Bicego, M.C. 2021. Polycyclic aromatic hydrocarbons in marine mammals: A review and synthesis. Mar. Pollut. Bull. 171: 112699, https://doi.org/10.1016/j.marpolbul.2021.112699).

Marine Ecotoxicology Facing a New Era

Marine ecotoxicology is facing new challenges related to the emergence of new and complex synthesised chemicals, combined with climate change. The authors called for updating the agenda and methodologies of this discipline, conducting long-term experiments, standardising sentinel species and benefiting from baseline studies and omics technologies. Because climate change may influence the fate of toxic substances, these proposed improvements must be seen in light of chronic chemical exposure, combined with changing physical parameters (e.g. seawater temperature and pH). While effects have been studied for conventional toxins, the effect of 'climate change on the fate and potential interaction of emergent toxicants such as micro and nanoplastics, drugs and health/care products residues, nanoparticles and new synthesized pesticides' represents a research gap.

(SOURCE: Tlili, S. and Mouneyrac, C. 2021. New challenges of marine ecotoxicology in a global change context. Mar. Pollut. Bull. 166: 112242, https://doi.org/10.1016/j.marpolbul.2021.112242).

Climate Change

Using Genetics to Investigate the Effect of Past Warming Events

Investigating the impact that the last rapid and extreme warming period had on cetaceans (during the Pleistocene- Holocene transition 7,000-12,000 years ago) might give insight into how cetaceans will respond to modern global warming in the long term. The authors examined temporal changes in genetic diversity during the past 30,000 years, which suggest that, as temperatures warmed, cetacean populations initially expanded in the Atlantic and Pacific Ocean basins. Presumably this increase in cetacean abundance during the Holocene was associated with changes in prey abundance and climate; for example, there were increases in both baleen whales and their prey in the Southern Ocean, suggestive of a dramatic increase in ocean productivity. However, Atlantic minke whale numbers began to decline with the onset of the Holocene, until ~4,000 years ago when populations started to increase exponentially. Blue and North Atlantic right whales initially increased in number with the onset of the Holocene, but then started to decline about 6,000-8,000 years ago. These trends might have been the result of the so-called '8.2 kya event', when there was a sudden, major release of meltwater into the

North Atlantic, lowering water temperatures and causing a decrease in ocean productivity. Assessments such as this can help assess how whale populations might respond to modern changing climate and oceanic conditions and suggest that some impacts may be long-lasting.

(SOURCE: Cabrera, A.A., Schall, E., Bérubé, M. et al. 2022. Strong and lasting impacts of past global warming on baleen whales and their prey. Global Change Biol. 28: 2657-2677, https://doi.org/10.1111/gcb.16085).

Gulf Stream Migration Makes Northwest Atlantic One of the Fastest Warming Ocean Regions

The Northwest Atlantic Shelf is experiencing marine heat waves, changes in fisheries composition and a surge in sea level rise. This is an area inhabited by many cetacean species, most notably the endangered North Atlantic right whale. Satellite data show that, when the Gulf Stream migrates closer to the underwater plateau of the Grand Banks (Newfoundland), it blocks the southwest flow of the Labrador Current, which would bring less saline, colder and more oxygen-rich water to the North American shelf. The most recent decade has been the hottest on record at the edge of the northeast United States and Canada, because the presence of the Gulf Stream prevented the inflow of this cooler water. By monitoring the flow of these currents (via satellite), it may be possible to predict impacts on this area and its marine ecology.

(SOURCE: Gonçalves Neto, A., Langan, J.A. and Palter, J.B. 2021. Changes in the Gulf Stream preceded rapid warming of the Northwest Atlantic Shelf. Comm. Earth Environ. 2: 74, https://doi.org/10.1038/s43247-021-00143-5).

Latest Ipcc Report: 'Oh God, Oh God, We're All Gonna Die' (Wash, *Serenity*, 2005)

The Latest IPCC report has some stark predictions for the planet. More than a trillion tons of anthropogenic carbon dioxide have entered the atmosphere since the start of the Industrial Revolution, leading to an average global temperature rise of more than 1° C compared to the late 19th century. These emissions, even if they ceased tomorrow, have set in motion a certain amount of irreversible change, leading to impacts that are larger than estimated in previous assessments. Shifts in seasonal timing of natural processes, such as annual animal migrations, have already occurred, with many species populations shifted poleward. Stronger hurricanes have damaged coastal ecosystems. Aquatic diseases, including zoonoses, are emerging in new areas. The oceans have become warmer, more acidic and depleted of oxygen, resulting in kelp forests, sea grass beds, coral reefs and other marine habitats being severely degraded. 'Globally, and even within protected areas, unsustainable use of natural resources, habitat fragmentation, and ecosystem damage by pollutants increase ecosystem vulnerability to climate change'. The best case scenarios, which look increasingly unlikely given the lack of emissions reductions, have a minimum temperature rise of 1.5°C, which risks a biodiversity loss for marine species ranging from 'moderate' to 'very high', including the loss of most coral reefs. The window of opportunity within which to act is ever smaller, and any action now must be significant to make a difference. In less than a century, the annual extinction rate could equal the rate caused by human activities over the past 12,000 years. To date, climate adaptation responses around the world have largely been reactive, small and 'designed to respond to current impacts or near-term climate change risks', rather than to the major changes that are coming.

(SOURCE: IPCC. 2022. Climate Change 2022. Impacts, Adaptation and Vulnerability, https://www.ipcc.ch/report/sixth- assessment-report-working-group-ii/).

Researchers Discover a Surprising Cause for the 'Little Ice Age' and Implications for the Currently Changing Climate

The 'Little Ice Age', a period of cooling in the North Atlantic that started approximately 600 years ago, was one of the coldest periods of the last 10,000 years. It had a major impact on human history, agriculture and ecosystems. The authors reconstructed 3,000 years of North Atlantic sea surface temperatures. Normally warm water from the tropics flows northwards and across the Atlantic, and, when it reaches cold Arctic waters, cools, becomes denser and sinks. This process is known as the Atlantic Meridional Overturning Circulation (AMOC). In the late 1300s, there was an unusually strong northward transfer of warm water and the waters south of Greenland and off Norway became much warmer than usual. This resulted in rapid Arctic ice loss. In only two decades, this melting led to large amounts of ice and meltwater entering the North Atlantic. This cooled North Atlantic waters and also reduced the salinity of surface waters and surface water density, ultimately leading to a severe weakening of the AMOC. Without this conveyor belt of warm tropical water transferring to the North Atlantic weather systems, Europe experienced the Little Ice Age. The fact that an increasing flow of warm water and melting Arctic ice triggered this substantial climatic shift, and over a period of just 20 years, has implications for the possible trajectory of our current climate.

(SOURCE: Lapointe, F. and Bradley, R.S. 2021. Little Ice Age abruptly triggered by intrusion of Atlantic waters into the Nordic Seas. Sci. Adv. 7: eabi8230, https://www.science.org/doi/pdf/10.1126/sciadv.abi8230).

Climate Change Impacts on Marine Mammals: Many Climate Change Predictions Realised but also Some Surprise Effects

Orgeret *et al.* (2022) reviewed the literature on impacts of climate change on marine mammals (*n*=154 studies), encompassing 23 species of toothed whale and 11 species of baleen whale (as well as polar bears and 22 species of

pinniped). Eighty-three percent of the data came from the northern hemisphere and 53% from polar regions. Thirty- four percent reported on demographic changes such as decreases in reproductive success and increases in adult mortality. Five percent reported on phenology and 8% on climate influences on diet. Very few investigated physiological impacts of climate change. Studies had to continue for 10 years at a minimum before an impact on marine mammals could be detected. Studies on Arctic marine mammals needed at least 19 years before an impact was detected. Species with a narrow window of thermal tolerances and longer generation times were more likely to be affected by changing climate. Gulland *et al.* (2022) also reviewed documented climate change effects on marine mammals, but focused on US waters and on which observations matched past predictions. Observed effects included species distribution shifts, but as yet there have been few studies showing evidence of changes in population abundance or vital rates in this region. While many of the observed effects of climate change were predicted (including shifting distributions), there have also been surprises, often because of a combination of climate change effects and human activities (e.g. increasing entanglement rates because of shifts in migration timing or distributions, leading to new overlaps with fisheries) or alterations in predator-prey relationships (e.g. increased attacks by killer whales on bowhead whales, or by bottlenose dolphins on harbour porpoises, as distributions shift). Such unpredicted effects complicate implementing conservation actions. Moreover, some climate change predictions have yet to be confirmed with evidence. The latter may reflect a lack of research attention. Gulland *et al.* emphasised the need for more focused research on the effects of climate change on marine mammals, and the need for managers to monitor closely, and be able to react quickly, should more unexpected climate change impacts occur.

(SOURCES: Orgeret, F., Thiebault, A., Kovacs, K.M., Lydersen, C., Hindell, M.A., Thompson, S.A., Sydeman, W.J. and Pistorius, P. 2022. Climate change impacts on seabirds and marine mammals: The importance of study duration, thermal tolerance and generation time. Ecol. Lett. 25, 218-239, https://doi.org/10.1111/ele.13920; Gulland, F.M.D., Baker, J.D., Howe, M., LaBrecque, E., Leach, L., Moore, S.E., Reeves, R.R. and Thomas, P.O. 2022. A review of climate change effects on marine mammals in United States waters: past predictions, observed impacts, current research and conservation imperatives. Climate Change Ecol. 3: 100054, https://doi.org/10.1016/j.ecochg.2022.100054).

Whale Distribution Has Shifted in Response to Climate Change Faster than Their Prey Species

It has been assumed that warm-blooded marine mammals would be less affected by changing water temperatures than their cold-blooded prey. The authors investigated the effect of climate change on the movement of long-finned pilot whales and their prey, over a 25-year period. The distribution of whales in the waters off the northeast United States shifted northwards as ocean temperatures rapidly warmed, but this distribution surprisingly shifted at three times the rate of their fish and squid prey species. The shifts in whale distribution were correlated with sea surface temperatures rather than with shifts in their prey distribution, which may have major implications for food web ecology and ecosystem structure.

(SOURCE: Thorne, L.H. and Nye, J.A. 2021. Trait-mediated shifts and climate velocity decouple an endothermic marine predator and its ectothermic prey. Sci. Rep. 11: 18507, https://doi.org/10.1038/s41598-021-97318-z).

Noise Impacts

Ports Can Play an Important Role in Reducing Vessel Noise

In an effort to reduce the noise stress on killer whales in the Canadian Pacific Ocean, the port of Vancouver offers incentives for quieter ships, but methodological issues hinder determining relative quietness. Ainslie *et al.* (2022) described two Canadian-led projects seeking to improve the harmonisation of underwater radiated noise measurements. One project supported efforts by the International Organization for Standardization; the other project involved efforts by ship classification societies. Virto *et al.* (2022) also examined the role ports can play in reducing vessel noise. Ports can support changes in hull, propeller and engine design, along with measures such as reduced speeds, route changes and even travel in convoy. Discounted port fees and reduced ship waiting times for quieter vessels are additional ways ports can facilitate the development of quieter vessels. The authors also noted that noise measurement methodologies should be standardised and that few vessel owners know their noise emissions. Noise reduction programmes should align with ongoing vessel-owner issues, such as fuel and ballast water requirements. Finally, Vakili *et al.* (2021) argued for a transdisciplinary policy framework - aligned with the IMO's initial Greenhouse Gas strategy - within which shipping companies would mitigate underwater noise pollution.

(SOURCES: Ainslie, M.A., Martin, S.B., Trounce, K.B., Hannay, D.E., Eickmeier, J.M., Deveau, T.J., Lucke, K., MacGillivray, A.O., Nolet, V. and Borys, P. 2022. International harmonization of procedures for measuring and analyzing of vessel underwater radiated noise. Mar. Pollut. Bull. 174: 113124, https://doi.org/10.1016/j.marpolbul.2021.113124; Virto, L.R., Dumez, H., Romero, C. and Bailly, D. 2022. How can ports act to reduce underwater noise from shipping? Identifying effective management frameworks. Mar. Pollut. Bull. 174: 113136, https://doi.org/10.1016/marpolbul.2021.113136; Vakili, S., Ölcer, A.I. and Ballini, F. 2021. The development of a transdisciplinary policy framework for shipping companies to mitigate underwater noise pollution from commercial vessels. Mar. Pollut. Bull. 171: 112687, https://doi.org/10.1016/j.marpolbul.2021.112687).

Whales React to Petrol Engine Whale Watching Vessels but not to Electric Engine Vessels

Drones were used to monitor the behaviour of short-finned pilot whale mother and calf pairs in relation to whale watching vessels off the coast of Tenerife, Spain. Groups were passed by electric and petrol-engine vessels at a distance of 60m (in

compliance with Canary Islands whale watching guidelines). Mothers approached by the vessel with the petrol engine spent on average 29% less time resting and 81% less time nursing their calves. However, there was no significant difference in resting or nursing behaviour in whales approached by the vessel with the electric engine, when compared to those not approached by a vessel.

(SOURCE: Arranz, P., Glarou, M. and Sprogis, K.R. 2021. Decreased resting and nursing in short-finned pilot whales when exposed to louder petrol engine noise of a hybrid whale-watch vessel. Sci. Reports 11: 21195, https://doi.org/10.1038/s41598-021-00487-0).

New Methodologies Improves Understanding of Free-Ranging Small Cetacean Responses to Navy Sonar

Navy mid-frequency active sonar is used for submarine detection and has caused atypical mass strandings in certain (deep-diving) cetaceans. This has triggered much research on cetacean responses to this noise source. A controlled exposure experiment approach involving shore-based group tracking, aerial photogrammetry and passive acoustics improved response detection in faster-swimming small cetaceans, for which high-resolution, multi-sensor tags are not an option. Importantly, these methodologies allow researchers to study group behaviour, which is a more relevant metric than individual responses for social species such as these.

(SOURCE: Durban, J.W., Southall, B.L., Calambokidis, J., Casey, C., Fearnbach, H., Joyce, T.W., Fahlbusch, J.A., Oudejans, M.G., Fregosi, S., Friedlaender, A.S., Kellar, N.M. and Visser, F. 2022. Integrating remote sensing methods during controlled exposure experiments to quantify group responses of dolphins to navy sonar. Mar. Pollut. Bull. 174: 113194, https://doi.org/10.1016/j.marpolbul.2021.113194).

Efforts to Harmonise Underwater Noise Measurements and Reduce Noise in ORCA Class Navy Ships

In the framework of better understanding noise with respect to Canadian whale populations, an effort was made to redesign the propeller of a Royal Canadian Navy ORCA-class training vessel. Numerical approaches showed promise for reducing propeller noise, but model scale testing failed to show the expected improvements. These efforts will be continued both for the navy vessel and for civilian ships, focusing on retrofit scenarios and examining trade-offs (e.g. speed). This includes the manufacture, installation and testing of a noise-optimised propeller on an ORCA training vessel.

(SOURCE: Gilroy, L. 2022. Ship noise management and the ORCA class of ships. Mar. Pollut. Bull. 174: 113196, https://doi.org/10.1016/j.marpolbul.2021.113196).

Seal Bomb Explosives to Protect Fishing Gear a Cause for Concern

Acoustic devices are often used to deter marine predators from aquaculture sites and fishing gear. In Southern California, explosives, referred to as 'seal bombs', are often used to deter pinnipeds from fishing gear. Between 2005 and 2016, passive acoustic monitoring within the Southern California Bight and near Monterey Bay recorded high numbers of these explosions. Up to 2800 explosions were recorded per day at received sound exposure levels of up to 189dB re 1µPa^2-s, i.e. at sound levels high enough to cause impacts to cetaceans. The spatio-temporal patterns of the explosions suggested seal bombs were being used extensively in the Californian squid purse-seine fishery. The impacts of this wide-scale use of explosives need to be evaluated, and environmental regulations should be required to reduce the impacts of these explosives on marine life.

(SOURCE: Krumpel, A., Rice, A., Frasier, K.E., Reese, F., Trickey, J.S., Simonis, A.E., Ryan, J.P., Wiggins, S.M., Denzinger, A., Schnitzler, H.-U. and Baumann-Pickering, S. 2021. Long-term patterns of noise from underwater explosions and their relation to fisheries in Southern California. Front. Mar. Sci. 8: 796849, https://doi.org/10.3389/fmars.2021.796849).

Small Boats - Beyond Shipping Vessels - Need to be Considered in Reducing Noise Levels

Small boats are abundant in most shallow waters worldwide. Wilson *et al.* (2022) examined four high-pressure recreational boating sites in New Zealand, some of which include MPAs and enjoy the highest protection the country affords to marine habitats. Such boats, however, significantly increased the low-frequency (100-88kHz) component of the soundscape - the frequency band used by many species for communication, orientation and predator avoidance. Only half of the world's marine reserves currently place restrictions on recreational boating, and the authors argued for a zoned marine reserve design and/or implementing speed restrictions, 'as has been successful in reducing sound emissions and ship strikes of whales by commercial ships'. Lo *et al.* (2022) made progress in estimating vessel speeds in the critical habitat of the endangered southern resident killer whales in Canada. Vessel speed is another important criterion determining noise levels, and this study also included small boats that lack Automatic Identification Systems.

(SOURCES: Wilson, L., Pine, M.K. and Radford, C.A. 2022. Small recreational boats: a ubiquitous source of sound pollution in shallow coastal habitats. Mar. Pollut. Bull. 174: 113295, https://doi.org/10.1016/j.marpolbul.2021.113295; Lo, C.F., Nielson, K.A., Ashe, E., Bain, D.E., Mendez-Bye, A., Reiss, S.A., Bogaard, L.T., Collins, M.S. and Williams, R. 2022. Measuring speed of vessels operating around endangered southern resident killer whales (Orcinus orca) in Salish Sea critical habitat. Mar. Pollut. Bull. 174: 113301, https://doi.org/10.1016/j.marpolbul.2021.113301).

ACKNOWLEDGMENTS

The editors thank Elke Burkhardt and Frances Gulland for submitting entries for inclusion. The editors are especially grateful to the Government of Austria and the Animal Welfare Institute for providing support for SOCER preparation, as requested by Resolution 2000-7. We also thank the IWC Secretariat for funding support for SOCER 2022.

REFERENCES

International Whaling Commission. 1998. Chairman's Report of the Forty-Ninth Annual Meeting. Appendix 7. IWC Resolution 1997-7. Resolution on environmental change and cetaceans. *Rep. Int. Whal. Comm.* 48:48-49.

International Whaling Commission. 1999. Chairman's Report of the Fiftieth Annual Meeting. Appendix 6. IWC Resolution 1998-5. Resolution on environmental changes and cetaceans. *Ann. Rep. Int. Whal. Comm.* 1998:43-44.

International Whaling Commission. 2001. Chairman's Report of the Fifty-Second Annual Meeting. Appendix 1. Resolutions adopted during the 52nd annual meeting. IWC Resolution 2000-7. Resolution on environmental change and cetaceans. *Ann. Rep. Int. Whal. Comm.* 2000:56-57.

Stachowitsch, M., Rose, N.A. and Parsons, E.C.M. 2003. State of the Cetacean Environment Report (SOCER) 2003: Second draft. Paper SC/55/E7 presented to the IWC Scientific Committee, May 2003, Berlin (unpublished). 13pp. [Paper available from the Office of this Journal].

Appendix 1

GLOSSARY

Glossary of terms

Bathymetry: The measurement of water depth in oceans, seas or lakes.

Benthic: Of, relating to or occurring at the bottom of a body of water, such as the ocean.

Bioaccumulation: Increase in concentration of a pollutant within an organism compared to background levels in its diet. Pollutant levels are highest in older individuals.

Biological carbon pump: The ocean's biological sequestration of carbon from the atmosphere and land runoff to the seabed sediments, where it often remains for thousands of years.

Biomagnification: To increase the concentration of a contaminant from one link in a food chain to another. Pollutant levels are highest in top predators.

CCAMLR: Commission for the Conservation of Antarctic Marine Living Resources.

Chlordane: An organochlorine pesticide.

Copepod: A small or microscopic aquatic crustacean.

dB: Decibel - a logarithmic measure of sound pressure level.

Diatom: A single-celled alga that has a cell wall of silica.

DL-PCB: Dioxin-like polychlorinated biphenyl.

DDT: The organochlorine pesticide dichlorodiphenyltrichloroethane, which tends to accumulate in the ecosystem and in the blubber and certain internal organs of cetaceans.

Diene: A hydrocarbon.

El Niño: The warm phase of the El Niño-Southern Oscillation and is associated with a band of warm ocean water that develops in the central and east-central equatorial Pacific, including the area off the Pacific coast of South America.

Endemic: Native and restricted to a certain place

HAB: Harmful algal bloom.

HCB: Hexachlorobenzene, a chlorinated pesticide.

HCH: Hexachlorocyclohexane, a chlorinated pesticide.

Heptachlor: An organochlorine compound that was used as an insecticide.

Hz: Hertz, a measure of sound frequency (pitch), in wave cycles per second (kHz=1,000 Hz).

IMO: International Maritime Organization.

IPCC: Intergovernmental Panel on Climate Change.

IUCN: International Union for Conservation of Nature.

Keystone species: A species on which other species in an ecosystem largely depend, such that if it were removed the ecosystem would change drastically.

µg: Microgram, one thousandths of a gram.

μPa^2 -s: Micropascal squared per second, a reference pressure for underwater sound exposure level.

MARPOL: The International Convention for the Prevention of Pollution from Ships.
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.
Nanoplastics: Plastic particles less than 1 µm in diameter.
Niche partitioning: The process by which natural selection drives competing species into different patterns of resource use or different ecological niches.
Ocean acidification: A reduction in the pH of the ocean over an extended period of time, caused primarily by uptake of carbon dioxide from the atmosphere.
OHI: Ocean Health Index.
Omics: The branches of biology ending in the suffix *-omics*, such as genomics, proteomics, and metabolomics. Omics sciences aim to characterise and quantify biological molecules that translate into the structure, function and dynamics of an organism or organisms.
OPEs: Organophosphate esters, widely used in industry and households as plasticisers, flame retardants and antifoaming agents.
PAH: Polycyclic aromatic hydrocarbon.
PAME: Protection of the Arctic Marine Environment.
PBDE: Polybrominated diphenyl ether.
PCB: Polychlorinated biphenyl.
PCDDs: Dibenzo-p-dioxins.
PCDFs: Polychlorinated dibenzofurans.
Phenology: The study of cyclic and seasonal natural phenomena, especially in relation to climate and plant/animal life.
Photogrammetry: The use of photography to measure distances between, or size of, objects, including animals.
Polyamide: A polymer with repeating units linked by amide bonds. Polyamides occur both naturally and artificially.
Polyethylene: A tough, light, flexible synthetic resin made by polymerising ethylene, chiefly used for plastic bags, food containers and other packaging. The most common plastic in use today.
Polymer: A substance that has a molecular structure consisting chiefly or entirely of a large number of similar units bonded together, e.g. many synthetic organic materials used as plastics and resins.
Polypropylene: A synthetic resin, a polymer of propylene, used especially for ropes, fabrics and moulded objects.
Polystyrene: Styrofoam.
POPs: Persistent organic pollutants, organic compounds that are resistant to degradation and thus persist in the environment.
PPCP: Pharmaceutical and personal care products.
Pteropod: A small mollusc with wing-like extensions to its body that it uses for swimming.
Salp: A free-swimming marine invertebrate related to the sea squirts, with a transparent barrel-shaped body.
SD: Standard deviation.
Sentinel species: Organisms, often animals, used to detect risks to humans by providing advance warning of a danger.
UN: United Nations.
UNEA: United Nations Environment Assembly.
UNEP: United Nations Environment Programme.
Water column: A conceptual column of water extending from the sea surface down to the seafloor.
Zoonosis: A disease transmissible from other animals to humans and vice versa (plural: zoonoses).

SPECIES GLOSSARY

Antarctic minke whale	*Balaenoptera bonaerensis*	Crabeater seal	*Lobodon carcinophagus*
White (beluga) whale	*Delphinapterus leucas*	Harbour seal	*Phoca vitulina*
Blue whale	Balaenoptera musculus	Northern fur seal	*Callorhinus ursinus*
Bowhead whale	*Balaena mysticetus*	North Pacific sea otter	*Enhydra lutris*
Bryde's whale	*Balaenoptera edeni*	Polar bear	*Ursus maritimus*
Common bottlenose dolphin	*Tursiops truncatus*	Ross seal	*Ommatophoca rossii*
Common minke whale	*Balaenoptera acutorostrata*	Steller sea lion	*Eumetopias jubatus*
Fin whale	*Balaenoptera physalus*	Weddell seal	*Leptonychotes weddellii*
Gray whale	*Eschrichtius robustus*		
Harbour porpoise	*Phocoena phocoena*	Northern fulmar	*Fulmarus glacialis*
Humpback whale	*Megaptera novaeangliae*	Black-footed kittiwake	*Rissa tridactyla*
Killer whale	*Orcinus orca*		
Long-finned pilot whale	Globicephala melas	Antarctic silverfish	*Pleuragramma antarcticum*
Narwhal	*Monodon monoceros*		
North Atlantic right whale	*Eubalaena glacialis*	Antarctic krill	*Euphausia superba*
Northern bottlenose whale	*Hyperoodon ampullatus*	Krill	Family *Euphausiidae* (euphausiids)
Sei whale	*Balaenoptera borealis*		
Short-finned pilot whale	*Globicephala macrorhynchus*		
Sperm whale	*Physeter macrocephalus*		
White-beaked dolphin	*Lagenorhynchus albirostris*		

HEAVY METALS

Cd	Cadmium	Hg	Mercury
Cu	Copper	Pb	Lead
Fe	Iron	Zn	Zinc

Annex M

Intersessional E-mail Groups

This list contains the intersessional groups identified at SC68D (as at March 2023). 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 SC69A. 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 SC69A.

(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 8.1.1 IA	SG	North Pacific humpback whales	Further the preparations for the North Pacific humpback whale Comprehensive Assessment, including organizing an intersessional meeting.	Cheeseman (Convenor), Baker, Calambokidis, Clapham, Donovan, Herr, Katara, Katsumata, Kitakado, Ivashchenko, Matsuoka, Mizroch, Palka, Palacios, Privitera-Johnson, Punt, Steel, Zerbini, Urbán and Wade. Email: *nphumpack@groups.iwc.int*
Item 8.1.2 IA	SG	North Pacific sei whales	Finalise the North Pacific sei whale Comprehensive Assessment and summary document.	Palka (Convenor), Allison, Butterworth, Cooke, Herr, Katara, Kitakado, Mizroch, Punt, Takahashi and Yoshida. Email: *npsei@groups.iwc.int*
Item 8.1.3 IA	SG	WNP common minke whales	Further the preparations for the western North Pacific common minke whales In-depth Assessment, including organizing an intersessional meeting.	Donovan (Convenor), Allison, Baker, Butterworth, de Moor, Hakamada, Herr, Hoelzel, Katara, Kitakado, Palka, Punt, Tiedemann, Wade, Wilberg and Yoshida. Email: *wnpminke@groups.iwc.int*
Item 8.1.3 IA	ICG	WNP common minke abundance	(1) Review the applicability of the accepted *g(0)* estimate from one cruise to other cruises. (2) Investigate the possibility of estimation of additional variance. (3) 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), Butterworth, Donovan, Miyashita, Palka and Takahashi. Email: *wnpcommminkeabun@groups.iwc.int*
Item 8.2.4 NH	ICG	NP blue whales	Locate and/or analyse data on abundance, catches and stock structure to prepare for a future assessment.	Branch (Convenor), Brownell, Clapham, Ivashchenko, Matsuoka, Mizroch, Monnahan, Olson, Palacios, Širović and Sremba. Email: *npbwa@groups.iwc.int*
Item 8.2.5 NH	ICG	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), Breiwick, Brownell, Mallette, Mizroch, Palka, Robbins, Rosenbaum and Weinrich. Email: *nasei@groups.iwc.int*
Item 8.2.7 NH	ICG	NA humpback whales	Identify and evaluate data available for a potential future assessment of North Atlantic humpback whales.	Robbins (Convenor), Allen, Allison, Cholewiak, Chosson, Clapham, Donovan, Jones, Katara, Lang, Mallette, Mattila, Øien, Palka, Palsbøll, Punt, Rosenbaum, Tiedemann, Vély, Weinrich, Wilberg and Witting. Email: *nahumpback@groups.iwc.int*
Item 8.2.7 NH	SG	NA humpback whales SG	Plan for an in-person intersessional meeting in 2022 or 2023 to advance the in-depth assessment of North Atlantic humpback whales.	Robbins, Donovan (co-Convenors) and ICG-4 members.

SC Agenda Item/Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 8.3.2 NH	ICG	UMEs and assessments	Review information on Unusual Mortality Events (Item 14.3.2) for relevance to potential future assessments of Northern Hemisphere populations.	Cholewiak (Convenor), Mallette, Mattila, Palka, Rowles, Robbins and Weinrich. Email: *umes@groups.iwc.int*
Item 9.2.1 SH	ICG	Humpback whales in the northern Indian Ocean including the Arabian Sea	Engage a group composed of Arabian Sea humpback whale experts, veterinarians/ cetacean health experts, and satellite tagging practitioners, to advise on best practices for a proposed renewed tagging effort, aimed at informing species distribution modelling and associated ship strike and bycatch risk assessment.	Willson (Convenor), Baldwin, Brownell, Cerchio, Collins, Gulland, Minton, Palacios, Robbins, Van Bressem, Weller and Zerbini. Email: *niohumpbacks@groups.iwc.int*
Item 9.2.1 SH	ICG	Advise on construction and analysis of southeast Pacific, southeast Indian Ocean and southwest Pacific mark recapture datasets	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, Findlay, Fewster, Galletti, Gill, Herr, Jenner, Matsuoka, Möller, Olson, Salgado-Kent, Torres, Torres-Florez, Weinrich and Zerbini. Email: *admrd@groups.iwc.int*
Item 8.2.2.1 SH	ICG	Antarctic blue whale song	Low- and mid-latitude analysis of Antarctic blue whale song to establish any differences between wintering grounds.	Shabangu (Convenor), Buchan, Barlow, Branch, Cerchio, McCauley, Miller, Samaran, Širović, Sousa-Lima, Stafford and Torres. Email: *antbluesong@groups.iwc.int*
Item 8.2.3 SH	ICG	Antarctic blue whale population structure hypotheses	Consideration of options for proposing alternative population structure hypotheses.	Jackson (lead), Herr, Lang, Olson, Branch, Sremba and Torres-Florez. Email: *antbluepop@groups.iwc.int*
Item 8.2.3.3 SH	ICG	Southern right whale body condition	Finalise a global, standardised southern right whale body condition and visual health assessment protocol for IWC endorsement.	Vermeulen, Charlton (co-Convenors), Christiansen, Findlay, Gregory, Hörbst, Kent, Leslie, Minton and Moore. Email: *srightcond@groups.iwc.int*
Item 8.2.3.5 SH	ICG	Using satellites to study whales	Coordination of information, data, and code-sharing among research groups conducting active research using satellite images to monitor whales. This group aims to facilitate development of automated methods, avoid duplication of effort, and negotiate better tasking opportunities with satellite providers.	Clarke (Convenor), Alfaro, Alpizar, Archer, Arias, Baird, Baldwin, Bamford, Bell, Bejder, Borowicz, Burkhardt, Carroll, Castro, Charry, Cholewiak, Collins, Coscarella, Crespo, Cubaynes, Dalla Rosa, di Sciara, Domit, Double, Elwen, Ferguson, Fernández, Fewster, Fretwell, Frias, García-Garin, Garita, Goetz, Green, Ham, Hines, Hodgins, Höeschle, Houliston, Houegnigan, Ivanchikova, Jackson, Jenner, Katara, Khan, Lauriano, Leaper, Lundquist, Mallette, Mizroch, Natoli, Neveceralova, Olavarría, Olson, Palacios, Palka, Panigada, Pisano, Plön, Porter, Ritter, Robbins, Rodofili, Rogan, Rowles, Schteinbarg, Schubert, Sousa-Lima, Stack, Stewart, Stockin, Sucunza, Tissier, Torres-Florez, Tulloch, Urbán, Vermeulen, Viera, Voss, Watt, Weinrich, Wilkin and Zerbini. Email: *satwhales@groups.iwc.int*
Item 8.2.3.6 SH	ICG	Southern right whale calls	Assess what southern right whale call data exists offshore and at high latitudes (including IMOS and SOHN data), and consider appropriate analysis framework for using these data to assess southern right whale offshore distribution.	Vermeulen (Convenor), Burkhardt, Calderan, Carroll, Charlton, Findlay, Friedlander, Leaper, McCauley, Miller, Reyes Reyes, Shabangu, Širović, Ward and Webster. Email: *srightcalls@groups.iwc.int*
Item 8.2.3.6 SH	ICG	Southern right whale catch data	Compile new SRW catch series and update regional catch estimates.	Findlay (Convenor), Allison, Andrews-Goff, Azizeh, Bell, Carroll, Charlton, Chatwin, Double, Jackson, Katara, Kemper, Paton, Reeves, Richards, Smith, Tryniw, Vermeulen and Zerbini. Email: *srightdata@groups.iwc.int*
Item 8.2.3.6 SH	ICG	Southern right whale stock structure hypotheses	Review of the available historical and contemporary evidence for southern hemisphere stock structuring, develop stock structure hypotheses for review and ranking, based on available evidence; and identify data gaps where further work is required to discriminate Hypotheses.	Jackson (Convenor) Agrelo, Azizeh, Baker, Carroll, Charlton, Evans, Findlay, Galletti-Vernazzani, Groch, Matsuoka, Richards, Rosenbaum, Sironi, Tiedemann, Torrez-Florez, Valenzuela, Vermeulen, Weinrich and Zerbini. Email: *srightssh@groups.iwc.int*
Item 8.2.3 SH	ICG	Southern right whale modelling	Progress towards the application of a common modelling framework on long-term sighting history datasets from southern right whale calving grounds to assess common: (1) population dynamics patterns; and (2) environmental drivers.	Charlton, Vermeulen (co-Convenors), Agrelo, Brandão, Butterworth, Carroll, Cooke, Double, Groch, Leaper, Rayment, Ross-Gillespie, Rowntree, Seyboth, Sironi and Watson. Email: *sright@groups.iwc.int*

SC Agenda Item/Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 8.4.2 SH	ICG	Population structure	Conduct inter-regional comparisons of SH fin whale songs, similar to Širović *et al.* (2018) for blue whales.	Širović (Convenor), Aulich, Harris, Miller, Samaran, Shabangu and Van Opzeeland. Email: *popst@groups.iwc.int*
Item 11.1 ASI	SG	Abundance Steering Group (ASG)	1. Coordinate the intersessional review of abundance estimates by the ASI SWG. 2. At a pre-meeting for the next meeting, review abundance estimates, make recommendations to ASI, and consider progress on the Status of Stocks Website project.	Givens, New (co-Convenors), Brownell, Donovan, Jackson, Katara, Kitakado, Palka, Porter, Robbins, Staniland, Walløe and Zerbini. Email: *reviewofae@groups.iwc.int*
Item 11.3 ASI	ICG	Abundance Review Process	1. Develop supplementary wording that explains how estimates in categories 1A, 1B, 2 and 3 might be used, and examples of the reasoning for choosing one category over another. 2. Consider changes to streamline the ASG review process for abundance estimates received regularly using consistent survey and analysis methods, e.g. as for ENP gray whales.	Givens (Convenor), Allison, Butterworth, Donovan, Jackson, New and Zerbini. Email:*arp@groups.iwc.int*
Item 11.1.13 ASI/SM	ICG	Franciscana abundance review	1. Coordinate the intersessional review and revision of franciscana abundance estimates. 2. Produce a report for presentation next year. 3. Provide estimates for which SM or CMP might request ASI review.	Zerbini (Convenor), Andriolo, Cañadas, Cremer, Crespo, Danilewicz, Domit, Doniol-Valcroze, Donovan, Ferguson, Fortuna, Givens, Herr, Miller, Palka and Sucunza. Email: *Franciscanaarg@groups.iwc.int*
Item 11.5 ASI	SG	Status of Stocks Steering Group	- Oversee the Status of Stocks Website Project, ensuring consistency and communication among the related ICGs. - Determine priority order in which species will be added to the website. - Receive draft material from other ICGs. Solicit review of draft content as needed for consistency, clarity, and accessibility to the appropriate audience. - Solicit SC approval of final material. - Organise creation of draft website.	Givens, Staniland (co-Convenors), Cipriano, Fortuna, New, Punt, Tandy, Wilson and Zerbini. Email: *sos-sg@groups.iwc.int*
Item 11.5 ASI	ICG	Status of Stocks Model-based Assessment	1. Determine specifications for model-based assessments for the Status of Stocks Website project. Such assessments are to be based on completed SC assessments, *Implementation Reviews*, and past projects. 2. Run model-based assessments for the appropriate species. 3. Summarise modelling results and provide them to the Status of Stocks Group on Language, Terminology, and Content Development. 4. Draft technical explanation of assessment specifications and results, for provision to the same group.	Givens (Convenor), Allison, Branch, Butterworth, Donovan, Katara, Palka, Punt and Wilberg. Email: *sos-assessments@groups.iwc.int*
Item 11.5 ASI	ICG	Status of Stocks group on language, terminology and content development	1. Draft Status of Stocks Website text for explanation of concepts such as population dynamics, carrying capacity, definition of stocks/population, and scientific uncertainty. 2. Draft website text for comparison of IUCN Red List and IWC Status of Stocks assessments (item 4.12). 3. Finalise choices for terminology, labels, nature of statements about recovery, and similar aspects of the draft website. 4. Draft text for summary pages, ensuring consistent format and language, in consultation with species experts to be solicited by this group as necessary.	Cipriano, Wilson (co-Convenors), Butterworth, DeMaster, Donovan, Givens, Katara, Lang, Staniland, Tandy, Wade and Zerbini. Email: *sos-ltcd@groups.iwc.int*
Item 11.1.6 ASI	ICG	North Pacific Sei Whale Review	Review the abundance estimates of Hakamada *et al.* (2009) and Hakamada and Matsuoka (2016) to better understand how the data were analysed, recommend at which level the estimates should be endorsed (and for which Categories), and assess how best to combine estimates across space and time to include estimates in the IWC Table of Accepted Abundance Estimates.	Punt (Convenor), Butterworth, Ferguson, Mizroch and Palka. Email: *npseirev@groups.iwc.int*

SC Agenda Item/Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 11.4.3 ASI	ICG	Mark-recapture Abundance Estimation	1. Consider diagnostic methods for mark-recapture models. 2. Clarify the appropriate interpretation, endorsement, and use of estimates derived from data over long timeframes. 3. Advise on appropriate methods for mark-recapture abundance estimation from studies with very heterogeneous sources of data.	Wade (Convenor), Butterworth, Fewster and Kelly. Email: *markrecapae@groups.iwc.int*
Item 11.2.2 ASI	ICG	IWC table text on spatial extent for mark-recapture and line transect estimates	Draft brief supplemental text for IWC Table of Accepted Abundance Estimates.	Butterworth (Convenor), Donovan and Wade. Email: *spatex@groups.iwc.int*
Item 11.2.1 ASI	ICG	Update IWC abundance webpage	1. Update the IWC webpage on abundance estimates to incorporate selected abundance estimates endorsed at SC68D. 2. Delete abundance estimates from this web-page if necessary to ensure a consistent approach. 3. Consider amended explanation of a 'confidence interval' on this webpage.	Givens (Convenor), Allison, Donovan, Katara and New. Email: *abunweb@groups.iwc.int*
Item 22.1 ASI	SG	IWC-POWER/SOWER	To provide advice on the 2022-2023 IWC-POWER cruises (including holding the Workshop and Planning Meetings), on data analyses, storage and requests for data/sample use of IWC-POWER/SOWER cruises.	Matsuoka (Convenor), An, Azeyanagi, Bizikov, Brownell, Clapham, Crance, Donovan, Fukui, Goetz, Gushcherov, Iida, Isoda, Kadota, Kato, Kelly, Katsumata, Kitakado, Miyashita, Murase, Palka, Pastene, Staniland, Taguchi, Wade, and Zerbini. Email: *iwcpowersower@groups.iwc.int*
Item 22.3 ASI	SG	IWC-ATLAFCO collaboration	1. Schedule the workshops into modules (annual or biennial). 2. Identify potential SC scientists to invite to design and lead these workshops. 3. Prepare a proposal to this regard for presentation at the next meeting.	Staniland (Convenor), Cerchio, Collins, Diallo, Freitas, Laamrich, Minton, Miyashita, Panigada, Pastene, Ploen, Ridoux, Tiedemann, Walløe, Yoshida and Zerbini. Email: *comhafatisg@groups.iwc.int*
ASI	SG	Indian Ocean pan-regional initiative	1. Compile additional sources of information (surveys, data sets etc) to that presented in SC/68D/ASI16, and further assess existing data for applicability to abundance estimation and ecological research. 2. Explore the design and development of the initiative, including the scale and scope, partnerships, roles governance structure and collaborations, and funding. 3. Convene virtual workshops or meetings with relevant experts, organisations and stakeholders across the region to create a network of interested collaborators and collect feedback on the proposed concept. 4. Identify potential external funding sources and develop proposals where appropriate. 5. Explore opportunities to engage with existing platforms of opportunity. 6. Prepare a detailed proposal on the pan-regional initiative for presentation at the next meeting.	Katara (Convenor), Braulik, Cerchio, Collins, Dulau, Kelly, Kitakado, Palka, Seakamela, Willson and Zerbini. Email: *iopriccs@groups.iwc.int*
Item 10.1.2.1 SD&DNA	ICG	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, Nakamura, Pampoulie, Punt, Scordino, Tiedemann and Weller. Email: *graypopstruct@groups.iwc.int*
Item 10.1.2.3 SD&DNA/SM	ICG	Franciscana population structure	Summarise 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, Archer, Buss, Cipriano, Cunha, Domit, Farro, Gariboldi, Hoelzel, Mendez, Pampoulie, Olíveira, Passadore, Secchi, Tiedemann, Torres-Florez and Zerbini. Email: *franciscanapopstruct@groups.iwc.int*
Item 10.1.2.3 SD&DNA/SM	ICG	*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, Buss, Cipriano, Cunha, Domit, Fruet, Lunardi, Natoli, Sousa-Lima, Tiedemann, Torres-Florez, Zerbini. Email: *sotaliapopstruct@groups.iwc.int*

SC Agenda Item/Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 10.2.1 SD&DNA	ICG	DNA quality	Review recent revisions in sections of the DNA quality guidelines that pertain to data produced using NGS approaches. Identify approaches to increase the visibility and use of the guidelines.	Tiedemann (Convenor), Archer, Baird, Baker, Bickham, Carroll, DeWoody, Hoelzel, Goto, Jackson, Lang, Palsbøll, Pampoulie, Sremba, Taguchi, Torres-Florez and Waples. Email: *dnaquality@groups.iwc.int*
Item 10.2.2 SD&DNA		Genetic data analysis	Generate a checklist of key aspects of the genetic data analysis guidelines and identify aspects of the guidelines that may need updating, particularly in the context of genomic methodologies and analysis. Identify approaches to increase the visibility and use of the guidelines.	Tiedemann (Convenor), Bickham, Buss, DeWoody, Hoelzel, Lang, Pampoulie, Sremba, Torres Florez and Waples. *Email: gendata@groups.iwc.int*
Item 10.3 SD&DNA	ICG	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, Harmon, Hoelzel, Goto, Jackson, Natoli, Palsbøll, Robertson, Sremba, Taguchi, Tiedemann and Torres-Florez. Email: *sampledepletion@groups.iwc.int*
Item 10.4 SD&DNA	ICG	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 and Scordino. Email: *terminology@groups.iwc.int*
Item 15.1 E	SG	Pollution	Planning activities and work priorities for Pollution 2025 (SC 68C).	Holm (Convenor), Avila, Barreto, Brownlow, Cholewiak, Domit, Eisfeld-Pierantonio, Fernandez, Frey, Genov, Gulland, Kershaw, Nash, Pierce, Plön, Rowles, Simmonds, Schwaeke, Staniland, Stimmelmeyer, Stockin, Uhart, Vermuelen, Webster and Walløe. Email: *pollution@groups.iwc.int*
Item 15.4 E	ICG	Noise	Advance underwater noise topics of interest, including collaboration with the Conservation Committee and consideration of IMO MEPC outcomes on noise.	Borsani, Burkhardt, Cerchio, Cholewiak, Cosentino, Frisch-Nwakanma, Genov, Holm, Kinneging, Leaper, Lundquist, Miller, B., Plön, Renell, Reyes, Ritter, Rosenbaum, Simmonds, Širović, Sousa-Lima, Sutaria, Torres, Vrooman, Webster and Williams. Email: *noiseicg@groups.iwc.int*
E	ICG	Diseases of concern	Continue work.	Cholewiak, Colegrove, Davidson, Delaney, Fernandez, Gulland, Groch, Hernandez, Holm, IP, Lee, Marcondes, Mazzariol, Noren, Rowles, Simmonds, Sierra, Stimmelmayr, Tashima and Uhart. Email: *diseasesofconcern@groups.iwc.int*
E	ICG	Climate change	Continue work.	Barreto, Frey, Genov, Gulland, Holm, Frisch-Nwakanma, Mallette, Marcondes, Noren, Nunny, Palka, Simmonds, Sousa-Lima, Staniland, Stimmelmayr, Renell, Rowles, Tulloch and Vrooman. Email: *climatechange@groups.iwc.int*
E	ICG	Marine debris	Continue work.	Simmonds (Convenor), Baulch, Cholewiak, Dolman, Eisfeld-Pierantonio, Frey, Fossi, Frisch-Nwakanma, Genov, Gulland, Holm, Long, Malatji, Mallette, Marcondes, Mattila, Nunny, Panti, Perry, Pierantonio, Rowles, Sutaria, Svoboda, Warrie and Williams. Email: *marinedebris@groups.iwc.int*
15.5.1 E	ICG	One Health	TBD	Fisher, Gulland, Holm, Lee, Mallette, Marcondes, Noren, Plön, Renell, Rowles, Simmonds, Staniland, Stimmelmayr, Sucunza and Uhart. Email: *onehealth@groups.iwc.int*
SM	ICG	Straits of Gibraltar, killer whale	The ICG will continue to compile information on the novel behaviour of the Strait of Gibraltar killer whale subpopulation and when required, will seek input from other marine mammal behaviour experts and suggest appropriate management actions.	Esteban (Convenor), Bolaños-Jiménez, Carvalho, Consentino, García-Bellido, Genov, Jourdain, Nunny, Pitman, Porter, Rose, Samarra, Sequeira, Simmonds, Smith, Staniland, Ritter, Tixier and Towers. Email: *sogkw@groups.iwc.int*

SC Agenda Item/Sub-Committee	Type	Group (short name)	Terms of Reference	Members
SM/E	ICG	Beaked whales	The ICG will consider: i. harmonised response protocols for beaked whale strandings to ensure that the necessary datasets (e.g. pathology, meteorology prior to the stranding, oceanography, acoustic monitoring, and any information on use of high intensity sound sources) can be rapidly assembled to assist with the identification of the time, location and cause of the mortality event. Identifying which data are required for such an investigation will also highlight data collection gaps which could be prioritised to ensure such data are available when needed; and ii. improved data sharing between countries to better identify and investigate mortality events: and progress further work on beaked whales.	Simmonds (Convenor), Baird, Cholewiak, Fonesca, Iñíguez, Plon, Stimmelmayr, Trujillo and Zerbini. Email: *beakedwhales@groups.iwc.int*
EM	ICG	Best practices for species distribution modelling (SDMs) and multi-species distribution modelling (MSDM)	(1) to finalise the guidelines for single species distribution models (SDMs); (2) to develop guidelines for multi-species distribution models (MSDMs); (3) to continue to conduct a literature review of SDMs and MSDMs; and (4) to develop possible simulation platforms to evaluate SDMs and MSDMs.	Ferguson, Kitakado, Palacios (co-Convenors), Biuw, Burkhardt, Friedlaender, Genov, Herr, Kelly, McKinlay, Miller, New, Palka and Solvang. Email: *msdm@groups.iwc.int*
EM/ASI/SH/NH	ICG	Preparation of estimates of pre-exploitation and current abundance of large whale populations	Provide plausible sets of pre-exploitation and current abundance of populations of relevant large whale species in the Southern Ocean and the North Atlantic from literature and conduct additional analyses if needed.	Kitakado, Givens (co-Convenors), Allison, Biuw, Butterworth, Donovan, Ferguson, Haug, Jackson, Palka, Punt, Robbins, Solvang, Tulloch, Zerbini + CCAMLR and NAMMCO scientists. Email: *pepecalpw@groups.iwc.int*
Item 15.7.1 EM	ICG	Cetacean and ecosystem functioning: a gap analysis workshop	Prepare the 2nd Workshop under a Steering Group.	Kitakado (Convenor), Biuw, Butterworth, Cavanagh, Donovan, Freitas, Frisch- Nwakanma, Galletti, Haug, Porter, Punt, Ritter, Roman, Staniland, Suydam, Virtue and Zerbini + others. Email: *cefgapanawksp@groups.iwc.int*
Item 17.1.2 WW	SG	Modelling and Assessment of Whale Watching Impacts (MAWI) Steering Group	Planning for and distributing the question-naire, analysing the results.	New (Convenor), Baldwin, Cooke, Cosentino, Currie, Forestell, Frey, Jiménez-Assmus, Leaper, Minton, Noren, Parsons, Reyes, Robbins, Rose, C. Smith, Suydam, Vermeulen, Weinrich, Urbán and Webster. Email: *modassmawi@groups.iwc.int*
Item 17.1 WW	ICG	Human-induced behavioural changes of concern	Continue to monitor the relevant literature on, e.g. solitary sociable cetaceans, out of habitat cetaceans; seek to produce a new review of information for the Committee across the whole range of interactions with humans; review appropriate terminology (e.g. 'habituation'); 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, Nunny, Parsons, C. Smith, Suydam, Vail, Wells and Urbán. Email: *hibcc@groups.iwc.int*
Item 17.1 WW	AG	Communication with the Indian Ocean Rim Association (IORA) Advisory Group	Help provide advice to IORA when app-ropriate; facilitate communication between IORA and the sub-committee; and consider ways to promote appropriate training workshops.	Robinson, (Convenor), Baldwin, Iñíguez, New, Parsons, Seakamela, Simmonds, Smith, C., Suydam, Weinrich and Urbán. Email: *commiora@groups.iwc.int*
Item 17.3 WW	ICG	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, Porter (co-Convenors), Noren, Parsons, Rose, Ritter, Suydam and Urbán. Email: *timorlesteww@groups.iwc.int*

SC Agenda Item/Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 17.3.2 WW	ICG	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, Suydam, Urbán and Webster. Email: *riverdolphnint@groups.iwc.int*
Item 17.4.2 WW	ICG	Communication between the CC's SWG WW and WW	Discuss development of better methods for disseminating Committee recommendations and advice on whale watching to the CC (joint with CC); discuss and identify *ex officio* members of the SWG.	Iñíguez (Convenor), Parsons, Rojas-Bracho, Simmonds, Slooten, Suydam and Urbán. Email: *cccomm@groups.iwc.int*
Item 17 WW	SG	Communications plan for outputs of WW and CC SWG	Develop a comprehensive communications plan and budget, to present to the Committee, Conservation Committee and Secretariat at SC/69A.	Rose (Convenor), Parsons, C. Smith and Urbán. Email: *commwwandccswg@groups.iwc.int*
Item 17 WW	ICG	Future of WW	Discuss future work of WW, including, *inter alia*, how to identify key regions or target species for review each year, who to invite as IPs, where and how to solicit primary papers.	Simmonds (Convenor), Parsons, Rojas-Bracho, Rose, Suydam, Truda-Palazzo and Urbán. Em*ail: futureww@groups.iwc.int*
Item 11.3 ASI	SG	Amendment of RMP Guidelines	Develop a set of specific instructions for the amendment of the RMP guidelines to consider model-based abundance estimates.	Staniland (Convenor), Butterworth, Cooke, Donovan, Herr, Kelly, Kitakado, Miller, New, Palka, Punt and Zerbini. Email: *rmpguidelines@groups.iwc.int*
Item 11.4 ASI	SG	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 SC68D for the species/regions identified.	Givens (Convenor), Allison, Branch, Brownell, Butterworth, Cooke, Donovan, Jackson, Katara, New, Palka, Porter, Punt, Staniland, Trujillo, Víkingsson, Walløe, Wilson and Zerbini. Email: *status@groups.iwc.int*
Item 11.6 ASI	ICG	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, Katara, Kelly, Matsuoka, Miyashita, New, Palka and Punt. Email: *npminkeabun@groups.iwc.int*
SM	ICG	Franciscana review	Co-ordinate outcomes of CMP across sub-committees.	Porter and Trujillo (co-Convenors). Email: *franciscana@groups.iwc.int*
SM	ICG	Poorly documented takes of small cetaceans	Continue development of framework for SM work on Aquatic Wildmeat.	Porter (Convenor), Avila, Fisher, Hodgins, Ingram, Katara and Vrooman. *Email: pdtsc@groups.iwc.int*
SM	AG	Small Cetacean Task Team	Provide ongoing advice and support to established Task Teams and consider any new proposals.	Simmonds (Convenor), Donovan, Genov, Parsons, Porter, Reeves, Rojas-Bracho, Staniland, Thomas and Trujillo. Email: *smallcetaceantaskteam@groups.iwc.int*
SM	ICG	*Sotalia guianensis*	Continue review of the Guiana dolphin (*Sotalia guianensis)*	Domit (Convenor), Caballero, Florez-Torres, Porter, Sousa-Lima, Trujillo and Zerbini. Email: *sotaliaworkshop@groups.iwc.int*
SM	ICG	SM Review of Recommendations	Make progress on a review framework and propose a mechanism to establish regional and species assessment teams.	Trujillo (Convenor), Couto di Tullio, Fortuna, Hines, Iñíguez, Jimenez, Natoli, Porter, Scheidat, Slooten, Vrooman, Webster and Zerbini. Email: *smrevrec@groups.iwc.int*
SM	ICG	Lahille's Dolphin Task Team	Develop research priorities for the next 5 years and identify funding opportunities.	Vermeulen, Fruet (co-Convenors), Berninsone, Coscarella, Daura-Jorge, Iñíguez, Laporta, Smith and Von Fersen. Email: *lahilles@groups.iwc.int*
SM	ICG	Direct takes	Make progress on the analyses of the direct take data of small cetaceans compiled by the SC since 1977.	Porter (Convenor), Fisher, Fortuna, Hodkins and Katara. Email: *directtakes@groups.iwc.int*
SM	ICG	*Tursiops* taxonomy	Develop *Tursiops* taxonomy database and monitor new publications related to this issue.	Cipriano (Convenor), Natoli and Rosel. Email: *turtax@groups.iwc.int*
SM	AG	Management of the Solitary Sociable Dolphin in Northwest Spain (AG)	The AG will continue to assess information pertaining to the dolphin and its' interactions, providing advice to the Government of Spain, if requested and through established communication plan, address any significant developments as quickly and efficiently as possible.	Simmonds (Convenor), Capdevila, Eisfeld-Pierantonio, Fernandez, García-Bellido, Garcia-Párraga, Nunny, O'Callaghan, Porter, Staniland and Torres. Email: *mssdns@groups.iwc.int*

SC Agenda Item/Sub-Committee	Type	Group (short name)	Terms of Reference	Members
SM	ICG	The South Pacific Island SM Group	To come.	Porter (Convenor), Amepou, Beasley, Baird, K., Baird, R., Baker, Bell, Childerhouse, Constantine, Fisher, Garrigue, Hines, Katara, Lawrence, Lundquist, Oremus, Poole, Stockin, Slooten and Trujillo. Email: *spisland@groups.iwc.int*
GDR	ICG	GDR workshop planning	- Review data collection procedures across the IWC identifying need, use and overlap with external data holdings. In particular seek ways that processes can be simplified, and streamlined, to increase submission rates and minimise duplication of effort. [with a focus on National Progress Reporting]. - Scope areas of potential integration and consolidation of current IWC databases and report on their status. - Define rules/expectations surrounding data accessibility for databases with different levels of IWC support. - Review any new database requests from SC68D.	Andrews-Goff, Fortuna, Hielscher, Iñíguez, Katara, Ki Sow, Lauriano, Mattila, O'Loughlin, Øien, Reeves, Staniland and Tandy. Email: *gdrplan@groups.iwc.int*
Item 13 HIM	ICG	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, Double, Fortuna, Herr, Hines, Holm, Livermore, Mattila, O'Loughlin, Panigada, Ritter, Rowles and Weinrich. Email: *ssdatareview@groups.iwc.int*
Item 13 HIM	ICG-	Ships Routeing Group	Consider how best to respond to requests for advice on routeing measures.	Leaper (Convenor), Bjørge, Donovan, George, Mattila, Panigada, Rojas-Bracho and Webster. Email: *shipsrouteing@groups.iwc.int*
12.9 HIM	ICG	Pinger interference advice group	Collaboration with Baltic range states and European Commission on technical issues associated with acoustic interference of military activities by pingers.	Carlen (Convenor), Bell, Berggren, Bjørge, Cosentino, Dolman, Leaper, Parsons, Plön Ritter, Simmonds and Staniland. Email: *pinger@groups.iwc.int*
12.8 HIM/IST	ICG	R_{max} Group	Develop a list of potential methods for estimating/setting R_{max} and an evaluation of the data requirements, strengths, and weaknesses of each approach.	Wilberg (Convenor), Butterworth, Cipriano, DeMaster, Donovan, Jackson, Lang, Mizroch, Punt, Slooten, Wade and Zerbini. Email: *rmax@groups.iwc.int*
HIM/SM	ICG	Small cetacean disentanglement	Develop best practice protocols for releasing free-swimming, entangled small cetaceans.	Minton (Convenor), Aranha, Baird, Genov, Kolesnikovas, Marmontel, Mattila, Porter, Renell, Rojas-Bracho, Simmonds, Trujillo and Wells. Email: *smerg@groups.iwc.int*
HIM	ICG	Krill fishery bycatch	Collaboration with CCAMLR on bycatch in Southern Ocean krill fishery.	Leaper (Convenor), Biuw, Favero, Johnson, Heinemann, Hines, Landry, Mattila, Meyer, Parker, Reeves, Söffker, Stimmelmayr and Walker. Email: *krill@groups.iwc.int*
HIM/SM	ICG	Steering group for Hector's and Māui dolphins spatial risk assessment	Organise reviews of topics related to spatial risk assessment for Hector's and Māui dolphins in New Zealand, including pre-meeting.	Staniland (Convenor), Cholewiak, DeMaster, Genov, Leaper, Minton, Porter, Suydam, Trujillo and Zerbini. Email: *hecmaui@groups.iwc.int*
ALL	SG	Group to assist the SC to transition to new budget and meeting schedules	1. Assist the Committee in planning for a new reduced budget scenario and a revised meeting structure once the Commission agrees on a new budget for the IWC. 2. Provide advice to the Commission with respect to: - the existing SC meeting format and possible changes to optimise a new meeting schedule, - the use of the SC Research budget to support virtual meetings and in-person meetings, - the alignment of SC and Commission; and - meetings should the SC meeting schedule change.	Zerbini, Porter, Bartmeier, Bjørge, Choi, Double, Fortuna, Iñíguez, Nelson, Palka, Seakamela, Sigurðsson, Stachowitsch, Staniland and Tandy. Email: *scbudget@groups.iwc.int*

SC Agenda Item/Sub-Committee	Type	Group (short name)	Terms of Reference	Members
4.12	SG	IUCN/IWC Coordination Group	(1) Develop a process to enhance coordination among IUCN, the IWC SC, and other relevant parties involved in conservation actions for cetaceans. (2) Facilitate coordination between those responsible for managing IUCN Red List assessments for cetaceans and developers of the IWC Status of Stocks Initiative, including: (a) providing input to the Status of Stocks Steering Group regarding prioritisation of cases to consider; (b) assisting the Status of Stocks Group on Language, terminology, and content development in drafting website text for comparison of IUCN Red List and IWC Status of Stocks assessments; and (c) advising all groups working on this project, as necessary, to help avoid duplication of effort, the appearance of conflicting results and public confusion about whale statuses.	Braulik, Porter (co-Convenors), Abel, Allison, Andriolo, Cipriano, Cooke, Donovan, Fortuna, Givens, New, Panigada, Punt, Reeves, Sigurðsson, Staniland, Taylor, Trujillo, and Zerbini. Email: *iucniwc@groups.iwc.int*

Annex N
Database Request Proforma

This proforma is to be used for new database requests, and major alterations to existing databases.

Date	Request type	Related sub-committee
New database/alteration (delete as appropriate)		

1. Database title
Please provide the title of the database.

2. Brief overview of the database or alteration
Give a very brief overview on your proposal and its expected usage within the IWC community. Be succinct and clear as this may be used to summarise your request in a report.

3. Identified scope and usage within the IWC and its committees
Please explain what data the database will hold, and how the database will be used within the IWC and its committees; to what questions of importance to the IWC will this database contribute?

4. Proposed database schema or architecture
Please provide an overview of the proposed database schema or architecture. Where possible, please consider providing an entity relationship diagram.

5. Interaction with other databases
Will the database be required to interact with any other databases or applications?

6. How will the data be populated?
Please explain how the data will be populated. Please consider the following: will the data be entered by the public or a select group? Will the data be verified after entry? Will it be web or mobile accessible?

7. Scale of use
Please provide a description of likely scale and frequency of use and the preferred approach to accessing and interaction with the database.

8. Other similar databases
Please list any other databases that capture similar data either within the IWC or externally.

9. Timetable for key planning activities

Activity to be undertaken	Key person(s)	Start (mm/yy)	Finish (mm/yy)

10. Proposed completion dates

Expected outputs	Completion data (mm/yy)

11. Associated people

Name	Affiliation	Role within database

12. Data ownership and sharing
Please state your expected data availability arrangements including data ownership and data sharing agreements.

13. Total costs

Please provide a breakdown of costs. These may require discussion within the IWC Secretariat.

Type	Description	Cost (GBP)
Planning costs (e.g. travel/subsistence)		
Development costs (e.g. salaries, contractors, software)		
Ongoing costs (e.g. servers, back-ups, maintenance)		
Equipment costs		
Expected ongoing data co-ordinator costs		
Expected ongoing and one-off data entry costs		
Other costs		
Total		

14. Funds and contributions

Please provide details of any existing funds or potential contributions

Type	Description	Cost (GBP)
Existing funds		
Potential contributions		
Total		

15. Have you read and agree to the IWC Database Guidelines? (please tick)

The guidelines can be found at the end of this pro forma. To ensure you have the latest version please contact the IWC Secretariat.

Yes	
No	

IWC DATABASE GUIDELINES VERSION 2017.05

To standardise the creation of databases, repositories, catalogues and applications, the following guidelines should be adhered to.

- All new scientific database requests must be submitted to the scientific committee for discussion, approval, prioritisation and funding. This must be submitted using a database proforma **after** being discussed by the relevant sub-committee.
- All agreed development work will be overseen by the IWC Secretariat, and the Committee where specific input is needed.
- Where possible, all databases must use open source software.
- Programming languages, database engines and other technologies used must be discussed and agreed with IWC Secretariat to minimise development, infrastructure and maintenance costs.
- All completed source code and database schemas must be provided to and held by the IWC Secretariat.
- All databases will have a 5-year review cycle to ensure code and databases are kept up-to-date and secure.
- Where appropriate, new databases should be developed in a way that will allow expansion and interaction from other databases and applications. This is to be discussed with the IWC Secretariat.
- Where user accounts are required, they should be authenticated by a central IWC authentication server to minimise login credentials for users of multiple databases.

Annex O

Status of DNA Registers

ANNEX O1

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 individual's 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 (2008-21), as well as from commercial North Atlantic fin whale catches have been genotyped and information stored in the database.

Footnote no.	1	2	3	4	5	6	7	8	9	10	11	12
Species/Year	Type	No. whales	No. duplicate	No. missing	No. lab problem	No. mtDNA	% mtDNA	No. msat	% msat	Sex analysed	% sexed	Note
North Atlantic minke whale												
2003-07	SP	196	0	0	0	195	99	196	100	196	100	
2008-20	C	442	0	0	0	400	90	402	91	396	89	
2021	C	1	0	0	0	0	0	0	0	0	0	
North Atlantic 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.

ANNEX O2

AN UPDATE OF THE JAPANESE REGISTER FOR LARGE WHALES

Mutsuo Goto and Mioko Taguchi

Institute of Cetacean Research, 4-5 Toyomi-cho, Chuo-ku, Tokyo 104-0055, Japan

INTRODUCTION

The technical specifications and the status of the Japanese DNA register for large whales was presented and discussed during the 2005 International Whaling Commission (IWC SC) meeting (IWC, 2006). Since then, the number of genetic samples and the number of individuals analyzed and registered have been reported to the IWC SC annual meetings. The annual reports have included information of whales taken by former special scientific permits in the North Pacific (JARPN/JARPNII and NEWREP-NP) and Antarctic (JARPA/JARPAII and NEWREP-A), the commercial whaling in the North Pacific, and bycatches.

It should be noted that the special scientific permit takes under NEWREP-A and NEWREP-NP programs were terminated in June 2019 as an effect of the withdrawal of Japan from the International Convention for the Regulation of Whaling (ICRW) on 30 June 2019. From 1 July 2019, commercial whaling within Japan's Exclusive Economic Zone (EEZ) was started, and samples taken have been registered in the Japanese DNA register. The Japanese regulation on bycatches of large whales (established from 1 July 2001) requires that all animals should be registered with a DNA profile before any products derived from a bycaught animal are sold in the market.

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 2021 is shown in Table 1.

REFERENCES

International Whaling Commission. 2006. Report of the Working Group on DNA testing. *J. Cetacean Res. Manage. (Suppl.)* 8: 252-258.

Kanda, N., Goto, M., Oikawa, H. and Pastene, L.A. 2014. Update of note on sampling and laboratory procedure protocols of the genetic work at the Institute of Cetacean Research (SC/65b/J27Rev). Paper SC/65b/DNA01 presented to the IWC Scientific Committee, May 2014 (unpublished). 6pp.

[Table 1 on next page]

Table 1

The update of the Japanese DNA register for large whales till 2021.

Footnote no.	1	2	3	4	5	6	7	8	9	10	11	12
Species/Year	Type	No. whales	No. duplicate	No. missing	No. lab problem	No. mtDNA	% mtDNA	No. msat	% msat	Sex analysed	% sexed	Note
North Pacific minke whale												
1994-2019	SP	3,057	0	0	8	3,049	99.7	3,049	99.7	3,057	100	
2019-20	CW	139	0	0	0	139	100	139	100	139	100	
2021	CW	91	0	0	0	91	100	91	100	91	100	
2001-20	BC	2,434	0	26	2	2,434	100	2,406	98.8	2,404	98.8	
2021	BC	80	0	0	0	80	100	80	100	80	100	
North Pacific sei whale												
2002-18	SP	1,622	0	0	4	1,618	99.8	1,622	100	1,622	100	
2019-20	CW	50	0	0	0	50	100	50	100	50	100	
2021	CW	25	0	0	0	25	100	25	100	25	100	
2001-20	BC	1	0	0	0	1	100	1	100	1	100	
2021	BC	1	0	0	0	1	100	1	100	1	100	
North Pacific Bryde's whale												
2000-17	SP	730	0	0	3	727	99.6	730	100	730	100	
2019-20	CW	374	0	0	0	374	100	374	100	374	100	
2021	CW	187	0	0	0	187	100	187	100	187	100	
2001-20	BC	5	0	0	0	5	100	4	80	4	80	Include three Omura's whale and one from the East China Sea stock
2021	BC	0	0	0	0	0	0	0	0	0	0	No BC
North Pacific humpback whale												
2001-20	BC	72	0	0	0	72	100	72	100	72	100	
2021	BC	0	0	0	0	0	0	0	0	0	0	No BC
North Pacific right whale												
2001-20	BC	4	0	1	0	4	100	3	75	3	75	One is missing by the 2011 tsunami, no microsats
2021	BC	0	0	0	0	0	0	0	0	0	0	No BC
North Pacific fin whale												
2001-20	BC	12	0	0	0	12	100	12	100	12	100	
2021	BC	2	0	0	0	2	100	2	100	2	100	
North Pacific sperm whale												
2000-17	SP	56	0	0	0	56	100	56	100	56	100	
2001-20	BC	2	0	0	0	2	100	2	100	2	100	
2021	BC	0	0	0	0	0	0	0	0	0	0	No BC
Antarctic minke whale												
1987/88-2004/05	SP	6,794	0	10	0	1,118	16.5	6,271	92.3	6,794	100	Incl. dwarf; 87/88-88/89. no microsats
2005/06-2018/19	SP	5,216	0	549	162	3,977	76.2	4,505	86.4	5,216	100	Some missing by the 3/11 tsunami in 2011
Antarctic fin whale												
2005/06-2011/12	SP	18	0	0	0	18	100	18	100	18	100	

1. Key to sample types: SP=special permit catch, CW=commercial catch, BC=bycatch.
2. Number of whales that potentially entered by the previous years and enters (new year) the markets.
3. Number of occurrences (tissues) sample switching on board the vessels as detected by comparison of genetic profiles.
4. Number of individuals for which tissue samples are missing for other reasons than sample switching.
5. Genetic laboratory not able to obtain microsatellite profiles mtDNA haplotypes from tissue samples.
6. Number of samples analysed for mitochondrial control region.
7. % of total samples analysed for mitochondrial control region.
8. Number of samples analysed for microsatellites.
9. % of total samples analysed for microsatellites.
10. Number of samples analysed for sex.
11. % of total samples analysed for sex.
12. Other problems or information.

Annex P

List of Recommendations Relating to Hector's and Māui Dolphins

Children	Number	Year	Text
	SC1201	2012	The Committee expresses particular concern about the low abundance of Māui's dolphins (North Island subspecies of Hector's dolphin). The latest abundance estimate of 55 individuals over one year old (CV 0.15) was calculated from a genetic mark-recapture analysis (Hamner *et al.*, 2012). The Committee recommends the immediate implementation of the proposal by the New Zealand Ministry for Primary Industries to extend the North Island protected area to approximately 80km south of the latest dolphin bycatch site (Maunganui Bluff to Hawera), offshore to the 100m depth contour, including the harbours, for gillnet and trawl fisheries. This would protect part of an area with high gillnet and trawl fishing effort between the North and South Islands. Further population fragmentation could be avoided by also protecting the north coast of the South Island, providing safe 'corridors' between North and South Island populations (Hamner *et al.*, 2012). Adequate observer coverage across all inshore trawl and gillnet fisheries is important in order to obtain robust scientific data on continuing bycatch as a means of assessing the effectiveness of protection measures.
	SC1301	2013	The Committee agrees that management measures must be precautionary. If any fisheries with the potential for bycatch were to remain active within the range of Māui's dolphins, 100% observer coverage would maximise the chance of identifying any bycatch and providing information that might trigger immediate further area closures. In conclusion, the Committee reiterates its extreme concern about the survival of Māui's dolphin given the evidence of population decline, contraction of range and low current abundance. The Committee agrees that the human-caused death of even one dolphin in such a small population would increase the extinction risk for this subspecies.
	SC1302	2013	The Committee therefore recommends that rather than seeking further scientific evidence, the highest priority should be given to immediate management actions that will lead to the elimination of bycatch of Māui's dolphins. This includes full closures of any fisheries within the range of Māui's dolphins that are known to pose a risk of bycatch of small cetaceans.
	SC1303	2013	The Committee commends the New Zealand Government on its initial and interim measures to protect Māui's dolphins. However, the Committee emphasises that the critically endangered status of this sub-species and the inherent and irresolvable uncertainty surrounding information on small populations require the immediate implementation of precautionary measures. Ensuring full protection of Māui's dolphins in all areas throughout their habitat, together with an ample buffer zone, will minimise the risk of bycatch and maximise the chances of population increase.
	SC1413	2014	The Committee commends the New Zealand Government for maintaining initial and interim protection measures for Māui's dolphin, and adding an additional 350 sq. km set net restriction. However, the Committee emphasises that these measures fall significantly short of those previously recommended (IWC, 2013; 2014). The Committee reiterates its extreme concern about the continued decline of such a small population as the human-induced death of even one dolphin would increase the extinction risk for this subspecies. It also reiterates that rather than seeking further scientific evidence it is of highest priority to take immediate management actions that will eliminate bycatch of Māui's dolphins. This includes full closures of any fisheries within the range of Māui's dolphins that are known to pose a risk of bycatch of small cetaceans (i.e. set net and trawl fisheries).
	SC1414	2014	The Committee re-emphasises that the critically endangered status of Māui's dolphin and the inherent and irresolvable uncertainty surrounding information on small populations, require the implementation of precautionary measures. Ensuring full protection of Māui's dolphins in all areas throughout their habitat, together with an ample buffer zone, would minimise the risk of bycatch and maximise the chances of population increase.
	SC1415	2014	The Committee notes that the current range of Māui's dolphins comprises the area from Maunganui Bluff in the north to Whanganui in the south, offshore to 20n.miles and including harbours. This range reflects all available sightings and strandings data for Māui's and Hector's dolphins along the West Coast of the North Island. The Committee notes that data from Hector's dolphins off the South Island, with most sightings in waters less than 100m deep and less than 20n. miles offshore support our understanding of the offshore distribution of Māui's dolphins and the recommendation that within this defined area, fishing methods other than set nets and trawling should be used.
	SC1416	2014	The Committee urges the New Zealand Government to commit to specific population increase targets and timelines, and respectfully requests that reports be provided annually on progress towards conservation goals.
	SC1501	2015	Given the information presented this year, the Committee concludes, again, that existing management measures in relation to bycatch mitigation fall short of its previous recommendations and expresses grave concern over the status of this small population. The human-caused death of even one individual would increase the extinction risk for this subspecies. It reiterates its previous recommendation that highest priority should be assigned to immediate management actions to eliminate bycatch of Māui dolphins. This includes closures of any fisheries within the range of Māui dolphins that are known to pose a risk of bycatch to dolphins (i.e. set net and trawl fisheries).
	SC1502	2015	It re-emphasises that the critically endangered status of this population and the inherent and irresolvable uncertainty surrounding information on small populations point to the need for precautionary measures. Ensuring full protection of Māui dolphins throughout their known range, together with an ample buffer zone, would minimise the risk of bycatch and maximise the chances of population increase.

Children	Number	Year	Text
	SC1503	2015	The Committee notes that the confirmed current range extends from Maunganui Bluff in the north to Whanganui in the south, offshore to 20 n.miles and included harbours. Within this defined area, fishing methods other than set nets and trawling should be used.
	SC1504	2015	The Committee again urges the New Zealand Government to commit to specific population increase targets and timelines, and again, respectfully requests that reports be provided annually on progress towards conservation goals.
	SC16299	2016	The Committee notes the intensive work undertaken since last year to review the aerial survey data and analyses from New Zealand. The Committee endorses the abundance estimate for Hector's dolphins around the South Island, New Zealand (excluding sounds and harbours) of 14,849 (CV: 11%; 95% CI 11,923-18,492) and considers it reasonable to inform management. The Committee also encourages further work to consider the suggestions and recommendations in Annex M, appendix 2 on how to improve aerial survey methods generally.
	SC16300	2016	The Committee welcomes the update on research on Māui dolphins provided but noted that no new management actions had been enacted since 2013. Given the information presented this year, the Committee concludes, as it has repeatedly in the past, that existing management measures in relation to bycatch mitigation fall short of what has been recommended previously and expresses continued grave concern over the status of this small, severely depleted subspecies. The human-caused death of even one individual will increase the extinction risk.
	SC16301	2016	The Committee: (a) re-emphasises that the critically endangered status of this subspecies and the inherent and irresolvable uncertainty surrounding information on most small populations point to the need for precautionary management; (b) reiterates its previous recommendation that highest priority should be assigned to immediate management actions to eliminate bycatch of Māui dolphins including closures of any fisheries within the range of Māui dolphins that are known to pose a risk of bycatch to dolphins (i.e. set net and trawl fisheries); and (c) notes that the confirmed current range extends from Maunganui Bluff in the north to Whanganui in the south, offshore to 20 n.miles, and it includes harbours - within this defined area, fishing methods other than set nets and trawling should be used.
	SC16302	2016	The Committee again respectfully urges the New Zealand Government to commit to specific population increase targets and timelines for Māui dolphin conservation, and again respectfully requests that reports be provided annually on progress towards the conservation and recovery goals.
	SC17327	2017	The Committee agrees that the evidence presented suggests that longlines are a potential alternative to reduce risk from the set nets and trawling currently associated with bycatch of Māui dolphin and that this should be investigated. It recognises that Government support is required to develop and implement such alternatives and assess any associated impacts on target catch or other marine species.
SC17386, SC17387, SC17388, SC17389	SC17385	2017	The Committee notes that no new management action regarding the Māui dolphin has been enacted since 2013. It therefore concludes, as it has repeatedly in the past, that existing management measures in relation to bycatch mitigation fall short of what has been recommended previously and expresses continued grave concern over the status of this small, severely depleted subspecies. The human-caused death of even one individual would increase the extinction risk. In addition, the Committee: (1) welcomes the update on research on Māui dolphins provided and looks forward to receiving the final report on the updated marine mammal risk assessment in 2018.
	SC17386	2017	The Committee: (2) notes with interest the reported fishing industry initiatives to reduce the use of potentially entangling gear in the range of Māui dolphins which are discussed in Leathers and Leslie (2017).
	SC17387	2017	The Committee: (3) re-emphasises that the critically endangered status of this [Māui dolphin] subspecies and the inherent and irresolvable uncertainty surrounding information on most small populations point to the need for precautionary management.
	SC17388	2017	The Committee: (4) reiterates its previous recommendation that highest priority should be assigned to immediate management actions to eliminate bycatch of Māui dolphins including closures of any fisheries within the range of Māui dolphins that are known to pose a risk of bycatch to dolphins (i.e. set net and trawl fisheries).
	SC17389	2017	The Committee: (5) notes that the confirmed current range extends from Maunganui Bluff in the north to Whanganui in the south, offshore to 20n.miles, and it includes harbours - within this defined area, fishing methods other than set nets and trawling should be used; and (6) respectfully urges the New Zealand Government to commit to specific population increase targets and timelines for Māui dolphin conservation, and again respectfully requests that reports be provided annually on progress towards the conservation and recovery goals.
	SC18172	2018	The Committee notes that no new management action regarding the Māui dolphin has been enacted since 2013. It therefore concludes, as it has repeatedly in the past, that existing management measures in relation to bycatch mitigation fall short of what has been recommended previously and expresses continued grave concern over the status of this small, severely depleted subspecies. The human-caused death of even one individual would increase the extinction risk.
SC18172, SC18174, SC18175, SC18176, SC18177	SC18173	2018	The Committee reiterates its previous recommendation that highest priority should be assigned to immediate management actions to eliminate bycatch of Māui dolphins including closures of any fisheries within the range of Māui dolphins that are known to pose a risk of bycatch to dolphins (i.e. set net and trawl fisheries). It re-emphasises that the critically endangered status of this subspecies and the inherent and irresolvable uncertainty surrounding information on most small populations point to the need for precautionary management.

Children	Number	Year	Text
	SC18174	2018	The Committee notes that the confirmed current range extends from Maunganui Bluff in the north to Whanganui in the south, offshore to 20n.miles, and it includes harbours - within this defined area, fishing methods other than set nets and trawling should be used.
	SC18175	2018	The Committee welcomes the update on Māui dolphins provided and looks forward to receiving the species-specific, spatially explicit, multi-threat risk assessment in 2019.
	SC18176	2018	The Committee respectfully encourages the New Zealand; Government to commit to specific population increase targets and timelines for Māui dolphin conservation.
	SC18177	2018	The Committee respectfully requests that reports be provided on progress towards the conservation and recovery goals as updates become available.
	SC19112	2019	The Committee reiterates last year's recommendations (Hamner *et al.*, 2012; IWC, 2019, p.17), given its continued grave concerns regarding Māui dolphins. The Committee thanks the Government of New Zealand for bringing forward the spatial risk assessment model for Māui and Hector's dolphins presented in Roberts *et al.* (2019). However, in order provide a rigorous evaluation of the approach and its outputs, the Committee recommends that an intersessional Working Group (Annex T) be convened to provide a thorough, independent review of the spatial risk assessment model. The Terms of Reference would include the preparation of solicited review papers on the information and analysis presented in Roberts *et al.* (2019) on: (a) Māui and Hector's dolphins' life history parameters; (b) Māui and Hector's dolphins' spatial distribution; (c) estimates of bycatch rates and vulnerability; (d) toxoplasmosis; and (e) the risk model outputs. A Steering Group of individuals from the Committee would be convened to coordinate the review process and identify individuals for the Review Panel. The Review Panel will consist of five independent experts with backgrounds appropriate to topics a-e above, and who are able to carry out a comprehensive review in their area of expertise. No individual on the Steering Group will also serve on the Review Panel to avoid any perceived conflict of interest. Further, in order to ensure the independence of the review and its process, in both perception and reality, no member of the Review Panel or the Steering Group will be associated with Roberts *et al.* (2019), Cooke *et al.* (2019) or Slooten *et al.* (2019). The results of the Review Panel's independent reviews would be discussed in a two-day pre- meeting to the 2020 Annual Meeting. All conclusions will be presented to the Committee in SC/68B for further discussion, and any decisions with regards to existing or future recommendations will be made at that time. The Committee encourages the Government of New Zealand to work with the Committee to consider how to support the independent reviewers and the pre-meeting needed to achieve a rigorous review and evaluation of the spatial risk assessment model presented in Roberts *et al.* (2019). The recommendations above are additional to, and do not supplant, the recommendations made by the Committee last year (IWC, 2019, p.17), including closures of any fisheries within the range of Māui dolphins that are known to pose a risk of bycatch to dolphins (i.e. set net and trawl fisheries).
	SC19113	2019	The Committee recommends that further research be carried out to better understand the source and potential risk of toxoplasmosis, as well as approaches to its mitigation, as it relates to Māui and Hector's dolphins, particularly as toxoplasmosis would compound the threat posed by bycatch. Given the link between the review on toxoplasmosis in Māui and Hector's dolphins and the planned Environmental Concerns focus session on toxoplasmosis at the 2020 Annual Meeting, the Committee agrees that there is a need for coordination in the selection of the expert reviewer for toxoplasmosis and that individual's participation across both fora.
	SC2155	2021	[Concerning threat assessment for Hector's and Māui's dolphins] Based on the reviews (Item 12.8.1), the Committee recommended scheduling a pre-meeting immediately prior to SC68D to: (1) evaluate the design and structure of the multi-threat risk assessment model; (2) evaluate the overall sensitivity to model choices, data selection, uncertainties or potential biases identified in the review papers; and (3) make recommendations to reduce key uncertainties and improve the utility of the model to inform management decisions.

REFERENCES

Cooke, J., Constantine, R., Hamner, R.M., Steel, D. and Baker, C.S. 2019. Population dynamic modeling of the Māui dolphin based on genotype capture-recapture with projections involving bycatch and disease risk. New Zealand Aquatic Environment and Biodiversity Report No. 216. 38 pp. [Available at: *www.mpi.govt.nz/news-and-resources/publications*].

Hamner, R., Oremus, M., Stanley, M., Brown, P., Constantine, R. and Baker, C. 2012. Estimating the abundance and effective population size of Māui's dolphins using microsatellite genotypes in 2010-11, with retrospective matching to 2001-07. Report to the Department of Conservation, Auckland. 44pp.

International Whaling Commission. 2013. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 14:1-86.

International Whaling Commission. 2014. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 15:1-75.

International Whaling Commission. 2019. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 20:1-78.

Leathers, A. and Leslie, A. 2017. Gear switching to remove threats to Māui dolphin and address the socio-economic barriers to effective conservation. Paper SC/67a/HIM12 presented to the IWC Scientific Committee, May 2017, Bled, Slovenia (unpublished). 17pp. [Paper available from the Office of this Journal].

Roberts, J.O., Webber, D.N., Goetz, K.T., Edwards, C.T.T., Roe, W.D. and Doonan, I.J. 2019. Spatial risk assessment of threats to Hector's and Māui dolphins (*Cephalorhynchus hectori*). New Zealand Aquatic Environment and Biodiversity Report: 169.

Slooten, E., Dawson, S.M. and Brough, T. 2019. Update on New Zealand dolphins and fisheries. Paper SC/68A/HIM/05 presented to the IWC Scientific Committee, May 2019, Nairobi, Kenya (unpublished). 32pp. [Paper available from the Office of this Journal].

Annex Q

Recommendations for Vaquitas

Children	Number	Text	Type	Year	Commission body	Endorsed	Commission endorsed at
	SC16291	Recalling what happened with the Baiji, the members of the Committee are deeply upset that the vaquita could actually become extinct in a very short time. The Committee first became concerned about the status of the vaquita more than 40 years ago (IWC, 1975), and has with increasing severity repeatedly recommended elimination of gillnets to reduce bycatch to zero. The only hope at this stage is that the Mexican government will move quickly and decisively to make the two-year partial gillnet ban permanent before it expires in less than a year (May 2017), and that enforcement is strengthened to the maximum possible extent. The choice is simple and stark: either gillnetting in the Upper Gulf ends or the vaquita will be gone - the second entirely preventable cetacean extinction that the Committee will have witnessed in the last ten years. The Committee recognises with dismay the critical nature of the situation expressed in the CIRVA-7 report (see Annex M, appendix 4 [online only], strongly endorses and adopts its recommendations and urges their immediate implementation.	Recommendation	2016	Scientific Committee, Sub-Committee on Small Cetaceans	Yes	IWC66
SC16291	SC16292	The Committee views with alarm the recent escalation of the illegal totoaba fishery and illegal international trade of totoaba swim bladders, which has continued despite the strong enforcement efforts in the Upper Gulf of California. The Committee recommends and reiterates that: (a) as a matter of utmost urgency, enforcement efforts are strengthened, against both illegal fishing in Mexico and totoaba smuggling out of Mexico and into transit and destination countries; (c) the Governments of Mexico and the United States consult closely on the continuing illegal international trade in CITES Appendix I totoaba, noting the opportunity afforded by the CITES Conference of Parties (CoP) later in 2016 to further address the additional losses of the critically endangered vaquita caused by this trade; (d) the illegal trade is also being progressed through the territories of other nations - it calls on those these nations to do everything in their power to interdict it with the goal of enhancing both enforcement and awareness;	Recommendation	2016	Scientific Committee, Sub-Committee on Small Cetaceans	Yes	IWC66
SC16291	SC16293	The Committee views with alarm the recent escalation of the illegal totoaba fishery and illegal international trade of totoaba swim bladders, which has continued despite the strong enforcement efforts in the Upper Gulf of California. The Committee recommends and reiterates that: (b) there is an urgent need to remove active and ghost gillnets from the range of the vaquita - this is an insidious, invisible and existing threat;	Recommendation	2016	Scientific Committee, Sub-Committee on Small Cetaceans	Yes	IWC66
SC16291	SC16294	The Committee views with alarm the recent escalation of the illegal totoaba fishery and illegal international trade of totoaba swim bladders, which has continued despite the strong enforcement efforts in the Upper Gulf of California. The Committee recommends and reiterates that: (e) the IWC Executive Secretary send letters to the CITES Secretariat and to appropriate Chinese authorities expressing the Commission's strong concern about the impact of the illegal totoaba trade on the vaquita;	Recommendation	2016	Scientific Committee, Sub-Committee on Small Cetaceans	Yes	IWC66
SC16291	SC16295	The Committee views with alarm the recent escalation of the illegal totoaba fishery and illegal international trade of totoaba swim bladders, which has continued despite the strong enforcement efforts in the Upper Gulf of California. The Committee recommends and reiterates that: (f) it is essential to maintain, properly funded, the acoustic monitoring programme as a key action in support of any recovery strategy.	Recommendation	2016	Scientific Committee, Sub-Committee on Small Cetaceans	Yes	IWC66

Children	Number	Text	Type	Year	Commission body	Endorsed	Commission endorsed at
SC16291	SC16296	The Committee respectfully requests that the Government of Mexico provide a report to SC/67a on further vaquita conservation efforts.	Recommendation	2016	Scientific Committee, Sub-Committee on Small Cetaceans	Yes	IWC66
	SC17361	The continued decline of the vaquita raises fundamental questions on how the recommendations of the Scientific Committee are communicated. The Committee recommends that the joint Conservation Committee/Scientific Committee Working Group considers the challenges associated with effectively communicating and implementing urgent conservation recommendations, particularly with respect to vaquita.	Recommendation	2017	Scientific Committee, Sub-committee on Small Cetaceans	Yes	IWC67
SC17391, SC17392, SC17393, SC17394, SC17395	SC17390	The Committee expresses its disappointment and frustration that, despite almost two decades of repeated warnings and the significant efforts made to protect vaquitas, the species continues to be on a rapid path towards extinction. The Committee is gravely concerned about the estimate that only 30 individuals remained as of November 2016, the news that 5 dead vaquitas were recovered during March/April 2017, and the fact that conservation measures have been ineffective and insufficient. Therefore, the Committee repeats the recommendations it made in 2016 and unreservedly endorses and adopts the recommendations made in the CIRVA-8 and CIRVA-9 reports (see SC/67A/SM/11 and SC/67A/SM/14) [(Rojas-Bracho, 2017a; 2017b)]. Given the extreme urgency of the situation, and the immediate extinction risk to the vaquita, the Committee: (1) recommends that the Government of Mexico ensures that the current ban on gillnets in the northern Gulf of California does not lapse, is effectively enforced and is made permanent, and that this ban is extended to include the possession and sale of gillnets throughout the immediate area.	Recommendation	2017	Scientific Committee, Sub-committee on Small Cetaceans	Yes	IWC67
	SC17391	The Committee recommends that the appropriate authority in Mexico further develop and permit the use of 'vaquita safe' fishing gears as a matter of urgency, and provide incentives for their immediate and full uptake.	Recommendation	2017	Scientific Committee, Sub-committee on Small Cetaceans	Yes	IWC67
	SC17392	The Committee commends the Government of Mexico for its attention and response to the CIRVA findings and respectfully requests that reports continue to be provided annually to the IWC Scientific Committee on actions and progress towards conservation and recovery goals for the vaquita.	Recommendation	2017	Scientific Committee, Sub-committee on Small Cetaceans	Yes	IWC67
	SC17393	The Committee requests that the Secretariat write to all IWC Commissioners to: (a) provide an update on the vaquita situation (including describing the species' status based on information reviewed by the SC at SC67a); (b) re-emphasise the commitments made under IWC Resolution 2016-5 [(IWC, 2017)]; (c) summarise the recommendations made by the SC over the last 20 years; and (d) urge them to raise this issue as a matter of urgency through the appropriate diplomatic channels;	Recommendation	2017	Scientific Committee, Sub-committee on Small Cetaceans	Yes	IWC67
	SC17394	The Committee recommends that members liaise with their Governments to raise the profile of the vaquita and identify and pursue wider international engagement opportunities such as through efforts to achieve the UN Sustainable Development Goals (SDG14).	Recommendation	2017	Scientific Committee, Sub-committee on Small Cetaceans	Yes	IWC67
	SC17395	The Committee noting that the demise of the vaquita is being driven by the high demand for totoaba swim bladders in international markets, requests that the IWC Secretariat send a written appeal to the CITES Secretariat to facilitate immediate action in addressing the illegal international trade in swim bladders from totoaba, an Appendix I species, as a matter of utmost urgency.	Recommendation	2017	Scientific Committee, Sub-committee on Small Cetaceans	Yes	IWC67

Children	Number	Text	Type	Year	Commission body	Endorsed	Commission endorsed at
	SC1873	The Committee draws the attention of the Commission to its serious concern over the high mortality levels from bycatches in Peru and especially those of the Burmeister's porpoise and dusky dolphin. It stresses that action is needed to avoid the same critical situation for Burmeister's porpoise as with the closely related vaquita. In this regard the Committee: (1) reiterates its advice (IWC, 2009, p.323) on bycatch monitoring and mitigation in these fisheries; (2) reiterates that the Burmeister's porpoise is a potential candidate for a Conservation Management plan; (3) highlights opportunities to focus on the bycatch of small cetaceans in Peru through the new IWC Bycatch Mitigation Initiative and recommends that they are considered as a potential pilot project; (4) offers its assistance to the Government of Peru; and (5) requests that the Commission, through the Secretariat, transmits the Committee's concern and offer of assistance to the Government of Peru.	Recommendation	2018	Scientific Committee	Yes	IWC67
SC18166, SC18168	SC18165	The Committee has stressed for many years that the vaquita population is at a critically low level, and the most recent evidence demonstrates that the cause of the decline – use of illegal large-mesh gillnets – continues, making extinction in the wild increasingly likely; the long-term decline in the vaquita reported previously has continued in 2017. The Committee yet again re-emphasises the serious concerns it has raised on the status of the vaquita, and in particular its recommendations of the past two Committee meetings.	Draw attention	2018	Scientific Committee, Sub-committee on Small Cetaceans	Yes	IWC67
SC18167	SC18166	Committee commends the Government of Mexico for its attention and response to the CIRVA findings and recommendations.	Draw attention	2018	Scientific Committee, Sub-committee on Small Cetaceans	Yes	IWC67
	SC18167	SC respectfully requests that reports continue to be provided annually to the IWC Scientific Committee on actions and progress towards saving the vaquita.	Recommendation	2018	Scientific Committee, Sub-committee on Small Cetaceans	Yes	IWC67
	SC18168	Committee strongly endorses the recommendations of CIRVA10 that: (a) the CIRVA10 acoustic monitoring programme, critical for evaluating the effectiveness of conservation actions, be continued as in previous years to provide an annual empirical estimate of population trend; (b) all Mexican enforcement agencies increase their efforts on land and in water immediately and continue this enhanced enforcement programme for the duration of the period of illegal totoaba fishing (at least until June 2018) to eliminate all setting of gillnets in the range of the vaquita; (c) emergency regulations be promulgated immediately to strengthen the current gillnet ban and enhance enforcement and prosecution by: (i) eliminating all fishing permits for transient fishermen and limiting fishing access to only those fishermen who can demonstrate residency in the fishing villages; (ii) confiscating any vessel that does not have the appropriate vessel identification, permits, and the required vessel monitoring system; (iii) requiring vessel inspection for each fishing trip at the point of departure and landing; (iv) prohibiting the sale or possession of gillnets on land and at sea within the area of the current gillnet ban and on adjacent lands within a specified distance of the coastline; (v) requiring that all gillnets be surrendered or confiscated and destroyed; and (vi) eliminating the exemptions for all gillnet fisheries, including the curvina and sierra fisheries; (d) efforts to remove gillnets from vaquita habitat be continued and enhanced and the numbers and locations of new nets recovered be published monthly; (e) the number of inspections, interdictions, arrests, sentences, and other enforcement actions be published monthly, together with information on observed levels of illegal activities obtained from intelligence operations, for example from drones; (f) successful prosecution and subsequent penalties be sufficient to deter illegal fishing; and (g) development of gillnet-free fisheries be enhanced and linkages to incentivise the conversion of the fleet to gillnet-free operations be strengthened.	Recommendation	2018	Scientific Committee, Sub-committee on Small Cetaceans	Yes	IWC67

Children	Number	Text	Type	Year	Commission body	Endorsed	Commission endorsed at
	SC19130	The Committee expresses grave concern at the violence directed towards scientists, legal fishermen, NGOs and law enforcement agencies from those who are involved in the illegal totoaba fishery, which is responsible for the continued bycatch of the vaquita.	Draw attention	2019	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
	SC19131	The Committee also commends the considerable contributions made by Rojas-Bracho and his Mexican colleagues on the vaquita issue and their regular expert updates to this Committee and other key fora across many years. Independent advice is of fundamental importance to the work of the Committee. Given the escalating violence in the Gulf of California, Mexico, the Committee requests that the Government of Mexico and all in appropriate positions of power ensure that independent scientists are able to provide data, advice and their expertise free from the threat of violence and other intimidation or retribution.	Recommendation	2019	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
SC19133, SC19134, SC19137, SC19138, SC19139, SC19140, SC19141, SC19142	SC19132	The Committee yet again expresses its disappointment and frustration that, despite almost three decades of repeated warnings, the vaquita's rapid decline to extinction continues because of ineffective management measures. As such, it re-emphasises the concerns it has raised on the status of the vaquita over many years, reiterates the urgent recommendations of the past three Committee meetings, and endorses and adopts the recommendations in the CIRVA-11 report (SC/68A/SM01) [(Rojas-Bracho, 2019)]. The precipitous decline of the vaquita reported previously has continued in 2018. As monitoring is critical for evaluating the effectiveness of conservation actions, the Committee strongly recommends that: (1) the CIRVA-11 acoustic monitoring programme be continued as in previous years to provide an annual empirical estimate of population trend, and that opportunistic use of smaller CPOD acoustic arrays be continued to assess vaquita presence and to support possible periodic photo-identification and visual monitoring efforts outside the regular summer sampling period.	Recommendation	2019	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
	SC19133	The Committee yet again expresses its disappointment and frustration that, despite almost three decades of repeated warnings, the vaquita's rapid decline to extinction continues because of ineffective management measures. As such, it re-emphasises the concerns it has raised on the status of the vaquita over many years, reiterates the urgent recommendations of the past three Committee meetings, and endorses and adopts the recommendations in the CIRVA-11 report (SC/68A/SM01). The precipitous decline of the vaquita reported previously has continued in 2018. As monitoring is critical for evaluating the effectiveness of conservation actions, the Committee strongly recommends that: (2) photo-identification efforts proposed in CIRVA-11 be conducted as soon as possible, to obtain information on the minimum number of animals alive, [and to refine understanding of life history parameters including survival rates].	Recommendation	2019	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
	SC19134	The Committee recommends that the CIRVA-11 proposal to use photographic capture-recapture techniques to obtain an estimate of minimum abundance be explored (which is preferable to relying on simple single day counts of different individuals) and that: (a) local marine mammal scientists and naturalists with training and experience in photo-identification techniques, organize rapid-response teams to take advantage of weather conditions suitable for such monitoring work; and (b) more local personnel be trained and equipped to maximize the number of opportunities to obtain photographs and potentially biopsies.	Recommendation	2019	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
	SC19137	The Committee also strongly endorses the recommendations made in CIRVA-11 and: (1) advises/recommends that the Government of Mexico fully mobilise its enforcement assets to eliminate illegal fishing in the area where the last few vaquitas survive, a small area henceforth referred to as the 'Zero Tolerance Area' (where the goal will be to remove any illegal net within hours of its deployment). In this Zero Tolerance Area, particularly during the totoaba season.	Recommendation	2019	Scientific Committee, Sub-committee on Small Cetaceans	Pending	

Children	Number	Text	Type	Year	Commission body	Endorsed	Commission endorsed at
	SC19138	The Committee also strongly endorses the recommendations made in CIRVA-11 and: (2) urges the Government of Mexico to: • fully fund and expand net-removal efforts to maintain the area as a net-free zone; • provide 24-hour surveillance and monitoring; • take all necessary measures to protect net-removal teams from harm or intimidation; and • arrest and prosecute illegal fishermen, for example, by placing an FGR agent on net removal ships and Navy vessels to facilitate arrests.	Recommendation	2019	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
	SC19139	With regards to the advice of the Expert Committee on Fishing Technology (ECOFT) reported in previous CIRVA reports, the Committee reiterates previous recommendations (IWC, 2019, p.52) to: • develop a transparent, multi-year workplan; • require INAPESCA to consult and inform ECOFT before conducting new field tests or proposing the approval of new gear; • implement the use of Electronic Monitoring Systems (EMSs) with video in all gear-testing and fishing operations in the Upper Gulf of California (UGC); • issue fishing permits (from CONAPESCA) for small trawls by commercial vessels equipped with EMSs; and • prohibit the use of monofilament or multimonofilament nylon line in the construction of alternative gear, including purse seines and suriperas.	Recommendation	2019	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
	SC19140	While recognising that the commitments embodied in the "Plan for the Comprehensive Care of the Upper Gulf of California and the Comprehensive Program for the Protection and Recovery of the Vaquita" were made by the previous administration, the Committee: (1) urges the present Government of Mexico to implement, fully and expeditiously, the commitments made in the Plan; (2) strongly approves the continued role of CIRVA with regards to their assistance in: reviewing monthly reports of enforcement efforts; • participating in an enforcement contact group; and • providing advice on implementation of the plan for alternative gear.	Recommendation	2019	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
	SC19141	With regards to strengthening direct linkages between the fishermen using alternative gears and the seafood buyers as a way of incentivising the conversion of the fleet to gillnet-free operations, the Committee; reiterates its previous recommendation that Mexico work with gear-testing partners to conduct rigorous cost-benefit analyses on the new gears and to test markets for the vaquita-safe products and that Mexico work with producers and buyers to develop and implement a comprehensive chain of custody and traceability system for vaquita-safe products from the Upper Gulf of California, noting that it is critical that this system be in place before legal shrimp fishing resumes in September 2019 and that information is accessible to producers, buyers, and consumers.	Recommendation	2019	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
	SC19142	Finally, the Committee: reiterates its previous recommendations that the Mexican enforcement agencies: (a) efforts to remove gillnets from vaquita habitat be continued and enhanced and the numbers and locations of new nets recovered be published monthly; (b) also publish monthly the number of inspections, interdictions, arrests, sentences, and other enforcement actions, together with information on observed levels of illegal activities obtained from intelligence operations, for example from drones; (c) ensure that successful prosecution and subsequent penalties be sufficient to deter illegal fishing; and (d) development of gillnet free fisheries be enhanced and linkages to incentivise the conversion of the fleet to gillnet-free operations be strengthened.	Recommendation	2019	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
	SC19223	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.	Recommendation	2019	Scientific Committee, Sub-committee on Environmental Concerns	Pending	

Children	Number	Text	Type	Year	Commission body	Endorsed	Commission endorsed at
	SC20181	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.	Recommendation	2020	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
	SC20182	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 (240km^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.	Recommendation	2020	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
	SC20183	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.	Recommendation	2020	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
	SC20184	Furthermore, the Committee strongly recommends that for Vaquita: (i) efforts to photo-identify 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.	Recommendation	2020	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
	SC20185	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.	Recommendation	2020	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
SC21172	SC21171	The Committee yet again expresses its disappointment and frustration that, despite almost three decades of repeated warnings, the vaquita population edges closer to extinction caused by gillnet entanglement and ineffective fisheries management and enforcement measures in the Upper Gulf of California. The Committee recalls its previous strong concerns and urgent recommendations for the vaquita (SC20181) and reiterates the urgent recommendations of the past five Committee meetings, especially regarding the need to remove gillnets from the species' range immediately.	Recommendation	2021	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
	SC21172	In addition, the Committee urges the Mexican Government to re-establish conditions in the field that are safe for field personnel and which allow acoustic sampling, as well as a visual survey, to continue unimpeded; this is the only way the scientific team can continue to obtain reliable information on the status of the vaquita population.	Recommendation	2021	Scientific Committee, Sub-committee on Small Cetaceans	Pending	
CO1640, CO1641, CO1633, CO1634, CO1635, CO1636, CO1637, CO1638, CO1639	CO1632	The Commission endorsed Resolution 2016-5 [(IWC, 2017)]on the Critically Endangered Vaquita.	Resolution	2016	Commission	Yes	IWC66

Children	Number	Text	Type	Year	Commission body	Endorsed	Commission endorsed at
	CO1640	Resolution 2016-5 urges Contracting Governments to support Mexico's efforts to prevent the extinction of the vaquita by assisting in providing financial resources as well as technical and socio-economic expertise;	Resolution	2016	Commission	Yes	IWC66
	CO1641	Resolution 2016-5 requests the IWC Secretary to forward a copy of this Resolution to the CITES, FAO and IUCN Secretariats.	Resolution	2016	Commission	Yes	IWC66
	CO1633	Resolution 2016-5 expresses deep concern that the vaquita numbers less than 59 animals and is facing imminent extinction;	Resolution	2016	Commission	Yes	IWC66
	CO1634	Resolution 2016-5 affirms that only a permanent, complete, and effective gillnet ban in all fisheries operating in the Upper Gulf of California will prevent the imminent extinction of the vaquita;	Resolution	2016	Commission	Yes	IWC66
	CO1635	Resolution 2016-5 commends the Mexican Government for the Strategy on the Comprehensive Care of the Upper Gulf of California that includes an interagency enforcement programme, a two-year gillnet ban (from May 2015), compensation for fishermen and those who work in fishery-related activities and the development of alternative fishing gear;	Resolution	2016	Commission	Yes	IWC66
	CO1636	Resolution 2016-5 commends the Mexican Government on the announcement of a permanent ban on gillnets in the Upper Gulf of California gillnet exclusion zone from April 2017 and the programme to remove derelict fishing gear in the Upper Gulf of California.	Resolution	2016	Commission	Yes	IWC66
	CO1637	Resolution 2016-5 urges the Mexican Government to eliminate any exemptions to the ban, which can facilitate illegal fishing for totoaba, and to prohibit the use of any gillnets within the range of the vaquita;	Resolution	2016	Commission	Yes	IWC66
	CO1638	Resolution 2016-5 endorses the recommendations of the IWC Scientific Committee, in particular the urgent need to strengthen enforcement efforts against illegal fishing in Mexico and totoaba smuggling out of Mexico and into transit and destination countries; the urgent need to remove active and ghost gillnets from the range of the vaquita; and the need to maintain the acoustic monitoring programme as a key action in support of any recovery strategy	Resolution	2016	Commission	Yes	IWC66
	CO1639	Resolution 2016-5 urges all Contracting Governments to follow the recommendations in CITES Decisions 17. 145 to 17.151 and strengthen enforcement actions to eliminate the illegal international trade in totoaba swim bladders, in particular those countries where totoaba products are consumed or in transit, including the United States and China;	Resolution	2016	Commission	Yes	IWC66
CO0725, CO0726, CO0727	CO0724	The Commission endorsed Resolution 2007-5 [(IWC, 2008)], Resolution: The Vaquita, from Critically Endangered to Facing Extinction.	Resolution	2007	Commission	Yes	IWC63
	CO0725	Resolution 2007-5 COMMENDS Mexico's intense recent efforts to prevent the extinction of the vaquita despite the difficulties involved in reducing bycatch to zero, and especially given the difficulties of providing alternative livelihoods to isolated fishing communities in the Northern Gulf.	Resolution	2007	Commission	Yes	IWC63
	CO0726	Resolution 2007-5 FURTHER COMMENDS the President of Mexico for the recent announcement on the Conservation Program for Endangered Species (PROCER), which calls for the implementation of specific Species Conservation Action Programs (PACE) for a list of selected species. The vaquita is among the top five species on this list.	Resolution	2007	Commission	Yes	IWC63
	CO0727	Resolution 2007-5 URGES the Members of IWC and the world community to support Mexico's efforts to prevent the extinction of the vaquita by reducing bycatch to zero in the immediate future and assisting in providing financial resources and technical as well as socio-economic expertise.	Resolution	2007	Commission	Yes	IWC63

REFERENCES

International Whaling Commission. 1975. Report of the International Whaling Commission, 1973-74. *Rep. Int. Whal. Comm.* 25:6-287.

International Whaling Commission. 2008. Chair's Report of the Fifty-ninth Annual Meeting. Annex E. Resolutions adopted at the 59th Annual Meeting. Resolution 2007-5. The vaquita, from critically endangered to facing extinction. *Ann. Rep. Int. Whal. Comm.* 2007:93.

International Whaling Commission. 2009. Report of the Scientific Committee. Annex L. Report of the sub-committee on small cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 11:311-33.

International Whaling Commission. 2017. Chair's Report of the 66th Meeting. Annex E. Resolutions Adopted at the 66th Meeting. Resolution 2016-5. Resolution on the Critically Endangered Vaquita. *Rep. 65 Mtg Int. Whaling Commn* 2016:51-52.

International Whaling Commission. 2019. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 20:1-78.

Rojas-Bracho, L. 2017a. Eighth Meeting of the Comité Internacional para la Recuperación de la Vaquita (CIRVA-8), Southwest Fisheries Science Center, November 29-30th, 2016, La Jolla, CA. Paper SC/67a/SM11 presented to the IWC Scientific Committee, May 2017, Bled, Slovenia (unpublished). 70pp. [Paper available from the Office of this Journal].

Rojas-Bracho, L. 2017b. Ninth meeting of the Comite Internacional para la recuperacion de la Vaquita, Southwest Fisheries Science Center, La Jolla, CA, April 25-26 2017. Note: revised version contains full report. Paper SC/67a/SM14rev1 presented to the IWC Scientific Committee, May 2017, Bled, Slovenia (unpublished). 38pp. [Paper available from the Office of this Journal].

Rojas-Bracho, L. 2019. Report of the Eleventh Meeting of the Comité Internacional para la Recuperación de la Vaquita (CIRVA). Paper SC/68A/SM/01 presented to the IWC Scientific Committee, May 2019, Nairobi, Kenya (unpublished). 35pp. [Paper available from the Office of this Journal].

Report of the IWC Climate Change Workshop

Virtual Meeting, 30 November-3 December 2021

Report of the IWC Climate Change Workshop[1]

30 November-3 December 2021, Virtual Meeting

1. INTRODUCTIONS

The workshop was opened by Mark Peter Simmonds, the convener, who welcomed everyone, noting that many distinguished scientists from all around the world would be participating. A list of participants is given in Annex A. He noted that the workshop was originally conceived as an in-person meeting some two years ago but that the steering committee agreed to go ahead with a virtual meeting because of the pandemic. The aims for the workshop are to increase understanding of how climate change is affecting and will affect cetaceans, and how the IWC's science and stewardship mission can best address these challenges, in collaboration with other organisations. Simmonds noted that although the IWC does not have a direct role in the human activities that are contributing to the climate crisis, it can provide advice to relevant bodies on how their practices may affect cetaceans. This guidance could be provided, for example, to the International Maritime Organization (shipping), CCAMLR (conservation), as well as the FAO (fishing) and regional fisheries management bodies. On a national level, this could include matters related to offshore renewables, coastal construction in response to sea level change, and storm related pollutant run off from land-based sources. Simmonds identified four strands of potential advice and recommendations:

(1) describing how climate change is expected to affect different cetacean populations;
(2) considering how other management measures (for example to address threats) may need to be adjusted to take into account the additional pressures on cetacean populations resulting from climate change;
(3) describing how shifts in cetacean distribution as a result of climate change may bring cetacean populations into contact with different pressures compared to the current situation; and
(4) considering how changes in human activities as a result of, or to address, climate change may impact cetaceans.

In summing up his introductory comments, Simmonds, noted that he well recalled the first IWC workshop on climate change in 1996 and the disappointing workshop conclusion that our understanding and predictive powers were limited such that implications for cetaceans were not clear. He noted that this workshop comes at a time when the effects of climate change are being felt by human populations globally. People have been killed or lost their homes as a result of severe weather events outside of the norm and many of us now live in fear of what the future holds for our families, our communities and our ways of life. He asked the meeting to pause for a moment to show respect to the lost, the fearful and the distressed.

2. REVIEW OF TERMS OF REFERENCE AND AGENDA

Simmonds outlined the Terms of Reference for the workshop which had been elaborated by the steering committee into the agenda (see Annex B). The agenda was approved.

3. APPOINTMENT OF CHAIR AND RAPPORTEURS

Simmonds was appointed as Chair with Sarah McCain, Laetitia Nunny, Debbie Palka, Sarah Rice, Imogen Webster acting as rapporteurs and Iain Staniland acting as Rapporteur-in-Chief. The Chair noted that Leaper would also assist in collecting recommendations as the meeting progressed. Recommendations of this workshop are given in blue boxes, target key: C=Commission; CG=Contracting Government; G=General; R=Research (community); S=Secretariat; CC=Conservation Committee; SC=Scientific Committee.

4. PREVIOUS AND ONGOING WORK ON CLIMATE CHANGE UNDERTAKEN BY IWC

The reports of the previous IWC workshops on climate change and the IWC's previous recommendations were made available on the SharePoint site. The workshop's steering committee had reviewed the recommendations as part of the process of developing the agenda and these could be drawn upon as appropriate by the current workshop (see Annex C).

5. SUMMARY OF IPCC LATEST REPORT

Striegel presented a summary of the IPCC report noting anthropogenic climate change is rapid, widespread, and intensifying (Intergovernmental Panel on Climate Change (IPCC), 2021). Global warming of 1.5 or 2°C - the upper limit defined in the Paris Agreement - will be exceeded during the 21st century unless deep reductions in CO_2 and other greenhouse gas

[1]Presented to the Scientific Committee meeting as SC/68D/Rep/01.

emissions occur. But even then, there are many changes due to past and future greenhouse gas emissions that will remain irreversible for centuries or even millennia, especially in the ocean. Examples include the melting of the Greenland and Antarctic Ice Sheets, global sea level rise, ocean warming, deep ocean acidification, and deoxygenation.

Human influence is the main driver of the observed trends in ocean warming, surface ocean acidification, the decrease in Arctic sea ice, and global mean sea level rise.

Ocean warming progressed faster over the past century than at any other time since the end of the last deglacial transition. Ocean acidification led to unusually low (i.e. increasingly acidic) surface open ocean pH levels in recent decades when compared to the last 2 million years. Both processes are projected to continue, as is ocean deoxygenation. Climate change might also affect entire ocean currents. The Atlantic Meridional Overturning Circulation (AMOC), for example, is predicted to weaken over the 21st century. While there is medium confidence that there will not be an abrupt collapse of the AMOC in this century, such a major tipping point of the climate system cannot be ruled out completely. The same holds true for other abrupt responses and tipping points, such as a strongly increased Antarctic Ice Sheet melt. The continued mass loss of both the Greenland and Antarctic Ice Sheets will contribute to global sea level rise over the 21st century. Even under large net negative CO2 emissions, it will take several centuries or even millennia for global mean sea level to reverse course. The Arctic Ocean will likely be practically ice-free during the seasonal ice minimum for the first time before 2050 under all scenarios, a state that might become the new normal by 2100 under continued high greenhouse gas emissions.

In discussion it was noted that COP25 was termed the 'blue COP' as there were many activities related to the ocean. COP26 in Glasgow resulted in a new declaration on the ocean and new members joined the 'blue leaders' aiming for 30% protection of the oceans by 2030. In the Glasgow Climate Pact there are also several references to the ocean, paving the path for more consistent inclusion and consideration of ocean issues in climate discussions. The US joined the high-level panel on oceans where members need to establish conservation management plans in their EEZ's that include many matters of interest to the IWC including shipping, tourism and climate change.

6. REVIEW OF LATEST DEVELOPMENTS IN TERMS OF UNDERSTANDING THE IMPLICATIONS OF CLIMATE CHANGE FOR CETACEANS

A list of recent publications had been produced for the workshop by Nunny and Frey and is annexed to this report (Annex D). This list was used to identify and subsequently invite workshop participants. Additional publications were added during the workshop.

The Chair noted that the matters under this topic would be discussed in the context of the presentations provided.

6.1 Major climate and non-climate drivers for impacts on cetaceans, including synergies

Smetacek and Savoca gave an overview on rebuilding baleen whale ecosystems and this is their authors' summary. They noted that the structure and functioning of marine pelagic ecosystems have been implicitly regarded as controlled by bottom-up factors. The same view was held by limnologists until whole-lake experiments demonstrated the effects of presence or absence of top predators: top-down control. Massive removal of top predators in the oceans by commercial fisheries was carried out without any management, hence its effects have not been appreciated. Whaling in the Southern Ocean (SO) provides a case study in which over a million great whales were removed but their recovery has been slow and is currently hampered by the decline of krill biomass.

To understand the impacts of top predators on ecosystem functioning the importance of iron availability in controlling productivity of the oceans needs to be considered. The bulk of this essential nutrient in productive ecosystems is located in the biota. The protein ferritin is highly effective at taking up and storing iron. Ferritin in body fluids renders these fluids as iron-limited as the open ocean. Phytoplankton blooms in today's SW Atlantic are almost entirely located along land margins that 'leak' iron to the impoverished water. Satellite imagery reveals that the spring diatom blooms are short-lived lasting only a month or two. Dedicated studies have demonstrated this is because biomass sinks to the sediments with its iron content. After the whales were removed the krill population shrank to a fraction of its former size over a period of several decades. The food required by baleen whales was initially estimated at 190 million tonnes of krill per year by Laws (1977); this has now been doubled by direct measurements of feeding rates of baleen whales in the field (Savoca *et al.*, 2021). The volume of krill consumed annually by whales is more than double the global fish catch. The size of the krill stock needed to satisfy large whale food demand will have been about 3 times the amount eaten: 1.2 Gt fresh biomass which is equivalent to 0.1 Gt carbon. This is in the same range of carbon in global livestock (0.1 Gt C) and human biomass (0.06 Gt C) (Bar-On *et al.*, 2018). The exceptionally high efficiency of conversion of plant production into animal biomass can only be explained by the biology of the animal actors involved in promoting transfer. They link the unique behavioural traits of krill and blue/fin whales into a pattern of recycling of the limiting element, iron, via bloom-forming diatom species in which the krill biomass acted as a gigantic reservoir of iron that was tapped and recycled by the whales which retained energy in the blubber. Since this function was eliminated with the removal of whales, the krill biomass sank to its current fraction of the original stock. The whale feeding grounds could be restored to their former glory by mimicking the whales as 'surrogate defecators' (Yong, 2021). The sole dependence of a dominant top predator on a single prey item contradicts the stability-by-diversity paradigm

of ecology. The enormous krill biomass functioned as a reservoir of iron that was tapped and effectively recycled by the combination of unique properties of the whales and krill. In the past, whales generally fed on krill at the surface, thereby retaining iron released by krill faeces there. However, in today's Southern Ocean, krill appear to have retreated to greater depths where this fertilising mechanism is less effective. Rebuilding the baleen-whale ecosystem will require restoring the size of the krill iron reservoir by mimicking whale feeding and iron recycling. This could be achieved by artificial ocean iron fertilization (OIF) to grow diatom blooms that will provide food for krill reproduction. All OIF experiments carried out so far have stimulated growth of phytoplankton. After the first successful OIF experiments there was a concern that this could lead to large-scale fertilization for carbon sequestration by venture capitalists. To counteract this tangible threat, the London Convention has passed an international legally binding moratorium on large-scale OIF, until the results of smaller-scale scientific experiments show the degree of threat they pose. Applications for small-scale scientific experiments have to be peer-reviewed before permission is granted. Unfortunately, the unjustified negative reputation of OIF has discouraged scientists, funding agencies and policy makers from carrying out these badly needed experiments.

After this presentation by Smetacek and Savoca, the workshop discussed how krill seem to have occurred much more frequently at the surface in historical reports compared to its current deeper distribution. This will affect whale behaviour and their fertilising effect will be reduced at depth. The process described here is symptomatic of the entire ocean; the sub-Arctic Pacific Ocean is also iron deficient with likely the same effect on the whales of that region. This may be a possible reason that bowhead whale populations have not recovered as expected. There was debate about whether the system would be able to recover without intervention. Smetacek stated he did not believe krill populations can recover on their own and the iron reservoir needs to be built up. Whales are now feeding on krill exposed by receding sea ice and the nutrients are not going to be used by the phytoplankton.

The application of the new consumption estimates was questioned, noting that they were several times larger than earlier estimates and that further work is needed to explain the discrepancies.

6.2 Observed effects (cetaceans, habitats, prey and other species)

Stimmelmayr and Sheffield presented an integrated view on recent developments related to climate change in the Bering-Chukchi-Beaufort Sea. Long-term harvest monitoring and ongoing health assessments of landed Bering-Chukchi-Beaufort (BCB) bowhead have provided solid baseline data on population status and general health status, indicating a healthy and robust population in a general low stressor habitat. Ongoing risk surveillance of bowhead whale habitat and increased understanding about direct and indirect climate change impacts on the Pacific Arctic-subarctic marine ecosystem indicate an increasing complexity of environmental, ecological and anthropogenic stressors. For example, environmental and ecological changes are numerous, ranging from dynamic northward distribution shifts of Bering Sea Pacific cod and pollock; reduction in biomass of important forage fish (capelin, sand lance); extended residence time and further northward movement of subarctic baleen whales; changes in timing of bowhead whale spring and fall migration as well as novel overwintering in the Beaufort Sea; increasing killer whale- baleen whale predation; multi-year sea surface temperature variations from normal; continued decline in sea ice coverage; increasing presence of harmful marine algal toxins; ongoing unusual mortality events in gray whales, seals, and seabirds and more.

Since 2019/20 novel fishing for Pacific cod and pollock has successfully expanded northward in the Bering Strait and into the southern Chukchi Sea due to human impacts to ocean temperatures. Within the same time frame, maritime traffic along the Northern Sea route has significantly increased due to loss of sea ice and traffic is anticipated to become year-round by 2022. In 2020/21, several foreign marine debris events, likely associated with northern fishing and commerce vessel traffic, have occurred along the Alaskan coastline within the Bering Strait region. Lastly, recent microplastic (MP) monitoring studies in landed Eastern Beaufort Sea beluga whales and their prey confirm MP presence. Sea ice likely functions as a sink and with increased sea ice reduction more MP will enter the Pacific Arctic food web. Taken together, a real time status change of the Arctic-subarctic marine habitat is occurring from a low-level stressor exposure to a novel habitat potentially with concurrent high-level stressors. Given the current evolving dynamic landscape of known and emerging stressors within core areas of bowhead whale habitat, there is much urgency for federal co-management partners and coastal communities to engage in targeted research. Real-time Arctic stressor identification and impact characterisation is needed to develop actionable transboundary mitigation strategies. It was suggested that the accumulated ecological and biological knowledge about the bowhead whale can provide valuable, relevant, and transferable information to manage core large whale habitats in the Arctic-subarctic and devise realistic management strategies for a multi-user/multi-cetacean species Arctic seascape.

In discussion it was noted that the IWC Secretariat has reached out to local communities in the Arctic to propose a collaborative project to recover ghost fishing gear.

In terms of climate change, there is much progress needed to tackle this issue with swift and effective decisions. Scientists would need to recommend mitigation measures, even if for many situations the impact of these forces is still unknown.

In further discussion it was noted that the rapid changes occurring in the Arctic and other places in the world are concerning for people and for cetaceans, which is natural given human nature's aversion to change. The presentation by

Stimmelmayr and the earlier presentation by Striegel underscore the many reasons for concern given the changes being experienced. However, scientists should be cautious in assigning value to those changes. For example, there is evidence that sea ice retreat has been positive for bowheads because increased ice retreat likely increases productivity in the Beaufort Sea resulting in improved body condition (George *et al.*, 2015). Sue Moore and others have also suggested there are winners and losers in the array of impacts of climate change. Some species may be negatively impacted, and others may experience positive changes, although this may also change over time. There is an obvious need to continue to monitor cetaceans and impacts from climate changes where possible.

In the Arctic, there are often opportunities for scientists to work closely with subsistence hunters to collect samples from harvested whales on body condition, reproduction, and other aspects of health. Increased understanding of how climate change might be impacting cetaceans, could shed light on actions that can be taken to mitigate impacts from increasing human activities especially those that may be related to climate change (i.e. increased Arctic shipping, fishing, mining, etc.).

It was highlighted that the IWC manages aboriginal subsistence harvests of baleen whales in the Arctic using Strike Limit Algorithms (SLAs), which were rigorously tested across a broad range of scenarios. Some of the stressors referenced by Stimmelmayr and Shefield are covered by those scenarios. Givens and Weller (2021) determined that some of those changes were well within tested parameter space and that the SLAs for BCB bowheads and gray whales were still the appropriate tool for the SC to provide advice to the Commission about the sustainability of aboriginal hunts.

It was emphasized that there will be some negative and positive effects from climate change, and the situation in the Arctic is complicated, as it is clear that increased human activity will definitely have an effect. Easy wins can be identified and implemented as a priority, where negative effects can be mitigated, especially those that will take a long time to reverse. Tulloch has started a meta-analysis on teasing out some of the differences between the northern and southern hemisphere in relation to the positive and negative effects and how they interplay.

Williams presented new information from a population viability analysis (PVA) for beluga (*Delphinapterus leucas*) that explicitly included climate change (Williams *et al.*, 2021). Decades after a ban on hunting, and despite focused management interventions, the endangered St Lawrence Estuary (SLE) beluga population has failed to recover. The authors conducted a population viability analysis (PVA) to simulate responses of the SLE beluga population across a wide range of variability and uncertainty under current and projected changes in environmental and climate-mediated conditions. Three proximate, anthropogenic threats to recovery were explored: ocean noise, which may reduce foraging efficiency; contaminants, which can increase calf mortality; and prey limitation, which can affect both survival and reproduction. Even the most optimistic scenarios the authors modelled failed to achieve the reliable positive population growth needed to meet Canada's stated recovery targets. Every climate change scenario that the authors considered exacerbated the immediate threats and further reduced population growth. The study found that the predicted effects of climate change may be a more significant driver of SLE beluga population dynamics than all three proximate threats considered. The authors concluded that aggressive mitigation of all three proximate threats will be needed to build the population's resilience and allow the population to persist long enough for global actions to mitigate climate change to take effect.

The PVA approach was thought to be useful in teasing out scenarios and this could be used for prey availability e.g. looking at climate change effects on herring. The inclusion of seasonal information into the approach would also be beneficial.

The workshop made the following recommendation on recovery efforts for endangered species.

Attn: CG, C, G, R
The workshop welcomed the information on St Lawrence Estuary beluga. The workshop encouraged countries to follow the good example set by Canada and consider climate change explicitly in recovery efforts for endangered species. The workshop ***recommended*** *that doing so will require swifter, more effective and targeted mitigation to reduce or remove anthropogenic stressors (e.g., prey limitation, ocean noise, bycatch, toxins). Additional protective measures (e.g., critical habitat designation, marine protected areas) may be required to help build the resilience of cetacean populations to withstand climate-mediated stressors.*

Carlén reported on climate change effects on the four species of marine mammals present in the Baltic; ringed seal (*Pusa hispida baltica*), grey seal (*Halichoerus grypus*), harbour seal (*Phoca vitulina*) and the critically endangered Baltic Proper harbour porpoise (*Phocoena phocoena*). The Baltic Sea is being highly affected by climate change. For example, sea surface temperatures (SST) have increased more in the Baltic than in many other areas. This influences the length of the ice season and maximum extent of sea ice, which has a negative effect on the reproductive success of the ice breeding ringed seal. Increased inflow of freshwater due to increased precipitation in the north in combination with increased influx of salt water from the southwest and warming of surface waters is expected to increase stratification which is already strong in the Baltic Sea. This in turn may aggravate the already serious oxygen depletion primarily in deep areas but also in some coastal areas of the Baltic. Oxygen depletion and ocean warming is likely to have a negative effect on pelagic saltwater fish species such as cod (*Gadus morhua*), herring (*Clupea harengus*) and sprat (*Sprattus sprattus*), which are thought to be important

prey for Baltic harbour porpoises. Meanwhile, smaller species such as three-spined stickleback (*Gasterosteus aculeatus*) are expected to benefit from warming. This may reinforce the ecosystem changes already observed and decrease harbour porpoise prey quantity and quality. Effects in the Baltic were recently reviewed in Meier *et al.* (2021).

The Baltic Proper harbour porpoise is critically endangered. The population is small (Amundin *et al.*, 2021) with a limited population range (Carlén *et al.*, 2018), and cumulative impacts from bycatch, environmental contaminants and underwater noise are already hindering population recovery (Carlén *et al.*, 2021). Additional pressure from climate change is likely to further aggravate the situation for this population. The IWC Scientific Committee in 2021 made recommendations related to action to help address the situation of the Baltic Proper harbour porpoise[2].

The workshop noted that the Baltic situation highlighted the need to account for cumulative effects as there is a whole suite of threats and problems that cannot be addressed in isolation, and therefore made the following recommendation.

Attn: CG, G
The workshop noted with concern the situation of the critically endangered porpoise of the Baltic proper, and the comments made previously about it by the scientific committee, and that climate change would likely exacerbate its demise. The workshop, therefore, called on its range states to urgently act to improve the resilience of this population by addressing the other imminent threats affecting it, including bycatch.

6.3 Lessons from other species

Staniland presented on the lessons learnt from the study of climate effects in other marine predators. Large and relatively conspicuous top predators, including cetaceans, are often used as 'Ocean Sentinels' sitting at, or near the top, of the food chain. As such, they integrate changes in the marine ecosystem and provide a range of different measures that can be used to provide a window into the cryptic marine environment. From simple counts on breeding sites to using animal-borne technology to measure individual dives, whole range of life history parameters and behaviours can be monitored, covering time periods of seconds to decades and beyond. Compared to cetaceans, other marine large predators such as seabirds, seals and turtles are often easier and cheaper to monitor as they haul out on land or ice to breed, rest or moult, etc. They can be proxies for what is, or may be, affecting cetacean populations as they often share the same habitats and overlap in diet. However, care is needed given the different life history constraints acting on these animals such as their need for access to land etc.

Examples include elephant seals (*Mirounga sp.*) carrying Conductivity-Temperature-Depth (CTD) tags which become oceanographic samplers, targeting areas of interest and giving an understanding of the preyscape through body condition changes (Costa *et al.*, 2010). The use of krill (*Euphausia superba*) carapaces in Antarctic fur seal (*Arctocephalus gazella*) scats was highlighted as a simple long-term study by which the recruitment of krill at South Georgia had been monitored. Dietary sampling has also been used to predict the future with the amount of sardines (*Sardinops sagax*) and anchovy (*Engraulis mordax*) correlated to fisheries catch per unit effort (CPUE) and landings in the following year (Velarde *et al.*, 2015). Range shifts have been observed in both Northern and Southern elephant seals, although interestingly the underlying mechanisms are probably different with hyperthermia affecting NH seals (García-Aguilar *et al.*, 2018) and ecosystem changes affecting the SH (Jones *et al.*, 2020). These range shifts are also observed in seals on the western Antarctic peninsula with less ice-dependent species increasing and the ice obligate Weddell seals (*Leptonychotes weddellii*) decreasing (Hückstädt *et al.*, 2020). In the Bering Sea, ribbon seals (*Histriophoca fasciata*) showed a long-term decrease in their body condition in contrast to adult spotted seals (*Phoca largha*). This appears to be related to decreasing sea ice extent which results in a separation between breeding and deep water foraging sites for ribbon seals but not for spotted seals which favour shelf waters (Boveng *et al.*, 2020).

The issue of nonlinear responses to environmental changes was highlighted in South American sea lions (*Otaria flavescens*), where wave power exceeding a threshold value significantly increased the number of pups washed away by storms (Sepúlveda *et al.*, 2020).

Seabirds are a group that are relatively well studied, and a global analysis of breeding success showed hemispheric differences (Sydeman *et al.*, 2021). The Northern Hemisphere, with greater industrial exploitation and warming, showed the strongest effects in fish-eating, surface-foraging species. In the final example, divorce in black-browed albatross (*Thalassarche melanophris*) was shown to increase with SST even accounting for the effects of chick failure (Ventura *et al.*, 2021). This has implications for the lifetime reproductive output of these birds and could be linked to delayed return to breeding sites or increased stress hormones. Staniland noted that all of the examples relied on long term monitoring and the importance of both maintaining these and establishing new programmes was emphasised.

The use of new and emerging technologies was also noted to be potentially of great help in long term monitoring, reducing costs or expanding what can be monitored, and the workshop made the following recommendation.

[2] *https://archive.iwc.int/?r=19277.*

Attn: R, CG, G
The workshop noted that long term monitoring programmes were essential to detect climate driven changes in both cetacean populations and their habitats. The workshop therefore:

(1) *urged funding bodies, other government agencies and relevant bodies to support existing long term monitoring programmes and encouraged the development of new programmes; and*
(2) *encouraged the use of new and emerging technologies to reduce the cost of these long term monitoring programmes and open up new areas of research.*

6.4 Case studies

6.4.1 North Atlantic right whales

Corkeron presented information on North Atlantic right whales *Eubalaena glacialis*, (NARW) and climate change: what lessons can we learn? North Atlantic right whales are an exemplar of the challenges facing large whale conservation in the face of climate disruption. Their slow, intermittent recovery from centuries of commercial whaling stuttered to a halt in 2010, when the species' abundance peaked at a little under 500 individuals (Pace *et al.*, 2017). NARW numbers have declined since then, to around 336. The primary causes of the decline are twofold: anthropogenic mortality, from entanglement in fishing gear and vessel strikes; and poor reproductive output, for reasons that remain less well established but include the effects of entanglement, and changes in the distribution and abundance of the whales' prey, *Calanus finmarchicus*. Record *et al.* (2019) and Meyer-Gutbrod *et al.* (2021) clearly outline the manner in which climate disruption has had a significant role in this disaster.

Work on NARW demonstrates how many of the projected concerns raised in other presentations at this workshop play out in real life once whales are impacted by climate disruption. Anthropogenic perturbation of the ocean is ubiquitous, so wherever whales move to, they will encounter new anthropogenic threats. In the case of NARW, it has taken too much time to: (1) recognize that their movement ecology has been altered; (2) locate their new habitats; (3) assess the manner in which these habitats are subject to anthropogenic perturbation; (4) identify key threatening process; and (5) take management action in a manner that is appropriate and effective in addressing these threats. Current scientific and management processes are demonstrably inadequate (NARW are still declining in abundance) to address their climate-driven changes in movement and foraging ecology. A new paradigm, that moves beyond the post-hoc approach of attempting to understand a problem long after it has occurred, is required for those cetacean species that occur at low abundance, and arguably, for all. NARW demonstrate that management for resilience, rather than management for immediate sustainability, is the required paradigm shift.

The workshop noted that the issue of the NARW showed that there was a need to respond to situations in a rapid dynamic way. There was a need to move away from thinking that the ocean was 'the wild' and animals could simply move from one industrialised area to another. Animals may also be more vulnerable than before when moving to a new area. The workshop therefore made the following statement.

Attn: GC, G
The workshop noted with concern that aspects of the movement, ecology and life history of the Critically Endangered North Atlantic Right whale have changed in response to ecosystem perturbations brought on by climate disruption. This means that more anthropogenic stressors are now impacting this species, which is in significant decline. The workshop therefore called for the relevant authorities to react more quickly and more effectively to reduce anthropogenic impacts in response to these changes.

6.4.2 Sea ice and the eastern North Pacific (ENP) gray whale

Joyce provided new information on the role that sea ice plays in the distribution, phenology, and population biology of eastern North Pacific (ENP) gray whales (*Eschrichtius robustus*), with a view towards trying to understand the mechanisms by which ongoing climate change may affect this population. Highly variable annual estimates of ENP gray whale calf production have shown a negative correlation (ρ = -0.6) with Pacific Arctic Sea ice cover over recent decades (Perryman *et al.*, 2020). This has prompted a hypothesis that extensive late-spring/early-summer ice may physically exclude reproductive females from early season access to important benthic foraging hotspot habitats during an energetically demanding phase of gestation associated with a return from long distance migration and accelerated foetal growth. Researchers examined whether patterns of gray whale distribution and phenology in the Pacific Arctic aligned with this proposed mechanism, particularly in light of two recent deviations (2013-14 and 2017-19) from historical patterns of negative correlation between reproductive output and ice cover. Overall, a nonlinear negative relationship was found between gray whale aerial counts and sea ice cover (GAM, p<0.001), with an increase in negative slope above 45-55% sea ice concentration. Extensive aerial survey effort (641,461km) recorded a small number of gray whale observations at local sea ice concentration values up to 90-95%. However, these rare sightings at high sea ice concentrations generally occurred along the periphery of larger

masses of sea ice and no gray whales were sighted >7km inside the 40% sea ice concentration contour. Comparisons of early season distribution patterns further revealed that gray whale sightings were absent in several key foraging hotspot habitats during years with delayed ice break-up but were present in these habitats in years of early-to-average ice retreat. Passive acoustic records of gray whale vocalizations were somewhat difficult to interpret, however the totality of evidence from aerial and acoustic gray whale observations in the Pacific Arctic was consistent with the hypothesized sea ice exclusion mechanism. These results provided additional lines of evidence supporting an important role of sea ice in gray whale habitat use and reproductive success with implications for population dynamics in a rapidly changing Arctic environment.

The influence of sea ice cover on algal blooms and the knock-on effects to prey availability was discussed as one of the research areas being addressed. Changes in the macro fauna and the dramatic habitat shift were being studied and there may be some switching to pelagic prey, again highlighting the factors where climate change is potential having an effect.

6.4.3 River dolphins

Fernando Trujillo, on behalf of himself, E. Aliaga, Y. Briceño and M. Frias, presented on the issue of climate change and river dolphins in the Amazon and Orinoco basins.

River dolphins in South America are distributed in three river basins: the Amazon, Orinoquia and Tocantins/Araguia, an area of more than 9 million square kilometers. The transformation of these watersheds is enormous due to multiple human activities that threaten not only the dolphins, but also the ecological integrity of these aquatic ecosystems. Climatic alterations, including temperature increases, changes in flood pulse patterns and water stress, constitute a major emerging threat to river dolphin conservation. This has been particularly evident in the Orinoco region of Colombia and Venezuela and in the Bolivian Amazon.

During the last ten years, an increased frequency of dolphins that become trapped in river segments and must be rescued and translocated to areas where their survival is guaranteed has been reported. In the Colombian Orinoquia there were at least 23 individuals and, in the area of the Rio Grande in Bolivia, at least 58. These events are the result of the combination of water stress with deforestation and industrial extraction of water for agricultural crops. The main threat of water stress to dolphins is the effective loss of habitat, considerable reduction of their prey and the possibility of being trapped in bodies of water that eventually dry up and where they would die from starvation, burns and thermal shock.

Future scenarios are not promising, as threats continue to increase. Climate models predict that by 2050 the Amazon could experience a temperature increase of 2 to 3° Celsius and a reduction in vegetation cover of between 30 and 60%, changing from tropical rainforest to savannah ecosystems. Reduced rainfall in the dolphins' range may drastically reduce nutrients in rivers, and flood pulses are already being affected in their periodicity and duration. High temperatures produce anoxic conditions in the water and changes in pH that can be lethal to fish and all life in the water. Dolphin stranding events are increasing every year and there is insufficient logistical and economic response capacity to deal with them. It is necessary to create an emergency fund, train teams in different regions and establish adequate translocation protocols.

In light of the climate-related threats to river dolphins, the workshop made the following recommendation.

Attn: CG, G, R

In light of the climate related threats to river dolphins the workshop **recommended** *the:*

(1) *development of translocation protocols, for dolphins marooned in unsuitable habitats, that include appropriate training, habitat analysis and funding;*
(2) *incorporation of hydrological monitoring into the CMP of South American river dolphins;*
(3) *creation of a network of appropriate experts to assist in river dolphin conservation and management incorporating scientists from different disciplines, representatives from local communities, and Government authorities;*
(4) *implementation of forest restoration programmes where dolphins might be affected; and*
(5) *enhancement of regulations in aquatic habitat conservation in Protected Areas and Ramsar sites.*

6.4.4 Movement of whale species

Tore Haug reported on a review of baleen whale ecology in high-latitude marine ecosystems of both the north Atlantic and north Pacific (Moore *et al.*, 2019).

Biophysical changes in marine ecosystems of the Arctic and subarctic sectors of the Atlantic and Pacific are now evident, driven primarily by sea ice loss, ocean warming and increases in primary productivity. As upper trophic species, baleen whales can serve as sentinels of ecosystem reorganization in response to these biophysical alterations, via changes in their ecology and physiological condition. Oceanographically the north Atlantic and north Pacific offer four contrasting habitats to baleen whales: (i) a broad-deep-strait and deep-shelf inflow system in the Northeast Atlantic (NEA); (ii) a combination of inflow and outflow systems north of Iceland in the central North Atlantic (CNA); (iii) an outflow shelf and basin in the Northwest Atlantic (NWA); and (iv) a narrow-shallow-strait inflow shelf system in the Pacific sector. Information on baleen whale ecology from visual and passive acoustic surveys, combined with available telemetry and diet studies, reveals contrasting patterns of baleen whale occurrence among sectors. In brief, arctic and subarctic waters in the Atlantic sector support a far greater number of seasonally migrant baleen whales than the Pacific sector. Thousands of humpback, fin and common

minke whales occupy the diverse habitats of the Atlantic sector. These species all exhibit flexible diets, focused primarily on euphausiids (krill) and forage fishes (e.g. capelin, herring, sand lance), which are now responding to ecosystems altered by climate change. Conversely, the Pacific sector supports a far greater number of arctic-endemic bowhead whales than the Atlantic sector, as well as a large population of seasonally migrant gray whales. Currently, differences in migratory timing and, to a lesser extent, foraging behaviours, serve to restrict prey competition between the arctic-endemic bowhead whale and seasonally migrant baleen whale species in both sectors. Regional aspects of changes in prey type and availability will likely impact future migratory timing, habitat selection, body condition and diet of baleen whales. Tracking variability in these attributes can provide valuable input to ecosystem models and thereby contribute the sentinel capability of baleen whales to forecasts of future states of high latitude marine ecosystems.

In discussion it was noted that in Icelandic and adjacent waters in the Central North Atlantic, substantial changes in the ecosystem have been reported during the last 2-3 decades concomitantly with increases in temperature and salinity (Astthórsson *et al.*, 2007; Jónsson and Valdimarsson, 2012; Tsubouchi *et al.*, 2021). These changes include pronounced changes in distribution and abundance of several fish species (Campana *et al.*, 2020; Carscadden *et al.*, 2013; Jansen *et al.*, 2020; Valdimarsson *et al.*, 2012) some of which are important forage fish for cetaceans (e.g. capelin and sandeel). During this period (1987-2015) appreciable changes have been observed in distribution and abundance of several cetacean species in Icelandic and adjacent waters (Víkingsson *et al.*, 2015). Fin whale distribution has expanded into the deep waters of the Irminger Sea and their overall abundance has increased. On the Icelandic continental shelf area, humpback whale densities have increased while common minke whale abundance decreased abruptly between 2001 and 2007 (Pike *et al.*, 2020). In terms of biomass, humpbacks have replaced common minke whales as the dominant cetacean species in the Icelandic shelf area (Víkingsson *et al.*, 2015). A research project on the diet of Icelandic minke whales during 2003-07 revealed substantial changes in diet composition, that appeared to be related to changes in prey abundance including a near-collapse of the sandeel population (Víkingsson *et al.*, 2014; 2015). According to the Norwegian NILS surveys (Solvang *et al.*, 2017), the abundance of common minke whales in the Jan Mayen area (also part of the Central North Atlantic medium management area) were considerably higher than in any of the previous surveys in that area. Thus, the data from surveys and diet studies suggest that minke whales in Icelandic waters have responded to recent changes in the environment by a northward shift in distribution and change in diet.

The workshop noted there might be complications in surveying whales due to populations shifting their ranges given climate change, as underscored in this study, and the need to consider whether the tools currently used are still fit for purpose. The timing of surveys may also need to change in line with migration patterns. Long-term surveys are typically consistent in their timing and the area covered, an issue that must be considered in conducting abundance surveys.

6.4.5 Out of habitat animals

Nunny presented on belugas (*Delphinapterus leucas*) which have been recorded potentially outside of what is regarded as their normal habitat or range. This is part of an ongoing project by OceanCare on marine mammals which appear in areas away from their natural habitat and in locations where their health and welfare may be threatened because they come into close contact with human activities or find themselves in unsuitable habitat. Nunny showed a map with 61 records of belugas in Canada, USA, Europe, Japan and Russia. Many of them were recorded in the last 20 years and suggested that it is worth considering whether climate change is prompting these animals to stray from their normal range. It was noted in discussion that other polar species are also being recorded far from what is thought to be their normal distributions, including two walruses in Europe this summer. An international workshop was recently held on these 'out of habitat' animals and how they might best be responded to under the auspices of the UK's Marine Animal Rescue Coalition (Anon., 2021).

It was also noted in discussion that some of the animals highlighted may be exhibiting a natural dispersal phase and that more work needed to be done to establish normal ranges and behaviours. This project is ongoing and this will be further considered.

6.5 Detecting effects

6.5.1 Population assessment

Bengston Nash gave a presentation on Southern hemisphere humpback whales (*Megaptera novaeangliae*) that were recently implemented as sentinels of the Antarctic sea ice system through a Southern Ocean Observing System (SOOS) endorsed project and UN Ocean Decade endorsed activity. Their dependence on southern hemisphere populations on sympagic (ice associated) Antarctic krill (*Euphausia superba*), and their extreme energetic adaptations and migratory life history render them highly suited to this ecosystem surveillance approach. To date, humpback whale populations migrating to Brazilian (A), western (D) and eastern (E1) Australian, and New Caledonian (E2), and Colombian (G) breeding grounds have been included into the Humpback Whale Sentinel Program (HWSP) for circumpolar surveillance of the Antarctic sea ice ecosystem. The longest record of annual measurements (14 years) is available for the E1 migrating stock. The Program targets the sentinel parameters of Adiposity, diet, and fecundity via a toolbox of eight traditional and novel ecological

tracer techniques applied to biopsied tissues from healthy free-roaming animals. To date, the E1 timeline has captured two extreme climatic events in Antarctica: the extreme La Niña event of 2010/11, and most recently, the anomalous climatic events of 2017. In these years whales migrated in poorer body condition, fewer females participated in the migration, and higher calf mortalities were recorded. The role of Antarctic sea ice in influencing krill abundance and availability to predators remains an active area of research, and one which carries clear consequences for the Southern Ocean baleen whale populations. Similarly, the HWSP presents a useful platform for investigating the ecophysiological response of a large cetacean to multiple stressors.

The workshop noted that this work related to several agenda items and posed the question of whether cetaceans make good indicators of climate change. The methodology used in the study was roundly praised and the difficulty in funding such projects was highlighted. A great deal of emphasis is put on novel research but the importance of longer timelines giving power to the analyses was again acknowledged. Piggybacking on other projects, developing new techniques, using existing platforms and collaborating widely were all ways of overcoming difficulties in maintaining these programmes.

The importance of understanding the monitored subjects' ecology was emphasized and a lot of effort had been spent in validating the assumptions such as whether the whales migrate every year. Another example was the use of fatty acid signatures needing careful interpretation as the whale's prey, krill, is omnivorous and this may be a way of looking at the source of the primary productivity. The study was also seen as a framework with which to study non-migratory species such as the Arabian Sea humpback whale. It was noted that tissue samples, if stored correctly could be used to look retrospectively at the animals' health at the time of sampling and only 100mg is needed.

The use of drones to collect data on body condition was an example of the use of new technology being incredibly useful and cost effect.

7. THE IWC ECOSYSTEMS FUNCTIONING WORKSHOP

Ritter reported on an Ecosystems Functioning (EF) workshop held in response to IWC Resolution 2016-3 (IWC, 2017) which 'recognized the need to include consideration of the contributions made by live cetaceans and carcasses present in the ocean to marine ecosystem functioning in conservation, management strategies and decision making.' The Resolution asked the IWC Scientific Committee to develop a gap analysis in regard to research and to develop a plan to prioritize research needs.

The Ecosystems Functioning workshop reviewed existing knowledge on the contribution of cetaceans to ecosystem functioning and addressed four topics: whale falls; nutrient circulation and ocean fertilization and cetaceans as predators (IWC, 2022)[3].

The EF workshop agreed that often it is not a question of whether whales play a role in ecosystem functioning but rather what role they play, which is largely dependent on the scale (from local to global). Given the differences amongst cetacean species it is important not to generalize ecological functions and variations in temporal and spatial scale. It was also noted that a variety of marine species, including small cetaceans, other marine mammals, sharks, large fish, and seabirds also contribute to nutrient availability and transport to marine and terrestrial ecosystems providing important ecological benefits including increasing primary production.

The impact of population declines from commercial whaling on ecosystem functioning was highlighted including the significant loss in carbon sequestration value as a result of commercial whaling. The impact of climate change and other anthropogenic threats on cetaceans and the ecosystem functions they provide was also discussed. It was agreed that studying human-induced changes, including climate change, and their impact on cetaceans' ecosystem functioning is important. Interest in the issue of ecosystem functioning of cetaceans, particularly in the context of climate change, has gained momentum internationally and will likely increase. Discussions about 'blue carbon' and nature-based solutions (NBS) are of interest to stakeholders, especially ENGOs and decision-makers.

In discussion all agreed that given the overlap of the Scientific and Conservation Committee groups it was important for them to work together. Given that climate change is ubiquitous, addressed across all groups, a discussion was needed about the best way to address this issue as it was felt it was not being picked up properly at the moment. Possible ways to do this was to form a working group or have it as an agenda item in more than one sub-group but it would be good learn from other similar organisations as to how they manage this issue. Several other issues span the work of the Scientific Committee, and a consolidated approach would be useful.

8. CAN CETACEANS BE USED AS INDICATORS OF CLIMATE CHANGE?

8.1 Which species, where/what and indicator for what?

See discussion and presentations in Item 6.

[3] *https://archive.iwc.int/?r=19252*.

8.3 Linking to appropriate political processes

See Item 10.

8.4 Identifying and collaborating with relevant climate processes and initiatives

Holm presented an overview of the workshop on Pollution 2025, an initiative of the Scientific Committee's sub-committee on Environmental Concerns. The aim was to study how cumulative impacts from exposure to multiple stressors could best be investigated, which new methods and techniques could be helpful, and which mitigation measures might be recommended. To this end, several frameworks and models were discussed, as well as the utility of tissue culture techniques, aerial and drone photogrammetry, -omics biomarkers, adipocyte index, epigenetics and novel in silico and in vitro techniques. Case studies were presented, such as on the *Deepwater Horizon* oil spill, on health assessments of bowhead whales, a Spanish project on stressors involving trophic interactions, and a monitoring project of harbour porpoises in the Baltic Sea. The participants agreed on the need to understand the biological processes on all levels of the organisms up to the population level. Baseline data, e.g. on adult survival rates, and health measures should be raised more systematically to facilitate comparisons amongst vulnerable populations and develop effective measures. There is a need for long term monitoring studies and the identification of potential indicator species and sentinel parameters. Monitoring of vulnerable populations before stressors occur should be promoted. Recommendations are under development but, in general, the reduction of the amount and level of stressors should be pursued. More interdisciplinary research is recommended and establishing or strengthening the science-policy interface to consider multiple sources of morbidity when developing conservation and management measures.

The Chair thanked Holm and congratulated her on a well-run workshop.

9. RESPONDING TO THE CLIMATE CHANGE THREAT THROUGH 'CLIMATE SMART' MANAGEMENT OR SIMILAR APPROACHES

9.1 Direct response to address and reduce causes of Climate Change - including how to make whale assessments carbon neutral

This matter was not discussed at the workshop but may be considered at a future meeting of the IWC Scientific Committee.

9.2 Adaptive management 1: Potential management actions in response to climate driven changes that may make cetaceans more vulnerable to anthropogenic threats (e.g. changes in distribution in relation to shipping and fisheries, impacts on health)

The workshop considered how changes in human activities as a result of climate change may impact cetaceans. Shipping presents a number of threats, in particular ship strikes and underwater noise, which have been being considered by the Scientific Committee for many years.

In 2018, the International Maritime Organization (IMO) adopted an initial strategy to reduce the total annual GHG emission by at least 50% by 2050 compared to 2008. In November 2021, the IMO recognised the need to strengthen the ambition of this initial strategy and agreed to revise its GHG strategy by 2023. However, it was not able to agree on the level of ambition or set specific new targets. Reducing speeds across shipping fleets has been shown to make a substantial contribution to reducing greenhouse gas (GHG) emissions and remains an effective short-term measure that could be implemented straight away.

Leaper presented an analysis of how reduced ship speeds would also reduce underwater noise and ship strike risk. A number of different speed reduction scenarios that would contribute to GHG reductions were examined. A modest 10% speed reduction across the global fleet has been estimated to reduce overall GHG emissions by around 13% (Faber *et al.*, 2012) and improve the probability of meeting the initial IMO GHG targets by 23% (Comer *et al.*, 2018). Leaper (2019) concluded that such a 10% speed reduction, could reduce the total sound energy from shipping by around 40%. The associated reduction in overall ship strike risk is more uncertain but could be around 50%. Thus, implementing speed reductions would have multiple environmental benefits. It would benefit whale populations globally and complement current efforts to reduce collision risk in identified high risk areas through small changes in routing.

A study commissioned by Belgium had also examined the expected changes in underwater noise in the North Sea based on limiting the speed of all ships to 75% of their design speed. This showed a significant reduction of the emission of greenhouse gasses (of about 10%) combined with a reduction of the underwater noise of 1 to 4 dB (de Jong *et al.*, 2020).

9.3 Adaptive management 2: Responses to expected and observed changes in human activities as a result of climate-driven changes (e.g. increased shipping in Arctic, changes in fisheries, storm-related sewage discharges) and potential management actions in anticipation of these changes

This issue was in part covered under agenda but may be considered at a future meeting of the IWC Scientific Committee.

Fig. 1. A slightly modified version of the Climate-Smart Conservation Cycle (adapted from Stein *et al.* (2014) showing where scenario planning can be incorporated to help address uncertainty.

9.4 Adaptation Toolbox: Management to enhance the adaptability and resilience of cetacean species

9.4.1 Climate Smart Conservation Cycle

Dick presented on this issue. Rapidly changing ecosystems are raising questions such as: How can we prepare for and respond to the impacts of climate change on wildlife and their habitats? What should we be doing differently given these climatic shifts and what actions make sense to continue? The field of Climate Change Adaptation evolved to address these questions and is founded on the concept of climate-smart conservation, defined by Stein *et al.* (2014) as 'the intentional and deliberate consideration of climate change in natural resource management, realized through adopting forward-looking goals and explicitly linking strategies to key climate impacts and vulnerabilities'. The goal of her presentation was to provide a brief overview of several climate adaptation tools and how their use can help address climate change impacts on species and ecosystems and lead to more climate-informed management and science actions.

There are four overarching themes behind climate-smart conservation: (1) act with intentionality; (2) manage for change, not just persistence; (3) reconsider goals, not just strategies; and (4) integrate adaptation into existing work. Ensuring that conservation planning addresses each of these themes can better prepare for managing resources in ways that account for surprises by adopting strategies that are robust to uncertainty.

Tools noted in the presentation were as follows.

(1) The Climate-Smart Conservation Cycle is a framework developed to help with the design and implementation of conservation and resource management issues in the face of climate change. The seven-step cycle, outlined in Fig. 1, is modified slightly to incorporate the scenario planning process. Although this cycle shows a one-way process, it is more of an iterative process, providing opportunities to reflect on previous steps and updating/adjusting as needed.

(2) Climate Vulnerability Assessments (CVAs) are based on the extent to which a species, habitat, ecosystem, place, or project is susceptible to impacts of climate change. CVAs can indicate what is more or less vulnerable and why. This information can contribute to setting priorities or adaptation and conservation actions whilst not specifying the management or policy decisions.

(3) Scenario Planning is a structured process that embraces uncertainty and uncontrollable conditions to explore plausible alternative future conditions under different assumptions to help manage risk and prioritize actions. This process lends itself well to exploring the uncertainty surrounding changing environmental conditions, and it is widely applicable to natural resource management issues. Scenario planning takes what is known today with any number of uncertainties to yield a number of relevant futures for which to prepare. Scenarios allow questions to be raised such as what risks and opportunities will be faced with each scenario? What should be done now to prepare for each scenario? How should any of these scenarios be tracked as they play out over time? This tool can be used to inform recovery planning, resource management in MPAs, and rapid response planning for oil spills, extreme weather events or other disasters.

(4) Resist - Accept - Direct Framework is a tool developed to help make informed, purposeful, and strategic choices to conserve species and ecosystems undergoing ecological transformation. Generally speaking, one can respond to a changing world by resisting - where you work to maintain or restore based upon historical or acceptable current ecosystem conditions, accepting - allowing an ecosystem to change without intervening, or directing - where you actively shape ecosystem change toward preferred new conditions.

(5) MPAs are a source of Blue Carbon through the biodiversity they contain, including the contributions made by the presence of marine mammals within MPAs. These combined benefits were recognized at COP26 with the formal establishment of the International Partnership on MPAs, Biodiversity and Climate Change[4] - an alliance of international government agencies and organizations, working together to progress the evidence base around the role of Marine Protected Areas (MPAs) and biodiversity in tackling climate change. This idea is being explored further by the Greater Farallones National Marine Sanctuary in their two-part series focused on increasing the protection of blue carbon through the use of MPAs[5].

9.4.2 Climate-informed goals and objectives

This matter was not fully discussed at the workshop (but see step 3 in the Climate-Smart Conservation Cycle discussed above) and could be more fully considered at a future meeting of the IWC Scientific Committee.

9.4.3 Vulnerability Assessments (examples: NOAA and ECOADAPT)

Lettrich gave an overview of the use of climate vulnerability assessments (CVAs) for NOAA. Marine mammal management and conservation rely on the best available information. CVAs provide a coarse step to improve understanding of climate change impacts on marine mammal populations. CVAs are a tool used to determine which populations are most vulnerable to a threat, in this case climate change, and what makes them vulnerable. The typical structure of a CVA is that it has three components: (1) exposure; (2) sensitivity; and (3) adaptive capacity (Intergovernmental Panel on Climate Change (IPCC), 2007). A number of vulnerability assessment frameworks exist for a variety of purposes (e.g. wildlife, built systems, social systems; Intergovernmental Panel on Climate Change (IPCC) (2014); Foden *et al.* (2019). Although more vulnerability assessments have been conducted for terrestrial species and habitats than for those in the marine environment, marine species have received recent attention and CVAs, or elements thereof, have been conducted for marine mammals with differing scopes and scales (Albouy *et al.*, 2020; Laidre *et al.*, 2008; Sousa *et al.*, 2021). NOAA Fisheries developed a trait-based CVA approach that uses expert elicitation to score an exposure module and a combined sensitivity/adaptive capacity module for each population and those scores are used to calculate a vulnerability score (Lettrich *et al.*, 2019). Exposure is scored by estimating projected change in environmental parameters within the population's range. Sensitivity and adaptive capacity are scored by estimating a population's biological and ecological traits within a defined scoring rubric (see Lettrich *et al.* (2019) for the full method description and Sousa *et al.* (2021) for use of the method in Macaronesia). Results from the CVAs are expected to be used to guide management actions, contribute to management plans, and help identify research questions. As these approaches are used in more regions, a comparison of methods and results would improve results interpretation and translation to management.

The workshop discussed the disconnect between the global distribution of a species and what can be done about it locally. NOAA scientists are looking at stocks, taking it to a level that management can act upon, looking at exposure to a threat rather than looking over entire large-scale regions. The potential problem with 'group think' was raised as the majority opinion or the loudest voices could sway others or bias results. In response, it was noted that the techniques used have been developed over decades. The criteria are well defined and, in this study, individuals first score independently before group discussions and then independently again, all to minimise undue bias. The IPCC and the Integrating Climate and Ecosystem Dynamics programme (ICED) have used these approaches, but expert consensus is always difficult to achieve.

Work with the North Atlantic right whale has had a strong local focus, with known threats when they are in US waters. NOAA has gone to the effort to assess the threats on the scale that they live their lives even if this means transboundary cooperation otherwise models may only be capturing a small percentage of the problem. It was highlighted that scientists/researchers should quantify the known as well as the unknown.

10. RECOMMENDATIONS FOR FURTHER RESEARCH AND IMPROVING POLICY, INCLUDING RECOMMENDATIONS TO OTHER IGOS AND BUILDING LIAISON, INCLUDING IUCN AND IMMAS

10.1 IMMAs

Important Marine Mammal Areas (IMMAs) are defined as discrete portions of habitat, important to marine mammal species, that have the potential to be delineated and managed for conservation. They are an initiative of the IUCN Species

[4] *https://www.mpabioclimate.org/*.

[5] *https://farallones.noaa.gov/.*

Survival Commission and Notarbartolo di Sciara provided a presentation about them. They are a place-based conservation tool with the potential to be delineated and managed for conservation. IMMAs are not MPAs and are not identified based on management considerations. The identification of IMMAs is an evidence-driven, purely biocentric process based on the application of scientific criteria and the best available science. There are four main IMMA criteria (species or population vulnerability; distribution and abundance; key life cycle areas; and special attributes), which include subcriteria. IMMAs are identified on a regional basis. Between 2016 and 2021, the process has concerned seven marine regions, covering about 35% of the world's ocean, resulting in the identification of 173 IMMAs. Workshops organised in each region follow a predefined process, developed in consultation with the regional marine mammal science and conservation community, to identify candidate IMMAs (cIMMAs) based on received proposals for preliminary Areas of Interest. After the workshop, cIMMAs are submitted to an Independent Review Panel, to verify that the criteria were applied correctly and that cIMMAs were identified based on robust scientific information. cIMMAs are then converted into IMMAs and are made available online via the Task Force's website and dedicated e-Atlas[6].

Place-based conservation approaches can help marine mammals cope with climate disruption by avoiding or mitigating noxious human-made pressures of a different nature that might cumulate with climate-derived pressures in their prime habitat. By pointing to marine mammal habitat whereabouts, IMMAs can indicate the need for establishing protected areas or for considering marine mammal conservation in marine spatial planning. However, climate-driven changes, in turn, affect where IMMAs are, by requiring: (a) adaptation of their boundaries as species shift their ranges poleward; and (b) reassessment of the importance of the area in terms of area occupation and the area's continued ecosystem services to the marine mammals. Accordingly, a need is recognised for repeating the region-based identification effort by reassessing IMMAs on a decadal basis.

One of the strengths of IMMAs is that all the information is gathered in one place and the workshop suggested that part of the assessment could include considering how animals might move with climate change. It was noted that IMMAs are regularly reviewed but highlighting ones which were more likely to be affected for more regular reviewing would be useful.

It was noted in discussion that a very useful aspect of the IMMA process is the collation of information on marine mammals within each area. The workshop made the following recommendation on the assessment process.

Attn: SC, R
The workshop **recommended** *that the IUCN IMMA assessment process should include an evaluation of how the habitat within the IMMA might be altered as a result of climate change and the potential for marine mammals to move to other areas in response to such changes.*

10.2 CCAMLR

Cavanagh on behalf of colleagues from the British Antarctic Survey presented on the impacts of climate change on Southern Ocean ecosystems, looking in particular at synergies between the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and IWC. Southern Ocean marine ecosystems are highly vulnerable to climate-driven change, the impacts of which must be considered as part of conservation and management. CCAMLR is aware of the urgent need to develop climate-responsive options within its ecosystem approach to management. This has been influenced by the body of research undertaken in this area by national and international programmes (including the Integrating Climate and Ecosystem Dynamics in the Southern Ocean programme - ICED; the Southern Ocean Observing System - SOOS and the Scientific Committee on Antarctic Research - SCAR). Moreover, much of this research has contributed to IPCC reports, including the Special Report on Oceans and Cryosphere in a Changing Climate (SROCC) and AR6.

While the regulation of whaling and management of whale stocks is beyond the competency of CCAMLR, the significance of whales as key components of the Antarctic marine ecosystem is increasingly important to CCAMLR in its fishery management approaches, as well as its responsibility for all marine living resources. Key aspects include whales as krill-dependent predators (density patterns, krill consumption estimates, recovery of historically exploited populations); the role of whales in biogeochemical cycling and carbon sequestration; and depredation from longlines by toothed whales (killer whales, sperm whales).

CCAMLR's Article XXIII highlights that its Scientific Committee should seek to develop co-operative working relationships and enter into agreements with the IWC. Over time the Scientific Committees of IWC and CCAMLR have developed such a relationship, including convening a joint IWC-CCAMLR workshop (CCAMLR, 2009), and further intention to hold a second one in the future.

Issues of common interest include interactions between whales and krill; ecosystem modelling; mitigation of anthropogenic threats (e.g. pollution, incidental mortality in fisheries, ship strikes), and impacts of climate change. There are clear benefits to IWC and CCAMLR of working together on climate change issues, including avoiding duplication of effort

[6] *www.marinemammalhabitat.org/imma-eatlas.*

(e.g. sharing relevant climate change information, e.g. see Cavanagh *et al.* (2021); applying relevant scientific expertise (e.g. neither body has climate experts, importance of engaging with external experts, expansion of relevant expert scientific networks); developing shared protocols and methods (e.g. common analytical tools, modelling approaches); strategic planning (e.g. helping define priorities); strengthening key messages using shared outputs (e.g. importance of coordinated long-term datasets and observational networks to better understand climate change impacts). Potential ways to facilitate further collaboration range from the individual expert level to organisational commitments (Castro Jiménez, 2019) such as a memorandum of understanding between IWC and CCAMLR.

There were discussions on the existing links between IWC and CCAMLR and earlier recommendation made by the Scientific Committee for the two organisations to work together on ecosystem function was recalled. A recent project (Castro Jiménez, 2019) explored issues of common interest between the two bodies, concluding that strengthening the relationship between CCAMLR and the IWC would be of mutual interest in addressing these. The two Secretariats have initiated discussion of next steps (including an MoU), although COVID restrictions have slowed progress. The workshop encouraged continued collaboration with CCAMLR and other Antarctic science bodies.

Attn: SC, S

The workshop recalled the Commission's desire for the IWC to continue collaboration with CCAMLR through the Scientific Committee (CO1828) and the Scientific Committee's previous recommendation on international collaboration (SC0918). It noted that climate change was an important issue for both organisations with obvious synergies. Therefore, the workshop **encouraged** *stronger collaboration between IWC and CCAMLR, as well potentially with other Antarctic science bodies (including SCAR and ICED) to enhance understanding of the impacts of climate change in Southern Ocean ecosystems, and to improve dialogue on other cross-cutting issues such as pollution, shipping and tourism.*

11. REVIEW OF ALL RECOMMENDATIONS, INCLUDING CONSIDERATION OF TARGET AUDIENCES

Due to the virtual nature of this workshop not all elements of the planned agenda had been completed. The workshop therefore made the following recommendation to address this matter.

Attn: SC

It was noted that the workshop has not completed all elements of its planned agenda. The workshop ***recommended*** *that a further (i.e. part two) and preferably in-person workshop, to look more fully at some matters, should be held after the review of this workshop report by the Scientific Committee.*

The workshop noted that there may be a need for new approaches to monitoring to provide the necessary data to understand and respond to climate driven changes in an appropriately rapid time frame. Table 1 identifies a number of considerations related to climate change that could be taken into account at the design stage of monitoring programmes in order to maximise the potential value of the data for understanding impacts of climate change and implementing effective management actions. However, these are broad general principles that would require further elaboration to be of most value. The workshop therefore made the following recommendation towards the appointment of a Climate Change Coordinator.

Attn: SC, CC, S

The Workshop therefore **recommended** *that the IWC seek funding to appoint a Climate Change Coordinator to generate a set of guidelines, standards and protocols for maximising the global utility of cetacean monitoring programmes and risk assessments from anthropogenic threats with respect to understanding the implications of climate change. This work would facilitate coordinated design of monitoring programmes as well as ensuring comparability in data sets for analysis.*

The initial task would be to prepare a document for the 2023 SC meeting possibly including a review of SC reports from 68A onwards and produce a summary in time for IWC69 of all the SC work relevant to climate change.

Climate-driven impacts are causing rapid changes to cetacean populations and habitats. In recognition of this fact and the options available for action from the cetacean research community, there was discussion of the need to adjust management goals from ensuring sustainability to building resilience for cetacean species in the coming decades. This approach would require scientific understanding of how climate change is impacting populations and species, marine ecosystems, and the landscape of other anthropogenic threats. In doing so, research could help identify high-priority issues, regions, or species in order to create strategic and targeted management actions that are most likely to minimize additional stressors and increase cetacean population resilience to the impacts of global change. To address these issues two tables related to research recommendations were developed (Tables 1 and 2).

Tables 1 and 2 were used to help produce overarching recommendations from the workshop:

Table 1

Issues related to climate-related research and proposed ways to address them.

Concepts	Types of impact	Issues identified at the workshop	Ideas for further research effort - see recommendations
- How climate change affects cetacean populations and species.	- Distribution, phenology, population dynamics, reproductive success, resilience, diet, health, behaviour in response to climate-induced alterations (e.g. habitat degradation, shifts in range and access to prey, exposure to novel pathogens, novel species compositions/interactions, potential trophic mismatches, and, shifts in range and access to prey).	- Need long time series to capture multiple cycles of global climate signals and/or provide baselines for cetacean responses. - Often difficult to distinguish inter-annual variability from longer-term climate-driven trends. - Confounding effects of other drivers (e.g. other anthropogenic impacts). - Climate impacts can be regionally variable or population/species-specific.	- Prioritise regions known to be experiencing intense climate change impacts, particularly those which are key habitats for cetaceans (for example, IUCN-defined IMMAs). - Improve methods to utilise results from detailed small-scale studies to make wider inferences, for example developing best practice guidance for studies, and power analysis for detection of significant effects. - Conduct multi-way analyses to identify most significant vulnerabilities for species/populations - Maximise survey effort through additional partnerships within and outside the cetacean research community to co-monitor species and relevant environmental parameters. - Assess cetacean population dynamics, behavioural responses, fertility, health, etc. following climate change-induced extreme events (e.g. marine heatwaves) to learn about cetaceans' capacity to respond to and resilience in face of extreme changes/potential future new-normal states. - Model climate impacts on cetacean habitat, prey, and populations.
- How climate change impacts marine ecosystems: using cetaceans as sentinel species. - Marine mammals can sometimes provide insights into changes within marine ecosystems where other methods fail.	- Climate-related shifts in cetacean distribution, health, diet, stranding rates, reproduction and human interactions as proxy for broader ecosystem changes. - Climate-related shifts in prey, foodweb, inter-species interactions, and in ecosystem services provided by cetaceans.	- Challenge in making marine mammal data useful to other research fields and conservation bodies. - Importance of long-term studies. - Understanding what cetaceans are indicating in relation to changes within the marine ecosystem.	- Incorporate multi-disciplinary considerations at the study design stage and identify collaborations with other environmental sciences (e.g. deep-sea, climate, cryosphere). - Investigate ways that cetaceans' 'indicator' or 'umbrella' status can be used to trigger management action. - Review and propose approaches to distinguish climate-related impacts on ecosystems from other variables. - Conduct retrospective studies of links between climate-driven changes and cetacean responses, to better interpret current and future changes.
- How climate change impacts the distribution and intensity of **other threats** to cetaceans.	- Changes in fisheries interactions, shipping routes, pollution, offshore development, noise, tourism, connected to climate (e.g. increasing marine access due to warming, oceanographic shifts in pollutant distribution). - How these stressors can combine to impact a species/population's climate resilience.	- Need for international cooperation to address transboundary/trans-nation threats (e.g. Arctic Council's Protection of Arctic Marine Environment PAME Working Group). - These 'other' threats may have more immediate impacts on cetaceans and may be more actionable for managers.	- Research needed to inform management for resilience: identify high impact or priority stressors/regions/ vulnerability windows and at-risk populations/species. - Use work on cumulative effects of multiple stressors to make inferences about climate change impacts.
- Re-assessments of **management measures** in light of climate change.	- Climate change is accelerating and intensifying population changes and management measures to mitigate threats are not keeping apace.	- How do we make management and conservation actions more dynamic and responsive to rapid climate-induced impacts or changes. - Multitude of assessment metrics available.	- Compare conservation/management outcomes across populations to contextualize and prioritize manage-ment actions. - Scientifically assess success of past management actions (e.g. positive population level responses such as increases in population size, reproductive success or improvements in health parameters) to establish best conservation practice. - Develop methods for tracking policy implementation. - Cooperate with/be aware of regional management bodies, international agreements in this regard.

Table 2

Tools and methods to assess climate-driven impacts on cetaceans.

Climate impact	Scale	Monitoring types (scale of monitoring)
Distribution/ phenology	Population/species	- Opportunistic sighting reports (population/species). - Direct survey (population level). - Passive acoustics (population level). - Satellite tracking (individual/population). - Modelling of environmental parameters and cetacean (or prey) population dynamics and distributions to inform survey locations.
Population dynamics (reproductive rates, mortality)	Population	- Direct survey in breeding areas with photo-ID. - Genetics to identify individuals/parentage (individual/population). - Hormones to assess pregnancy/stress (individual/population). - Sightings/observations e.g. cow-calf counts (population). - stranding monitoring (population).
Diet	Individual/population	- Tissue samples for stable isotopes/fatty acids (individual/population). - Faecal samples to identify prey, stomach contents of strandings (individual/population). - Prey associations based on observation/concurrent prey surveys (population). - Short-term tagging to measure foraging behaviour (individual/population). - Short-term camera-tagging/video analyses (individual).
Health	Individual/population	- Body condition via: UAV or side-on photography. - Use of noninvasive Blow collection - free-ranging cetaceans - evolving technique - various explorations (hormone, disease possible). - Tissue samples - adipose index, pollutant load (individual/population). - Novel tools epigenetics - biological age versus chronological age - concept is accelerated ageing is driven by poor health (link to IWC cumulative stressor workshop). - Use of molecular diagnostics for CDOC (cetacean diseases of concern) - the latter are likely being introduced through range expansions. - Strandings thorough workup link to IWC Stranding Expert Panel work.
Stress and behavioural responses	Individual/population	- Observational studies (e.g. changes in time spent foraging; alterations to diving/surfacing patterns; altered vocalizations/communication; avoidance behaviour; tagging studies).

Attn: R, SC

The workshop **recommended** *that work on how climate change affects cetacean populations and species should:*

(1) *prioritise regions known to be experiencing intense climate change impacts, particularly those which are key habitats for cetaceans (for example, where these may overlap with IUCN-defined IMMAs);*
(2) *improve methods to utilise results from detailed small-scale studies to make wider inferences, for example developing best practice guidance for studies, and power analysis for detection of significant effects;*
(3) *conduct multi-way analyses to identify most significant vulnerabilities for species/populations; and*
(4) *maximise survey effort through additional partnerships within and outside the cetacean research community to co-monitor species and relevant environmental parameters.*

Attn: CG, C, S, R

The workshop noted how cetaceans could be used as sentinel species providing insights into marine ecosystem changes where other methods fail. In this regard the workshop **recommended***:*

(1) *the incorporation of multi-disciplinary considerations at the design stage of any research programme and identify possible collaborations with other environmental sciences (e.g. deep-sea, climate, cryosphere);*
(2) *investigation into ways that cetaceans' 'indicator' or 'umbrella' status can be used to trigger management actions; and*
(3) *that research programmes review and propose approaches to distinguish climate-related impacts on ecosystems from other variables and conduct retrospective studies of links between climate-driven changes and cetacean responses, to better interpret current and future changes.*

Attn: CG, C, S, R

Climate change is known to impact the distribution and intensity of other threats to cetacean populations and thus the workshop **recommended** *that:*

(1) *research is needed to inform a switch in the focus for management of cetaceans from sustainability to one of building resilience in their populations;*

(2) *research is needed to identify priorities, including: high impact stressors, regions under the greatest threat, vulnerability windows and at-risk populations or species; and*
(3) *work on cumulative effects of multiple stressors should be used to make inferences about climate change impacts.*

Attn: CG, C, S, R
The workshop noted that climate change is accelerating changes in cetacean populations and current management measures to mitigate threats may no longer be suitable. The workshop therefore **recommended***:*

(1) *research to compare across populations to contextualize and prioritize management actions;*
(2) *scientific assessment of the success of past management actions to establish best conservation practice;*
(3) *the development of methods for tracking policy implementation; and*
(4) *cooperation with regional management bodies and international agreements in the mitigation of climate threats to cetacean populations.*

12. CLOSE OF MEETING AND FUTURE PLANS

Staniland, on behalf of Zerbini the Chair of the SC and Lent the Executive secretary thanked everyone for participating in the workshop, for sharing their expertise and giving their valuable time. He noted that all the speakers had made excellent presentations and the workshop had hosted some fascinating discussions.

He thanked the rapporteurs and gave special thanks to Simmonds for organising the workshop that had presented a number of challenges notably an enforced shift from being held in person to virtual. Staniland noted the amazing job Simmonds had done facilitating the workshop discussions and encouraging people to produce text, tables and recommendations.

The Chair thanked everyone for taking part and noted that we had heard not only about whales but also 'diatom fluff', 'black swans' and many other things, and that he had learnt a lot. He recognised the difficulties and frustration of working across many time zones in the virtual world and thanked everyone for their patience. He thanked the IWC team for their support, including Julie Creek and the IT staff. He also thanked Russell Leaper, Iain Staniland, Laetitia Nunny and Silvia Frey for invaluable support in the preparation and delivery of the workshop and, likewise, the workshop Steering Committee. Finally, he closed the meeting by wishing everyone a happy, safe and healthy festive season.

REFERENCES

Albouy, C., Delattre, V., Donati, G., Frölicher, T.L., Albouy-Boyer, S., Rufino, M., Pellissier, L., Mouillot, D. and Leprieur, F. 2020. Global vulnerability of marine mammals to global warming. *Sci. Rep.* 10(1): 1-12.

Amundin, M., Carlström, J., Thomas, L., Carlén, I., Koblitz, J.C., Teilmann, J. and Tougaard, J. 2021. Estimating the abundance of the critically endangered Baltic Proper Harbour Porpoise (*Phocoena Phocoena*) population using passive acoustic monitoring'. Author preprint in review (July). [Available at: *https://doi.org/10.22541/au.162755770.03327482/v1*].

Anon. 2021. 'Out of Habitat' Marine Mammals Workshop Report. 30 September-1 October 2021. Held virtually. 46pp. [Available at: *https://wildanimalwelfare.com/reports/*].

Astthórsson, O.S., Gislason, A. and Jonsson, S. 2007. Climate variability and the Icelandic marine ecosystem. *Deep-Sea Res. II* 54: 2456-77.

Bar-On, Y.M., Phillips, R. and Milo, R. 2018. The biomass distribution on Earth. *Proc. Nat. Acad. Sci.*: 201711842. Available at: *http://www.pnas.org/content/115/25/6506*.

Boveng, P.L., Ziel, H.L., McClintock, B.T. and Cameron, M.F. 2020. Body condition of phocid seals during a period of rapid environmental change in the Bering Sea and Aleutian Islands, Alaska. *Deep Sea Res. II: Topical Studies in Oceanography* 181: 104904.

Campana, S.E., Stefánsdóttir, R.B., K.B., J. and Sólmundsson, J. 2020. Shifting fish distributions in warming sub-Arctic oceans. *Sci. Rep.* 10(1): 16448.

Carlén, I., Nunny, L. and Simmonds, M.P. 2021. Out of sight, out of mind: How conservation is failing European porpoises. *Front. Mar. Sci.* 8: 617478. [Available at: *https://doi.org/10.3389/fmars.2021.617478*].

Carlén, I., Thomas, L., Carlström, J., Amundin, M., Teilmann, J., Tregenza, N. and Tougaard, J. 2018. Basin-scale distribution of harbour porpoises in the Baltic Sea provides basis for effective conservation actions. *Biol. Cons.* 226(October): 42-53. [Available at: *https://doi.org/10.1016/j.biocon.2018.06.031*].

Carscadden, J.E., Gjøsæter, H. and Vilhjálmsson, H. 2013. A comparison of recent changes in distribution of capelin (*Mallotus villosus*) in the Barents Sea, around Iceland and in the Northwest Atlantic. *Prog. Oceanog.* 114: 64-83. [Available at: *https://doi.org/10.1016/j.pocean.2013.05.005*].

Castro Jiménez, M. 2019. What are the issues of common interest facing the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and the International Whaling Commission (IWC) Scientific Committees in studying and managing anthropogenic impacts on Southern Ocean ecosystems?, University of Cambridge, Department of Geography, Cambridge, UK.

Cavanagh, R.D., Trathan, P.N., Hill, S.L., Melbourne-Thomas, J., Meredith, M.P., Hollyman, P., Krafft, B.A., Muelbert, M.M.C., Murphy, E.J., Sommerkorn, M., Turner, J. and Grant, S.M. 2021. Utilising IPCC assessments to support the ecosystem approach to fisheries management within a warming Southern Ocean. *Mar. Pol*. [Available at: *https://doi.org/10.1016/j.marpol.2021.104589*].

Convention on the Conservation of Antarctic Marine Living Resources. 2009. Report of the twenty-seventh meeting of the Commission, Hobart, Australia, 27 October - 7 November 2008. 203pp.

Comer, B., Chen, C. and Rutherford, D. 2018. Relating short-term measures to IMO's minimum 2050 emissions reduction target, in Appendix to paper MEPC 73/INF.27 presented to IMO Marine Environment Protection Committee. 73rd session, (London).

Costa, D.P., Huckstadt, L.A., Crocker, D.E., McDonald, B.I., Goebel, M.E. and Fedak, M.A. 2010. Approaches to studying climatic change and its role on the habitat selection of Antarctic pinnipeds. *Integrative and Comparative Biology* 50(6): 1018-30.

de Jong, C., Harmsen, J., Bekdemir, C. and Hulskotte, J. 2020. Summary of report TNO 2020 R11855. Reduction of emissions and underwater radiated noise for the Belgian shipping sector. IMO MEPC 76/INF.17.

Faber, J., Nelissen, D., Hon, G., Wang, H. and Tsimplis, M. 2012. *Regulated Slow Steaming in Maritime Transport: An Assessment of Options, Costs and Benefits*. CE Delft, Delft.

Foden, W.B., Young, B.E., Akçakaya, H.R., Garcia, R.A., Hoffmann, A.A., Stein, B.A., Thomas, C.D., Wheatley, C.J., Bickford, D., Carr, J.A. and Hole, D.G. 2019. Climate change vulnerability assessment of species. *Wiley Interdisciplinary Reviews: Climate Change* 10(1): p.e551.

García-Aguilar, M.C., Turrent, C., Elorriaga-Verplancken, F.R., Arias-Del-Razo, A. and Schramm, Y. 2018. Climate change and the northern elephant seal (*Mirounga angustirostris*) population in Baja California, Mexico. *PloS ONE* 13(2): e0193211.

George, J.C., Druckenmiller, M., Laidre, K.L., Suydam, R. and Person, B. 2015. Bowhead whale body condition and links to summer sea ice and upwelling in the Beaufort Sea. *Prog. Oceanog.* 136: 250-62. [Available at: *https://doi.org/10.1016/j.pocean.2015.05.001*].

Givens, G.H. and Weller, D.W. 2021. Two Aboriginal Subsistence Whaling stocks remain in tested parameter space. 10pp. Paper SC/68C/ASW/02 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 10pp. [Paper available from the Office of this Journal].

Hückstädt, L.A., Piñones, A., Palacios, D.M., McDonald, B.I., Dinniman, M.S., Hofmann, E.E. and Costa, D.P. 2020. Projected shifts in the foraging habitat of crabeater seals along the Antarctic Peninsula. *Nature Climate Change* 10(5): 472-77.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II. pp.976. *In*: Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J. and Hanson, C.E. (eds). *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK.

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate change 2014: impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of Working Group II. pp.1132. *In*: Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastandrea, P.R. and White, L.L. (eds). *Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK.

Intergovernmental Panel on Climate Change (IPCC). 2021. Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I. *In*: Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S.L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M.I., Huang, M., Leitzell, K., Lonnoy, E., Matthews, J.B.R., Maycock, T.K., Waterfield, T., Yelekçi, O., Yu, R. and Zhou, B. (eds). *Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK.

International Whaling Commission. 2017. Chair's Report of the 66th Meeting. Annex E. Resolutions Adopted at the 66th Meeting. Resolution 2016-3. Resolution on Cetaceans and their Contribution to Ecosystem Functioning. *Rep. 65 Mtg Int. Whaling Commn* 2016:50.

International Whaling Commission. 2022. Report of the IWC-CMS Workshop on the Cetacean Ecosystem Functioning, virtual meeting, 19-21 April 2021. *J. Cetacean Res. Manage. (Suppl.)* 23:39pp.

Jansen, T., F.T., H. and Bárðarson, B. 2020. Larval drift dynamics, thermal conditions and the shift in juvenile capelin distribution and recruitment success around Iceland and East Greenland. *Fish. Res.* 236: 105845. [Available at: *https://doi.org/10.1016/j.fishres.2020.105845*].

Jones, C.W., Risi, M.M. and Bester, M.N. 2020. Local extinction imminent for southern elephant seals *Mirounga leonina* at their northernmost breeding site, Gough Island - South Atlantic Ocean. *Polar Biol.* 43(2020): 893-97.

Jónsson, S. and Valdimarsson, H. 2012. Water mass transport variability to the North Icelandic shelf, 1994-2010. *ICES J. Mar. Sci.* 69(5): 809-15.

Laidre, K.L., Stirling, I., Lowry, L.F., Wiig, Ø., Heide-Jørgensen, M.P. and Ferguson, S.H. 2008. Quantifying the sensitivity of Arctic marine mammals to climate-induced habitat change. *Ecol. Appl.* 18(2 Supplement): S97-S125. [Available at: *https://doi.org/10.1890/06-0546.1*].

Laws, R.M. 1977. Seals and whales of the southern ocean. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences* 279: 81-96.

Leaper, R. 2019. The role of slower vessel speeds in reducing greenhouse gas emissions, underwater noise and collision risk to whales. *Front. Mar. Sci.* 6. [Available at: *https://www.frontiersin.org/article/10.3389/fmars.2019.00505*].

Lettrich, M.D., Asaro, M.J., Borggaard, D.L., Dick, D.M., Griffis, R.B., Litz, J.A., Orphanides, C.D., Palka, D.L., Pendleton, D.E. and Soldevilla, M.S. 2019. A method for assessing the vulnerability of marine mammals to a changing climate. *NOAA Tech. Mem.* NMFS-F/SPO-196.

Meier, H.E.M., Kniebusch, M., Dieterich, C., Gröger, M., Zorita, E., Elmgren, R., Myrberg, K., Ahola, M., Bartosova, A., Bonsdorff, E., Börgel, F., Capell, R., Carlén, I., Carlund, T., Carstensen, J., Christensen, O.B., Dierschke, V., Frauen, C., Frederiksen, M., Gaget, E., Galatius, A., Haapala, J.J., Halkka, A., Hugelius, G., Hünicke, B., Jaagus, J., Jüssi, M., Käyhkö, J., Kirchner, N., Kjellström, E., Kulinski, K., Lehmann, A., Lindström, G., May, W., Miller, P., Mohrholz, V., Müller-Karulis, B., Pavón-Jordán, D., Quante, M., Reckermann, M., Rutgersson, A., Savchuk, O.P., Stendel, M., Tuomi, L., Viitasalo, M., Weisse, R. and Zhang, W. 2021. Climate Change in the Baltic Sea Region: A Summary [preprint]. *Earth Syst. Dynam. Discuss.* [Available at: *https://doi.org/10.5194/esd-2021-67*].

Meyer-Gutbrod, E.L., Greene, C.H., Davies, K.T.A. and Johns, D.G. 2021. Ocean regime shift is driving collapse of the North Atlantic right whale population. *Oceanography* 34(3): 22-31. [Available at: *https://doi.org/10.5670/oceanog.2021.308*].

Moore, S., 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. Oceanol.* 76: 15. [Available at: *https://doi.org/10.1016/j.pocean.2019.05.010*].

Pace, R.M., Corkeron, P.J. and Kraus, S.D. 2017. State-space mark-recapture estimates reveal a recent decline in abundance of North Atlantic right whales. *Ecol. Evol.* 7: 8730-41. [Available at: *https://doi.org/10.1002/ece3.3406*].

Perryman, W.L., Joyce, T., Weller, D.W. and Durban, J.W. 2020. Environmental factors influencing eastern north Pacific Gray whale calf production 1994-2016. *Mar. Mamm. Sci.* 37(2): 1-15. [Available at: *https://doi.org/10.1111/mms.12755*].

Pike, D.G., Gunnlaugsson, T., Sigurjómsson, J. and Víkingsson, G. 2020. Distribution and abundance of cetaceans in Icelandic waters over 30 years of aerial surveys. *NAMMCO Sci. Pub.* 11. [Available at: *https://doi.org/10.7557/3.4805*].

Record, N.R., Runge, J.A., Pendleton, D.E., Balch, W.M., Davies, K.T.A., Pershing, A.J., Johnson, C.L., Stamieszkin, K., Ji, R. and Feng, Z. 2019. Rapid climate-driven circulation changes threaten conservation of endangered North Atlantic right whales. *Oceanography* 32(2): 162-69. [Available at: *https://doi.org/10.5670/oceanog.2019.201*].

Savoca, M.S., Czapanskiy, M.F. and Kahane-Rapport, S.R. 2021. Baleen whale prey consumption based on high-resolution foraging measurements. *Nature* 599: 85-90. [Available at: *https://doi.org/10.1038/s41586-021-03991-5*].

Sepúlveda, M., Quiñones, R.A. and Esparza, C. 2020. Vulnerability of a top marine predator to coastal storms: a relationship between hydrodynamic drivers and stranding rates of newborn pinnipeds. *Sci. Rep.* 10: 12807. [Available at: *https://doi.org/10.1038/s41598-020-69124-6*].

Solvang, H.K., Skaug, H.J. and Øien, N. 2017. Preliminary abundance estimates of common minke whales in Svalbard 2014, the Norwegian Sea 2015, and Jan Mayen 2016 – the first three years of the survey cycle 2014-2019 of the Northeast Atlantic. Paper SC/67a/RMP03 presented to the IWC Scientific Committee, May 2017, Bled, Slovenia (unpublished). 12pp. [Paper available from the Office of this Journal].

Sousa, A., Alves, F., Arranz, P., Dinis, A., Fernandez, M., García, L.G., Morales, M., Lettrich, M., Coelho, R.E., Costa, H. and Lourenço, T.C. 2021. Climate change vulnerability of cetaceans in Macaronesia: Insights from a trait-based assessment. *Sci. Total Environ.* 795: 148652.

Stein, B.A., Glick, P., Edelseon, N. and Staudt, A. 2014. *Climate-Smart Conservation: Putting Adaptation Principles into Practice*. National Wildlife Federation, Washington, D.C.

Sydeman, W.J., Schoeman, D.S., Thompson, S.A., Hoover, B.A., García-Reyes, M., Daunt, F. and Watanuki, Y. 2021. Hemispheric asymmetry in ocean change and the productivity of ecosystem sentinels. *Science* 372(6545): 980-83.

Tsubouchi, T., Våge, K., Hansen, B., Larsen, K.M.H., Østerhus, S., Johnson, C., Jónsson, S. and Valdimarsson, H. 2021. Increased ocean heat transport into the Nordic Seas and Arctic Ocean over the period 1993-2016. *Nature Climate Change* 11: 21-26.

Valdimarsson, H., Ástþórsson, Ó. and Pálsson, J. 2012. Hydrographic variability in Icelandic waters during recent decades and related changes in distribution of some fish species. *ICES J. Mar. Sci.* 69: 816-25.

Velarde, E., Ezcurra, E. and Anderson, D.W. 2015. Seabird diet predicts following-season commercial catch of Gulf of California Pacific Sardine and Northern Anchovy. *J. Mar. Syst.* 146: 82-88.

Ventura, F., Granadeiro, J.P., Lukacs, P.M., Kuepfer, A. and Catry, P. 2021. Environmental variability directly affects the prevalence of divorce in monogamous albatrosses. *Proc. Roy. Soc. B* 288(1963): 20212112.

Víkingsson, G., Elvarsson, B., Olafsdóttir, A., Sigurjónsson, J., Chosson, V. and Galan, A. 2014. Recent changes in the diet composition of common minke whales (*Balaenoptera acutorostrata*) in Icelandic waters. A consequence of climate change? *Mar. Biol. Res.* 10: 138-52.

Víkingsson, G.A., Pike, D.G., Valdimarsson, H., Schleimer, A., Gunnlaugsson, T., Silva, T., Elvarsson, B.Þ., Mikkelsen, B., Øien, N., Desportes, G., Bogason, V. and Hammond, P.S. 2015. Distribution, abundance, and feeding ecology of baleen whales in Icelandic waters: have recent environmental changes had an effect? *Front. Ecol. Evol.* 3: 1-18.

Williams, R., Lacy, R.C., Ashe, E., Hall, A., Plourde, S., McQuinn, I. and Lesage, V. 2021. Climate change complicates efforts to ensure survival and recovery of St. Lawrence Estuary beluga. *Mar. Poll. Bull.* 173(B): 113096. [Available at: *https://doi.org/10.1016/j.marpolbul.2021.113096*].

Yong, E. 2021. The enormous hole that whaling left behind. *The Atlantic Magazine* 3 November 2021. [Available at: *https://www.theatlantic.com/science/archive/2021/11/whaling-whales-food-krill-iron/620604/*].

Annex A

List of Participants

Alexandre Zerbini, Marine Mammal Laboratory, Alaska Fisheries Science Center, NOAA Fisheries, 7600 Sand Point Way NE, Seattle, WA, 98115-6349, USA. *Email: alex.zerbini@noaa.gov*

Alyson Fleming, University of Wisconsin, Madison, USA. *Email: alyson.fleming@gmail.com*

Andreia Sousa, Faculty of Sciences, University of Lisbon, Portugal. *Email: agsousa@fc.ul.pt*

Chris Johnson, WWF Protecting Whales & Dolphins Initiative, WWF-Australia, 60 Leicester St. Level 3, Carlton, Victoria 3053, Australia. *Email: cjohnson@wwf.org.au*

Chris Parsons, National Science Foundation, Division of Ocean Sciences, National Science Foundation, 2415 Eisenhower Ave, Alexandria, VA 22314, USA. *Email: ecparson@nsf.gov*

David Weller, NOAA Fisheries, Southwest Fisheries Science Center, La Jolla, California 92037, USA. *Email: dave.weller@noaa.gov*

Debra Palka, Research Fishery Biologist, Northeast Fisheries Science Center, 166 Water St., Woods Hole, MA, USA. *Email: debra.palka@noaa.gov*

DJ Schubert, Animal Welfare Institute, 900 Pennsylvania Avenue, SE, Washington DC 20003, USA. *Email: dj@awionline.org*

Dori Dick, Senior Technician/Scientist, OPR-OST Directors' Climate Initiative, Contractor with Ocean Associates, Inc. in support of NOAA Fisheries Office of Protected Resources, U.S. Department of Commerce. *Email: dori.dick@noaa.gov*

Ed Goodall, Green Whale Programme Manager, WDC, Whale and Dolphin Conservation, Brookfield House, 38 St. Paul Street, Chippenham, Wiltshire, SN15 1LJ, UK. *Email: ed.goodall@whales.org*

Elisa Seyboth, Cape Peninsula University of Technology, Centre for Sustainable Oceans, Faculty of Applied Sciences, Cape Peninsula University of Technology, Cape Town 8000, South Africa. *Email: seybothe@cput.ac.za*

Elliott Hazen, NOAA Southwest Fisheries Science Center, 99 Pacific St. #255A Monterey, CA 93940, USA. *Email: elliott.hazen@noaa.gov*

Fabian Ritter, Whale and Dolphin Conservation (WDC), Implerstraße 55, D-81371 München, Germany. *Email: fabian.ritter@whales.org*

Fernando Trujillo, Foundation Omacha, Carrera 20-130-32, Bogotá, Colombia. *Email: fernando@omacha.org*

Frances Gulland, Marine Mammal Commission, USA, 267 Bret Harte Road, San Rafael, CA 94901, USA. *Email: francesgulland@gmail.com*

Gianna Minton, Megaptera Marine Conservation. *Email: gianna.minton@gmail.com*

Gísli Víkingsson, Marine and Freshwater Research Institute, Fornubúðum 5, 220 Hafnarfjörður, Iceland. *Email: gisli.vikingsson@hafogvatn.is*

Giuseppe Notarbartolo di Sciara, Tethys Research Institute, Via Benedetto Marcello 43, 20124 Milano, Italy. *Email: disciara@tethys.org*

Heidrun Frisch-Nwakanma, Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals (CMS), UN Campus, Platz der Vereinten Nationen 1, 53113 Bonn, Germany. *Email: heidrun.frisch-nwakanma@un.org*

Iain Staniland, Head of Science, Conservation and Management, International Whaling Commission, The Red House, 135 Station Road, Impington, Cambridge, CB24 9NP, UK. *Email: Iain.Staniland@iwc.int*

Ida Carlén, Coalition Clean Baltic, Östra Ågatan 53, SE-753 22 Uppsala, Sweden. *Email: ida.carlen@ccb.se*

Imogen Webster, Lead for Programme Development, International Whaling Commission, The Red House, 135 Station Road, Impington, Cambridge, CB24 9NP, UK. *Email: imogen.webster@iwc.int*

Jennifer Jackson, British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 0ET, UK. *Email: jeck@bas.ac.uk*

Jeremy Kiszka, Florida International University, 3000 NE 151st Street, North Miami, FL-33181, USA. *Email: jkiszka@fiu.edu*

Kate O'Connell, Animal Welfare Institute. *Email: kate.oconnell@balaena.org*

Laetitia Nunny, Wild Animal Welfare, Carrer Consell, 08530 La Garriga, Barcelona, Spain. *Email: laetitia.nunny@mac.com*

Lindsay Porter, Southeast Asia Marine Mammal Research, Hong Kong. *Email: lindsay.jp@gmail.com*

Lorenzo Rojas-Bracho, PNUD Sinergia Conanp. *Email: lrojasbracho@gmail.com*

Luís António de Andrade Freitas, Head of the Unit, Madeira Whale Museum, Rua Garcia Moniz n° 1, 9200-031 Caniçal, Madeira. Email: *luisfreitas@museudabaleia.org*

Mark Simmonds, University of Bristol, School of Veterinary Sciences, Langford House Dolberry, Bristol, BS40 5DU, UK. *Email: mark.simmonds@sciencegyre.co.uk*

Martina Janů Mrnková, Ministry of the Environment, Czech Republic, Unit of International Conventions, Department of Species Protection and Implementation of International Commitments, Ministry of the Environment of the Czech Republic, Vršovická 65, 100 10, Prague 10, Czech Republic. *Email: martina.janu@mzp.cz*

Matthew Lettrich, ECS Federal in support of NOAA Fisheries. *Email: matthew.lettrich@noaa.gov*
Matthew Savoca, Stanford University. *Email: msavoca13@gmail.com*
Miguel Angel Iñíguez Bessega, Delegation of Argentina, Potosí 2087, Olivos, Province of Buenos Aires, Argentina. *Email: iniguez1966@gmail.com*
Nadine Johnston, British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 0ET, UK. *Email: nmj@bas.ac.uk*
Nathalie Houtman, WWF-NL. *Email: nhoutman@wwf.nl*
Nature McGinn, Conservation Biology Division Director, Northwest Fisheries Science Center, Conservation Biology, 2725 Montlake Blvd. East, Seattle WA 98112, USA. *Email: Nature.McGinn@noaa.gov*
Patricia Holm, University of Basel, Dept Environm Sci., MGU, Vesalgasse 1, CH-4056 Basel, Switzerland. *Email: patricia.holm@unibas.ch*
Peter Corkeron, New England Aquarium, Anderson Cabot Center for Ocean Life, Central Wharf, Boston, MA 02110, USA. *Email: pcorkeron@neaq.org*
Philip Trathan, British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 OET, UK. *Email: pnt@bas.ac.uk*
Rachel Cavanagh, British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 OET, UK. *Email: rcav@bas.ac.uk*
Randall Reeves, Okapi Wildlife Associates. *Email: rrreeves@okapis.ca*
Raphaela Stimmelmayr, Veterinary Surgeon, M.Sc. Ph.D., Wildlife Veterinarian/Research Biologist. (1) Department of Wildlife Management North Slope Borough, North Slope Borough, Barrow 99723, Alaska. (2) Research Scientist, Institute of Arctic Biology, University of Alaska Fairbanks, 902 N. Koyukuk Dr., P.O. Box 757000 Fairbanks, AK 99775-7000, USA. *Email: Rafstimmel@gmail.com; raphaela.stimmelmayr@north-slope.org*
Rebecca Lent, Executive Secretary, International Whaling Commission, The Red House, 135 Station Road, Impington, Cambridge, CB24 9NP, UK. *Email: rebecca.lent@iwc.int*
Rob Williams, Oceans Initiative, 117 E. Louisa Street #135 Seattle, WA 98102, USA. *Email: Rob@oceansinitiative.org*
Robert Suydam, Senior Wildlife Biologist, North Slope Borough, Department of Wildlife Management, Box 69, Barrow, AK 99723, USA. *Email: Robert.Suydam@north-slope.org*
Russell Leaper, IFAW, Canal House, Banavie, Fort William, PH337LY, UK. *Email: russell@rcleaper.com*
Sandra Striegel, OceanCare, PO Box 372, CH-8820 Wädenswil, Switzerland. *Email: sstriegel@oceancare.org*
Sarah McKain, Programme Officer, International Whaling Commission, The Red House, 135 Station Road, Impington, Cambridge, CB24 9NP, UK. *Email: sarah.mckain@iwc.int*
Silvia Frey, KYMA Sea Conservation and Research, Nelkenstrasse 7, CH-8006 Zürich, Switzerland. *Email: silvia@kyma-sea.org*
Stephanie Langerock, Federal Public Service Health, Food Chain Safety and Environment, Belgium. *Email: stephanie.langerock@health.fgov.be*
Stephanie Ploen, Stellenbosch University, South Africa. *Email: stephanie.ploen@gmail.com*
Stephanie Reiss, Oceans Initiative, 117 E. Louisa Street #135 Seattle, WA 98102, USA. *Email: stephanie@oceansinitiative.org*
Steve Ferguson, Fisheries and Oceans Canada, 501 University Crescent, Winnipeg, MB, R3T 2N6, Canada. *Email: steve.ferguson@dfo-mpo.gc.ca*
Susan Bengtson Nash, Griffith University, Australia. *Email: s.bengtsonnash@griffith.edu.au*
Susie Grant, British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 0ET, UK. *Email: suan@bas.ac.uk*
Teri Rowles, Senior Advisor for Marine Mammal Health Science, Office of Protected Resources, National Marine Mammal Health and Stranding Response Program, Office of Protected Resources, 1315 East-West Highway, 13th Floor Silver Spring, MD 20910, USA. *Email: teri.rowles@noaa.gov*
Theresa Koch, University of Vienna. *Email: theres-koch@web.de*
Tina Fahy, NOAA Fisheries. *Email: Christina.Fahy@noaa.gov*
Tore Haug, Institute of Marine Research, Fram Centre, PO Box 2606, Stakkevollan, 9294 Tromsø, Norway. *Email: tore.haug@hi.no*
Toshihide Kitakado, Tokyo University of Marine Science and Technology, Japan. *Email: kitakado@kaiyodai.ac.jp*
Trevor Joyce, contractor with: Environmental Assessment Services, Inc. Affiliated with: NOAA Southwest Fisheries Science Center, 8901 La Jolla Shores Drive, La Jolla, CA 92037, USA. *Email: trevor.joyce@noaa.gov*
Véronique Lesage, Fisheries and Oceans Canada, Maurice-Lamontagne Institute, Mont-Joli, Quebec , Canada. *Email: veronique.lesage@dfo-mpo.gc.ca*
Vicki James, WDC, Whale and Dolphin Conservation, Brookfield House, 38 St Paul Street, Chippenham, Wiltshire, SN15 1LJ, UK. *Email: vicki.james@whales.org*
Victor Smetacek, Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Postbrookstr. 2, 27574 Bremerhaven, Germany. *Email: victor.smetacek@awi.de*
Viv Tulloch, Conservation Decisions Lab, Department of Forest and Conservation Sciences, University of British Columbia, Vancouver BC, Canada. *Email: v.tulloch@ubc.ca*

Annex B

Agenda

1. Introductions
2. Review of TOR and agenda
3. Appointment of Chair and Rapporteurs
4. Previous and ongoing work on climate change undertaken by IWC
5. Summary of IPCC latest report (executive summary)
6. Review of the latest developments in terms of understanding the implications for cetaceans of climate change
   (a) Major climate and non-climate drivers for cetaceans impacts, including synergies
   (b) Predicted effects (cetaceans, habitats and prey)
   Direct and indirect impacts
   (c) Observed effects (cetaceans, habitats and prey and other species)
   Direct and indirect impacts
   Other species - pinniped examples
   (d) Case studies
   - North Atlantic right whales
   - Gray whale die off
   - Southern right whale recovery affected by El Niño
   - Movement of whale species - e.g. into Arctic
   - Out of habitat animals - e.g. wandering belugas
   - Baltic porpoises
   - River dolphins

   (e) Detecting effects
   i. Population counts
   ii. Health assessments
   Nutritional assessments (and fecundity), biopsies, photography
   Indicators needed to assess status of cetaceans
   iii. Migration and habitat selection
   iv. Consideration of how to better survey cetacean population that may move habitats
7. Report from the IWC Ecosystems Functioning Workshop (summary and highlighting any issues of mutual interest)
8. Can cetaceans be used as indicators of climate change?
   (a) Which species/where/what and indicator for what?
   (b) How do we tease out the effects of climate change from other factors
   (c) Linking this to appropriate political processes - e.g. in other conventions such as the potential for cetacean indicators to feed into CBD - monitoring framework and providing examples of cetaceans into the work of the IPCC
   (d) Identifying and collaborating with relevant climate processes and initiatives
9. Responding to the climate change threat through 'climate SMART' management or similar approaches
   (a) Direct response to address and reduce causes of Climate Change - including how to make whale assessments carbon neutral
   (b) Adaptive management 1: Potential management actions in response to climate driven changes that may make cetaceans more vulnerable to anthropogenic threats (e.g. changes in distribution in relation to shipping and fisheries, impacts on health)
   (c) Adaptive management 2: Responses to expected and observed changes in human activities as a result of climate driven changes (e.g. increased shipping in Arctic, changes in fisheries, storm related sewage discharges) and potential management actions in anticipation of these changes
   Slowing shipping/blue carbon

(d) Adaptation Tool Box: Management to enhance the adaptability and resilience of cetacean species
- Climate Smart Conservation Cycle
- Climate informed goals and objectives
- Vulnerability assessments (examples: NOAA and ECOADAPT)
- Scenario planning
- RAD (Resist, Adapt, Direct)
- The role of MPAs/blue carbon

(e) Issues with implementing management
(f) Limitations in our current assessment capacity and data gaps
(g) Policy issues
(h) The use of vulnerability assessment(s)
(i) Other responses?

10. Recommendations for further research and improving policy, including recommendations to other IGOs and building liaison, including IUCN and IMMAs
11. Review of all recommendations, including consideration of target audiences

Annex C

Previous Recommendations

2010 RECOMMENDATIONS MADE BY THE WORKSHOP ON SMALL CETACEANS AND CLIMATE CHANGE

Held Vienna, Austria from 28 November to 1 December 2010. 2011 SC Report, endorsed at IWC63.

Number	Text	Progress
SC1001	The Workshop recommended that an assessment be conducted to provide resource managers, government officials and representatives of multi-lateral institutions with an in-depth understanding of the implications of climate change on freshwater-dependent cetaceans and to suggest a range of practical measures for mitigating climate-related threats. The Workshop also recognised that any meaningful assessment of the implications of climate change and any recommendations on management interventions for freshwater-dependent cetaceans needed to incorporate consideration of the impacts of water development.	Ask
SC1002	Consideration was given to the planned ACCOBAMS climate change Workshop and the Vienna Workshop recommended that a theme of oceanography would be advantageous to help understand future changes in cetacean distribution.	Complete
SC1004	The Workshop recommended that baseline data on health parameters (including body condition), prevalence and intensity of pathogens, effects of toxicants, modes of disease transmission, host specificity, temporal and spatial patterns in diseases, and the relationship to environmental factors was needed to understand the potential effects of climate change on small cetacean health. These data must be integrated with long-term demographic data to determine whether effects of diseases and toxicants are significant at the population level.	Integrated into other work areas (E)
SC1006	As a first step toward understanding health and reproductive impacts of climate change, the Workshop strongly recommended that appropriate existing data sets on the health of cetaceans (like Sarasota Bay) be examined to identify possible relationships with climate change parameters.	Integrated into other work areas (E)
SC1011	The Workshop recommended that climate change be considered as a potential causal factor when investigating Unusual Mortality Events (UMEs) and where animals are outside of their normal species ranges (small and large cetaceans).	Superseded Integrated into other work areas (E)
SC1015	The Workshop commended ASCOBANS for their recovery plan (known as the Jastarnia Plan) and recommended investigating the anticipated temperature related changes to the Baltic Sea ecosystem in relation to its suitability as habitat for harbour porpoises. Bjørge expressed concern that increased run-off due to climate change will exacerbate the threats to Baltic harbour porpoises. These threats include increased pollution mobilisation, enhanced eutrophication with an increased risk of toxic alga blooms and expansion of the anoxic areas.	Check with ASCOBANS if this area has been investigated A major review on CC in the Baltic is in press and does consider the one cetaceans species there. See pre-print here: *https://esd.copernicus.org/preprints/esd-2021-67/* One of the authors will be invited to the w/s.
SC1018	The Workshop encourages studies relating multi-species habitat requirements to observed shifts in environmental factors at biodiversity hotspot sites, so as to identify processes induced by climate change, for example in the Canary Islands where a suitable long term data sets exists.	Check in for latest info with Canary Islands, possibly CCAMLR, also integrated into other work areas
SC1021	This Workshop recommends similar long-term studies on small cetaceans, including endemic beluga whale and narwhal, through individual's lives and across generations in Arctic waters to determine the impacts of climate change on individual fitness, population viability and species adaptability	Ongoing, incorporated into other work areas
SC1024	The Workshop recommended that a comprehensive assessment be conducted on the implications of climate change on freshwater-dependent cetaceans.	Ask Fernando *et al.*
SC1025	The Workshop recommended that the impact of climate change on dolphin and whale-watching operations should also be assessed by conducting socio-economic evaluations and modelling, especially in regions where environmental changes are already ongoing.	Ask WW Sub-com
SC1028	The Workshop agreed that Marine Protected Areas are a useful tool in addressing climate changes, but it was stressed that they would need to be adaptable and adequately large to allow for responsive movements of cetaceans (in effect the Workshop noted that they were part of a suite of available responses). MPA networks, should include corridors and critical habitat areas. The Workshop recommended that better information should be gathered on how these areas might change in the future and a synthesis of existing information.	Ongoing incorporated in other work
SC1030	The Workshop recommended that, in the face of climate change, all intentional removals of small cetaceans should be carefully managed via precautionary quotas which should allow for the effects of climate change.	OPEN - discuss

Number	Text	Progress
SC1031	With respect to freshwater cetacean conservation, the Workshop stressed that there may be few options available to prevent or mitigate the direct impacts of climate change on marine cetaceans, however, possibilities for freshwater dependent species could include manipulation of upstream flows using existing water engineering structures to maintain suitable salinity gradients in estuaries and preserve essential habitat features, such as bars and mid-channel islands that induce counter-currents, in rivers.	No direct actions
SC1033	The Workshop commended the ongoing work by the IUCN to integrate climate change into the elaboration of its Red List designations (IUCN, 2010). It was noted that climate change impacts had not been considered in the last (2008) review of cetaceans and the Workshop recommended that a re-evaluation of cetaceans be initiated in a timely manner.	Complete
SC1037	The Workshop stressed that all of its recommendations should only be considered stop-gap measures, designed to understand and mitigate the effects of climate change on small cetaceans. More appropriate and effective conservation action would be to eliminate anthropogenic sources of climate change at their roots.	Superseded

2014 IWC WORKSHOP ON IMPACTS OF INCREASED MARINE ACTIVITIES ON CETACEANS IN THE ARCTIC

Held 6-7 March 2014, Anchorage, Alaska, USA. The workshop focused on human activities related to oil and gas exploration, commercial shipping and tourism, as well as likely changes to the ecosystem as a result of climate change. Endorsed at IWC65. (CO1429).

Number	Text	Comment
SC1401	The Workshop strongly emphasized that the IWC has an important role to play in the protection of the Arctic environment and its subsistence whaling communities. An important challenge for the IWC is to determine the details of how best it can encourage and contribute to such a major effort in a timely and comprehensive manner.	
SC1402	The Workshop also recommends that the IWC considers including a standing agenda item on the Arctic at each biennial meeting to consolidate the progress made by its subsidiary bodies and the Secretariat during intersessional periods and to discuss future actions.	
SC1403	The Workshop recognises the importance of the work already underway by the Arctic Council and its working groups and programmes (see Item 5.1.1). As a matter of highest priority, it strongly recommends that the IWC Secretariat: (1) Approaches the Arctic Council requesting observer status and provides as part of that request a short summary of the types of expertise the IWC can provide (see Item 5.1.4) as well as a copy of the present report; (2) Liaises with the Arctic Council Secretariat and chairs of the various Arctic Council working groups to determine how best the IWC can contribute to and participate in their work, including cetacean-related aspects of the development of common standards, measures and monitoring across the Arctic (see Item 5.1.3); (3) Invites the Arctic Council to participate in relevant IWC meetings and workshops, including those of Committees, sub-committees and working groups; (4) Liaises with the Arctic Council over the need for a formal Memorandum of Understanding between the two bodies, as appropriate; (5) Invites the Arctic Council to publicise the IWC global ship strikes database and encourage member nations, observer nations and observers to submit data to the database to allow a better characterisation of the issue for the Arctic; (6) Encourages the Arctic Council to continue to recognise the importance of taking into account the needs of subsistence whaling communities and offers to provide information on IWC regulated hunts.	
SC1404	The Workshop requests that the Commission develops an approach to funding IWC participation at relevant meetings of the Arctic Council and its working groups.	
SC1405	The Workshop recommends increased co-operation by the IWC (Secretariat and member nations) with IMO with respect to mitigation measures for threats to cetaceans (e.g. Traffic Separation Schemes, speed restrictions, noise reduction) and increased awareness of the issue of ship strikes and the importance of the IWC global ship strikes database. It strongly urges Arctic nations to submit data to the IWC database to allow priorities for action to be developed and referred to the July 2014 IWC workshop on ship strikes as an appropriate place to take this general issue forward.	
SC1406	The Workshop strongly endorses the need for such a code [mandatory international code of safety for ships operating in polar waters (the 'Polar Code')] and commends the excellent work carried out to date. It urges IWC member nations and others to support the finalisation and ratification of the Polar Code as soon as possible.	
SC1408	In an IWC context, the Workshop recommends: (1) Stakeholder participation is encouraged in relevant meetings of the IWC and its subsidiary bodies, as well as meetings of other intergovernmental organisations such as the Arctic Council and national authorities.	

Number	Text	Comment
SC1409	In an IWC context, the Workshop recommends: (2) The IWC Secretariat, in consultation with others (e.g. the Arctic Council and IMO secretariats), draws up a list of relevant international and national stakeholder bodies for the Arctic region, in light of the discussions at this workshop that prioritised the following: oil and gas operations; vessel traffic (of many kinds including transport, tourism/whale watching, fishing, servicing oil and gas operations); fishing activities; and hunting. (3) The IWC Secretariat contacts the identified organisations with a copy of the present Workshop report and subsequent Commission discussions of it, expressing the interest of the IWC in co-operating and providing advice on issues of mutual interest including: (1) the sharing of scientific expertise (see Item 5.1.4); (2) assistance with issues of data sharing and common field work and analyses; and (3) information on subsistence hunts.	
SC1410	In an IWC context, the Workshop recommends: (4) The IWC considers additional ways (including possible expansion of the Commission's successful whale disentanglement training effort) to increase the awareness of and sensitivity of industry operators (e.g. the shipping, oil and gas, fishing and tourism sectors) to conservation concerns and the cultural aspects of aboriginal subsistence whaling. (5) The IWC considers mechanisms to provide technical support to individual companies or industry bodies.	
SC1411	The Workshop recommends that the IWC Scientific Committee be requested to: (1) Develop a summary of present knowledge of cetacean population status, distribution and movements, density and important habitat of the Arctic species; (2) Develop plans for a co-hosted specialist workshop or workshops with appropriate stakeholder participation (with a focus on the Arctic and with particular case studies to be determined) on identifying and evaluating threats to cetaceans from human activities including: (a) Data and analytical requirements (both for cetaceans and human activities) for identifying high risk areas to cetaceans at the correct geographical and temporal scales; (b) Evaluation of non-direct threats to cetaceans at the population level including chemical pollution, noise, climate change etc.; (c) Methods to examine synergistic and cumulative effects of a range of actual and potential threats at the population level (see Item 4.1.3); (d) Specific recommendations with respect to data requirements and monitoring for the Arctic region in the light of projected human activities within the region. (3) Collate a summary of advice relevant to the Arctic it has provided with respect to a number of issues identified at this workshop including: climate change; chronic and acute noise; oil spills, ship strikes, fishery bycatch, habitat degradation; and (4) work with the IWC Secretariat to increase the prominence, awareness and availability of its advice through the IWC website.	Refer to the workshop for assessment and discussion
SC1412	The Workshop also recommends that the IWC Scientific Committee contributes to efforts to develop of common standards, measures and monitoring across the Arctic (see Item 5.1.3) with respect to issues related to the effects of human activities on cetaceans.	

2009 RESOLUTIONS ENDORSED AT IWC63 BY CONSENSUS

Number	Text
CO0902	Resolution 2009-1 ENDORSES the outcome of the climate change workshop and associated recommendations of the Scientific Committee given in IWC/61/Rep1, including the need to expand the current international multi-disciplinary efforts and collaborative work with other relevant bodies;
CO0903	Resolution 2009-1 REQUESTS Contracting Governments to incorporate climate change considerations into existing conservation and management plans
CO0904	Resolution 2009-1 DIRECTS the Scientific Committee to continue its work on studies of climate change and the impacts of other environmental changes on cetaceans, as appropriate
CO0907	Resolution 2009-1 APPEALS to all Contracting Governments to take urgent action to reduce the rate and extent of climate change.

2011 RECOMMENDATIONS MADE BY THE SC ENDORSED AT IWC63

Number	Text	Comments
SC1101	The Committee endorses the Workshop's recommendations, many of which were in accord with previous Committee recommendations on the general subject of the impact of climate change on cetaceans (e.g. IWC, 2010j).	Referring to the small cetaceans and climate change workshop

2018 RESOLUTION ENDORSED AT IWC67 BY VOTE

Number	Text
CO1804	Resolution 2018-2 Encourages Contracting Governments to integrate the value of cetaceans' ecological roles into local, regional and global organisations on biodiversity and environment, including climate change and conservation policies.

2015 WORK PLAN MADE BY THE SC ENDORSED AT IWC66

Number	Text	
SC1626	The Committee agrees to continue the intersessional working group under Simmonds (see Annex V for members and terms of reference) to develop a strategy to address the potential vulnerability of climate change on cetacean species.	Ongoing

2017 RECOMMENDATION AND WORK PLAN MADE BY THE SC ENDORSED AT IWC67

Number	Text	Progress
SC17352	With respect to climate change, the Committee agrees that: (1) the impact of climate change should be considered in an integrated manner highlighted when it is a specific driver within the topics being covered; and (2) that the intersessional correspondence group (Annex X) refine ideas for a future workshop and identify relevant climate change issues, noting the discussions under Item 15.10.1.	In progress (this workshop 2021)
SC17353	The Committee agrees that the thematic and focus topics of the Standing Working Group on Environmental Concerns are all occurring in the context of climate change, as are all other topics considered in several subcommittees of the Committee (e.g. SM, EM). Therefore, the Standing Working Group on Environmental Concerns recommends that Climate Change be better integrated in the work of the full Committee. The Committee agrees that Arctic Issues will no longer be a standing topic in the Standing Working Group on Environmental Concerns agenda and papers would be addressed under the most appropriate agenda items for the issue being presented.	Consider within this workshop, likely to be superseded for a stand alone climate change group

2018 SC DRAWS ATTENTION TO ENDORSED AT IWC67

Number	Text
SC1891	The Committee draws attention to the fact that climate change remains a threat that interacts with other threats and stressors impacting cetacean populations.

2021 SC RECOMMENDATION AND WORK PLAN PENDING ENDORSEMENT

Number	Text	Progress
SC21132	The Committee reiterates the importance of understanding baleen whale demographics and long-term environmental variability and re-established an intersessional corresponding group led by Cooke (convenor) with membership of Butterworth, Friedlaender, Kitakado, de la Mare, Palacios and Tulloch to conduct a literature review into the effects of climate change and environmental variability on whales and marine ecosystems.	Check in with Cooke on this
SC2143	The Committee encourages: (1) that research include continuous and simultaneous passive acoustic monitoring in identified ASHW habitat in both the western Arabian Sea (different parts of Oman's waters) and eastern Arabian Sea (Pakistan, India and Sri Lanka) to better understand the population's spatiotemporal distribution and potential connectivity across a larger area of suspected range, as well as to understand if range or distribution shifts begin to emerge as a result of climate change and other threats (noting that this technique also yields valuable data on other whale species, e.g. blue whales); (2) that research include the use of UAVs to assess body condition, and that body condition indices be used together with other metrics to assess seasonal and annual variation and to evaluate health, scarring, and foraging success (e.g. Ramp *et al.* 2021); and (3) that future research include methods to assess (modelled) whale distribution in relation to oceanographic variables and data on fisheries and likely prey species, to better understand the drivers of distribution for ASHW, as well as the potential threat of fisheries interactions.	Check in with Tim and/or Gianna for this

Annex D

List of Recent Relevant Literature

Alava, J.J., Cisneros-Montemayor, A.M., Sumaila, U.R., *et al.* 2018. Projected amplification of food web bioaccumulation of MeHg and PCBs under climate change in the Northeastern Pacific. *Scientific Reports* 8, 13460. *https://doi.org/10.1038/s41598-018-31824-5*

Albouy, C., Delattre, V., Donati, G., *et al.* 2020. Global vulnerability of marine mammals to global warming. *Scientific Reports* 10, 548. *https://doi.org/10.1038/s41598-019-57280-3*

Alvarado-Rybak, M., Toro, F., Escobar-Dodero, J., *et al.* 2020. 50 Years of Cetacean Strandings Reveal a Concerning Rise in Chilean Patagonia. *Scientific Reports* 10, 9511. *https://doi.org/10.1038/s41598-020-66484-x*

Amstrup, S.C. and Lehner, F. 2017. Anthropogenic Ocean Change: The Consummate Threat to Marine Mammal Welfare, in: A. Butterworth (Ed.) *Marine Mammal Welfare*. Springer, Cham, Switzerland, pp. 9-26.

Askin, N., Belanger, M. and Wittlich, C. 2017. Humpback whale expansion and climate change - evidence of foraging in new habitats. *Journal of Marine Animals and their Ecology* 9(1), 13-17.

Becker, E.A., Forney, K.A., Redfern, J.V., *et al.* 2019. Predicting cetacean abundance and distribution in a changing climate. *Diversity and Distributions* 25, 626-643. *https://doi.org/10.1111/ddi.12867*

Berger, J., Hartway, C., Gruzdev, A. *et al.* 2018. Climate Degradation and Extreme Icing Events Constrain Life in Cold-Adapted Mammals. *Scientific Reports* 8, 1156. *https://doi.org/10.1038/s41598-018-19416-9*

Bestley, S., Ropert-Coudert, Y., Bengtson Nash, S., *et al.* 2020. Marine Ecosystem Assessment for the Southern Ocean: Birds and Marine Mammals in a Changing Climate. *Frontiers in Ecology and Evolution*, 8, 566936. *https://doi:10.3389/fevo.2020.566936*

Boyd, C. and Punt, A.E. 2021. Shifting trends: Detecting changes in cetacean population dynamics in shifting habitat. *PLOS ONE* 16, 1-22. *https://doi.org/10.1371/journal.pone.0251522*

Brower, A.A., Clarke, J.T. and Ferguson, M.C. 2018. Increased sightings of subArctic cetaceans in the eastern Chukchi Sea, 2008-2016: population recovery, response to climate change, or increased survey effort? *Polar Biology*, 41, 1033-1039. *https://doi.org/10.1007/s00300-018-2257-x*

Brüniche-Olsen, A., Bickham, J.W., Godard-Codding, C.A., *et al.* 2021. Influence of Holocene habitat availability on Pacific gray whale (*Eschrichtius robustus*) population dynamics as inferred from whole mitochondrial genome sequences and environmental niche modeling. *Journal of Mammalogy* 102, 986-999. *https://doi.org/10.1093/jmammal/gyab032*

Bryndum-Buchholz, A., Tittensor, D.P., Blanchard, J.L., *et al.* 2019. Twenty-first-century climate change impacts on marine animal biomass and ecosystem structure across ocean basins. *Global Change Biology*, 25: 459-472. *https://doi.org/10.1111/gcb.14512*

Cañadas, A. and Vázquez, J.A.,2017. Common dolphins in the Alboran Sea: Facing a reduction in their suitable habitat due to an increase in Sea surface temperature. *Deep Sea Research Part II: Topical Studies in Oceanography* 141, 306-318. *https://doi.org/10.1016/j.dsr2.2017.03.006*

Cartwright, R., Venema, A., Hernandez, V., *et al.* 2019. Fluctuating reproductive rates in Hawaii's humpback whales, *Megaptera novaeangliae*, reflect recent climate anomalies in the North Pacific. *Royal Society Open Science*, 6, 181463. *http://dx.doi.org/10.1098/rsos.181463*

Chambault, P., Albertsen, C.M., Patterson, T.A., *et al.*, 2018. Sea surface temperature predicts the movements of an Arctic cetacean: the bowhead whale. *Scientific Reports*, 8, 9658. *https://doi:10.1038/s41598-018-27966-1*

Chambault, P., Tervo, O.M., Garde, E., *et al.* 2020. The impact of rising sea temperatures on an Arctic top predator, the narwhal. *Scientific Reports* 10, 18678. *https://doi.org/10.1038/s41598-020-75658-6*

Choy, E.S., Giraldo, C., Rosenberg, B., *et al.* 2020. Variation in the diet of beluga whales in response to changes in prey availability: insights on changes in the Beaufort Sea ecosystem. *Marine Ecology Progress Series*, 647, 195-210. *https://doi.org/10.3354/meps13413*

Cimino, M.A., Santora, J.A., Schroeder, I., *et al.* 2020. Essential krill species habitat resolved by seasonal upwelling and ocean circulation models within the large marine ecosystem of the California Current System. *Ecography*, 43, 1536-1549. *https://doi.org/10.1111/ecog.05204*

Davidson, S.C., Bohrer, G., Gurarie, E., *et al.* 2020. Ecological insights from three decades of animal movement tracking across a changing Arctic. Science, 370, 6517. pp. 712-715. *https://doi:10.1126/science.abb7080*

Derville, S., Torres, L.G. Albertson, R., *et al.* 2019. Whales in warming water: Assessing breeding habitat diversity and adaptability in Oceania's changing climate. *Global Change Biology*, 25, 1466-1481. *https://doi:10.1111/gcb.14563*

Descamps, S., Aars, J., Fuglei, E., *et al.* 2017. Climate change impacts on wildlife in a High Arctic archipelago - Svalbard, Norway. *Global Change Biology* 23, 490-502. *https://doi.org/10.1111/gcb.13381*

Díaz López, B. and Methion, S. 2019. Habitat drivers of endangered rorqual whales in a highly impacted upwelling region. *Ecological Indicators*, 103, 610-616. *https://doi.org/10.1016/j.ecolind.2019.04.038*

Eero, M., Dierking, J., Humborg, C., *et al.* 2021. Use of food web knowledge in environmental conservation and management of living resources in the Baltic Sea. *ICES Journal of Marine Science*. *https://doi.org/10.1093/icesjms/fsab145*

Evans, P.G.H. and Waggitt, J.J. 2020. Impacts of climate change on marine mammals, relevant to the coastal and marine environment around the UK, MCCIP Science Review 2020. Marine Climate Change Impacts Partnership.

Fandel, A.D., Garrod, A., Hoover, A.L., *et al.* 2020. Effects of intense storm events on dolphin occurrence and foraging behavior. *Science Reports*, 10, 19247. *https://doi.org/10.1038/s41598-020-76077-3*

Fleming, A.H., Clark, C.T., Calambokidis, J., *et al.* 2016. Humpback whale diets respond to variance in ocean climate and ecosystem conditions in the California Current. *Global Change Biology*, 22, 1214-1224. *https://doi.org/10.1111/gcb.13171*

Foden, W.B. and Young, B.E. (eds.) 2016. IUCN SSC Guidelines for Assessing Species' Vulnerability to Climate Change. Version 1.0. Occasional Paper of the IUCN Species Survival Commission No. 59. Cambridge, UK and Gland, Switzerland: IUCN Species Survival Commission. x+114pp.

Grose, S.O., Pendleton, L., Leathers, A., *et al.* 2020. Climate Change Will Re-draw the Map for Marine Megafauna and the People Who Depend on Them. *Frontiers in Marine Science* 7, 547. *https://doi.org/10.3389/fmars.2020.00547*

Guilpin M, Lesage V, McQuinn I, *et al.* 2020. Repeated Vessel Interactions and Climate- or Fishery-Driven Changes in Prey Density Limit Energy Acquisition by Foraging Blue Whales. *Frontiers in Marine Science*, 7, 626. *https://doi.org/10.3389/fmars.2020.00626*

Hamilton, C.D., Vacquié-Garcia, J., Kovacs, K.M., *et al.* 2019. Contrasting changes in space use induced by climate change in two Arctic marine mammal species. *Biology Letters* 15, 20180834. *https://doi.org/10.1098/rsbl.2018.0834*

Hamilton, C.D., Lydersen C., Aars, J., *et al.* 2021. Marine mammal hotspots in the Greenland and Barents Seas. *Marine Ecology Progress Series*, 659, 3-28. *https://doi.org/10.3354/meps13584*

Hastings, R.A., Rutterford, L.A., Freer, J.J., *et al.* 2020. Climate Change Drives Poleward Increases and Equatorward Declines in Marine Species. *Current Biology*, 30(8), 1572-1577. *https://doi.org/10.1016/j.cub.2020.02.043*

Häussermann, V., Gutstein, C.S., Bedington, M., *et al.* 2017. Largest baleen whale mass mortality during strong El Niño event is likely related to harmful toxic algal bloom. *PeerJ Life & Environment*, 5, e3123. *https://doi.org/10.7717/peerj.3123*

Hazen, E.L., Abrahms, B., Brodie, S. *et al.* 2019. Marine top predators as climate and ecosystem sentinels. *Front in Ecology and the Environment*, 17(10), 565-574. *https://doi.org/10.1002/fee.2125*

Hindell, M.A., Reisinger, R.R., Ropert-Coudert, Y., *et al.* 2020. Tracking of marine predators to protect Southern Ocean ecosystems. *Nature*, 580, 87-92. *https://doi.org/10.1038/s41586-020-2126-y*

Hirawake, T. and Hunt Jr., G.L. 2020. Impacts of unusually light sea-ice cover in winter 2017-2018 on the northern Bering Sea marine ecosystem - An introduction. *Deep Sea Research Part II: Topical Studies in Oceanography*, 181-182, 104908. *https://doi.org/10.1016/j.dsr2.2020.104908*

Houde, M., Taranu, Z.E., Wang, X., *et al.* 2020. Mercury in Ringed Seals (*Pusa hispida*) from the Canadian Arctic in Relation to Time and Climate Parameters. *Environmental Toxicology and Chemistry*, 39, 2462-2474. *https://doi.org/10.1002/etc.4865*

Ingman, K., Hines, E., Mazzini, P.L.F., *et al.* 2021. Modeling changes in baleen whale seasonal abundance, timing of migration, and environmental variables to explain the sudden rise in entanglements in California. *PLOS ONE* 16, 1-19. *https://doi.org/10.1371/journal.pone.0248557*

IPCC (Intergovernmental Panel on Climate Change), 2018. Global Warming of 1.5oC. An IPCC Special Report on the impacts of global warming of 1.5oC above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Summary for Policy Makers. Available at: *https://www.ipcc.ch/sr15/chapter/spm/*

Jepson, P.D., Deaville, R., Barber, J.L., *et al.* 2016. PCB pollution continues to impact populations of orcas and other dolphins in European waters. *Scientific Reports* 6, 18573. *https://doi.org/10.1038/srep18573*

Keith, S.A. and Bull, J.W. 2017. Animal culture impacts species' capacity to realist climate-driven range shifts. *Ecography*, 40, 296-304. *https://doi.org/10.1111/ecog.02481*

Kershaw, J.L., Ramp, C.A., Sears, R., *et al.* 2021a. Declining reproductive success in the Gulf of St. Lawrence's humpback whales (*Megaptera novaeangliae*) reflects ecosystem shifts on their feeding grounds. *Global Change Biology* 27, 1027-1041. *https://doi.org/10.1111/gcb.15466*

Klein, E.S., Hill, S.L., Hinke, J.T., *et al.* 2018. Impacts of rising sea temperature on krill increase risks for predators in the Scotia Sea. *PLoS ONE*, 13(1), e0191011. *https://doi.org/10.1371/journal.pone.0191011*

Lacoue-Labarthe, T., Nunes, P.A.L.D., Ziveri, P., *et al.* 2016. Impacts of ocean acidification in a warming Mediterranean Sea: An overview. *Regional Studies in Marine Science* 5, 1-11. *https://doi.org/10.1016/j.rsma.2015.12.005*

Lefebvre, K.A., Quakenbush, L., Frame, E., *et al.* 2016. Prevalence of algal toxins in Alaskan marine mammals foraging in a changing arctic and subarctic environment. *Harmful Algae* 55, 13-24. *https://doi.org/10.1016/j.hal.2016.01.007*

Leroy, E.C., Royer, J.-Y., Bonnel, J., *et al.* 2018. Long-Term and Seasonal Changes of Large Whale Call Frequency in the Southern Indian Ocean. *Journal of Geophysical Research: Oceans* 123, 8568-8580. *https://doi.org/10.1029/2018JC014352*

Løviknes, S., Jensen, K.,H., Krafft, B.A., *et al.* 2021. Feeding Hotspots and Distribution of Fin and Humpback Whales in the Norwegian Sea From 2013 to 2018. *Frontiers in Marine Science*. 8,632720. *https://doi.org/10.3389/fmars.2021.632720*

McGinty, N., Barton, A.D., Record, N.R., *et al.* 2021. Anthropogenic climate change impacts on copepod trait biogeography. *Global Change Biology*, 27, 1431-1442. *https://doi.org/10.1111/gcb.15499*

Meyer-Gutbrod, E.L and Greene, C.H. 2018. Uncertain recovery of the North Atlantic right whale in a changing ocean. *Global Change Biology*, 24, 455-464.*https://doi.org/10.1111/gcb.13929*

Meynecke, J.-O., Seyboth, E., De Bie, J., *et al.* 2020. Responses of humpback whales to a changing climate in the Southern Hemisphere: Priorities for research efforts. *Marine Ecology*, 41, e12616. *https://doi.org/10.1111/maec.12616*

Miralles, L., Oremus, M., Silva, M.A., *et al.* 2016. Interspecific Hybridization in Pilot Whales and Asymmetric Genetic Introgression in Northern Globicephala melas under the Scenario of Global Warming. *PLOS ONE* 11, 1-15. *https://doi.org/10.1371/journal.pone.0160080*

Moore, S.E., George, J.C., Reeves, R.R. 2021. Chapter 27 - Bowhead whale ecology in changing high- latitude ecosystems, in: George, J.C., Thewissen, J.G.M. (Eds.), *The Bowhead Whale*. Academic Press, pp. 417-427. *https://doi.org/10.1016/B978-0-12-818969-6.00027-3*

Moore, S.E. and Reeves, R.R. 2018. Tracking arctic marine mammal resilience in an era of rapid ecosystem alteration. *PLOS Biology* 16, 1-7. *https://doi.org/10.1371/journal.pbio.2006708*

Morato, T., González-Irusta, J.-M., Dominguez-Carrió, C., *et al.* 2020. Climate-induced changes in the suitable habitat of cold-water corals and commercially important deep-sea fishes in the North Atlantic. *Global Change Biology* 26, 2181-2202. *https://doi.org/10.1111/gcb.14996*

Notarbartolo di Sciara, G.N. , Castellote, M., Druon, J.-N., *et al.* 2016. Chapter Three - Fin Whales, *Balaenoptera physalus*: At Home in a Changing Mediterranean Sea? in: Sciara, G.N.D., Podestà, M., Curry, B.E. (Eds.), *Mediterranean Marine Mammal Ecology and Conservation, Advances in Marine Biology*. Academic Press, pp. 75-101. *https://doi.org/10.1016/bs.amb.2016.08.002*

Nowicki, R., Heithaus, M., Thomson, J., *et al.* 2019. Indirect legacy effects of an extreme climatic event on a marine megafaunal community. *Ecological Monographs*, 89(3), e01365. *https://doi.org/10.1002/ecm.1365*

Nunny, L. and Simmonds, M.P. 2021. Climate Change and Ocean Acidification - A Looming Crisis for Europe's Cetaceans, in: Under Pressure: The Need to Protect Whales and Dolphins in European Waters. OceanCare Report, pp. 132-139. Available at: *https://www.oceancare.org/wp-content/ uploads/2021/04/Report_UNDER-PRESSURE_need-to-protect-whales-and-dolphins-in-European- waters_OC.pdf*

Nunny, L. and Simmonds, M.P. 2019. Climate change and cetaceans - an update. Paper submitted to the Scientific Committee of the International Whaling Commission, SC/68A/E/07, p.13. Available at: *https://archive.iwc.int/pages/view.php?ref=11982&k=*

Owen, K., Jenner, K.C.S., Jenner, M.-N.M. *et al.* 2019. Water temperature correlates with baleen whale foraging behaviour at multiple scales in the Antarctic. *Mar. Freshwater Res.* 70, 19-32. *https://doi.org/10.1071/MF17288*

Pagano, A.M. and Williams, T.M. 2021. Physiological consequences of Arctic sea ice loss on large marine carnivores: unique responses by polar bears and narwhals. *Journal of Experimental Biology*, 224 (Suppl_1), jeb228049. *https://doi.org/10.1242/jeb.228049*

Pendleton, D.E., Holmes, E.E., Redfern, J., *et al.* 2020. Using modelled prey to predict the distribution of a highly mobile marine mammal. *Diversity and Distributions*, 26, 1612-1626. *https://doi.org/10.1111/ddi.13149*

Piatt, J.F., Parrish, J.K., Renner, H.M., *et al.* 2020. Extreme mortality and reproductive failure of common murres resulting from the northeast Pacific marine heatwave of 2014-2016. *PLoS ONE*, 15(1), e0226087. *https://doi.org/10.1371/journal.pone.0226087*

Pirotta, E., Mangel, M., Costa, D.P., *et al.* 2019. Anthropogenic disturbance in a changing environment: modelling lifetime reproductive success to predict the consequences of multiple stressors on a migratory population. *Oikos*, 128, 1340-1357. *https://doi.org/10.1111/oik.06146*

Popov, I., and Eichhorn, G., 2020. Occurrence of sperm whale (*Physeter macrocephalus*) in the Russian Arctic. *Polar Research*, 39. *https://doi.org/10.33265/polar.v39.4583*

Purdon, J., Shabangu, F.W., Pienaar, M. *et al.* 2020. Cetacean species richness in relation to anthropogenic impacts and areas of protection in South Africa's mainland Exclusive Economic Zone. *Ocean and Coastal Management* 197, 105292. *https://doi.org/10.1016/j.ocecoaman.2020.105292*

Record, N.R., Runge, J.A., Pendleton, D.E., *et al.* 2019. Rapid Climate-Driven Circulation Changes Threaten Conservation of Endangered North Atlantic Right Whales. *Oceanography* 32. *https://doi.org/10.5670 /oceanog.2019.201*

Richards, R., Meynecke, J.-O. and Sahin, O. 2021. Addressing dynamic uncertainty in the whale-watching industry under climate change and system shocks. *Science of the Total Environment*. 756, 143889. *https://doi.org/10.1016/j.scitotenv.2020.143889*

Sanderson, C.E. and Alexander, K.A., 2020. Unchartered waters: Climate change likely to intensify infectious disease outbreaks causing mass mortality events in marine mammals. *Global Change Biology* 26, 4284-4301. *https://doi.org/10.1111/gcb.15163*

Santora, J.A., Mantua, N.J., Schroeder, I.D., *et al.* 2020. Habitat compression and ecosystem shifts as potential links between marine heatwave and record whale entanglements. *Nature Communications* 11, 536. *https://doi.org/10.1038/s41467-019-14215-w*

Savoca, MS, Czapanskiy, MF, Kahane-Rapport, SR, *et al.* 2021. Baleen whale prey consumption based on high-resolution foraging measurements. *Nature*, 599, 85-90. *https://doi.org/10.1038/s41586-021-03991-5*

Seyboth, E., Groch, K.R., Dalla Rosa, L. *et al.* 2016. Southern Right Whale (*Eubalaena australis*) Reproductive Success is Influenced by Krill (*Euphausia superba*) Density and Climate. Scientific Reports, 6, 28205. *https://doi.org/10.1038/srep28205*

Shelton, A.O., Sullaway, G.H., Ward, E.J., *et al.* 2021. Redistribution of salmon populations in the northeast Pacific Ocean in response to climate. *Fish and Fisheries*, 22, 503-517. *https://doi.org/10.1111/faf.12530*

Siddon, E.C., Zador, S.G. and Hunt Jr., G.L. 2020. Ecological responses to climate perturbations and minimal sea ice in the northern Bering Sea. *Deep Sea Research Part II: Topical Studies in Oceanography*, 181-182, 104914. *https://doi.org/10.1016/j.dsr2.2020.104914*

Silber, G.K., Lettrich, M.D., Thomas, P.O., *et al.* 2017. Projecting Marine Mammal Distribution in a Changing Climate. *Frontiers in Marine Science*, 4, 413. *https://doi.org/10.3389/fmars.2017.00413*

Simmonds, M.P. 2017. Evaluating the Welfare Implications of Climate Change for Cetaceans, in: A. Butterworth (Ed.) *Marine Mammal Welfare*. Springer, Cham, Switzerland, pp. 125-135.

Sousa, A., Alves, F., Arranz, P., *et al.* 2021. Climate change vulnerability of cetaceans in Macaronesia: Insights from a trait-based assessment. *Science of The Total Environment* 795, 148652. *https://doi.org/10.1016/j.scitotenv.2021.148652*

Sousa, A., Alves, F., Dinis, A., *et al.* 2019. How vulnerable are cetaceans to climate change? Developing and testing a new index. *Ecological Indicators* 98, 9-18. *https://doi.org/10.1016/j.ecolind.2018.10.046*

Stenson, G.B., Haug, T. and Hammill, M.O. 2020. Harp Seals: Monitors of Change in Differing Ecosystems. *Frontiers in Marine Science*, 7, 569258. *https://doi.org/10.3389/fmars.2020.569258*

Stephenson, F., Hewitt, J.E., Torres, L.G., *et al.* 2021. Cetacean conservation planning in a global diversity hotspot: dealing with uncertainty and data deficiencies. *Ecosphere* 12, e03633. *https://doi.org/10.1002/ecs2.3633*

Szesciorka, A.R., Ballance, L.T., Širović, A. *et al.* 2020. Timing is everything: Drivers of interannual variability in blue whale migration. *Science Reports*, 10, 7710. *https://doi.org/10.1038/s41598-020-64855-y*

Thiel, M., Luna-Jorquera, G., Álvarez-Varas, R., *et al.* 2018. Impacts of Marine Plastic Pollution From Continental Coasts to Subtropical Gyres – Fish, Seabirds, and Other Vertebrates in the SE Pacific. *Frontiers in Marine Science* 5, 238. *https://doi.org/10.3389/fmars.2018.00238*

Tinker, J.P. and Howes, E.L. 2020. The impacts of climate change on temperature (air and sea), relevant to the coastal and marine environment around the UK. *MCCIP Science Review* 2020 1-30. *https://doi.org/10.14465/2020.arc01.tem*

Tulloch, V.J.D., Plagányi, É.E., Brown, C., *et al.* 2019. Future recovery of baleen whales is imperiled by climate change. *Global Change Biology* 25, 1263-1281. *https://doi.org/10.1111/gcb.14573*

Ullah, H., Nagelkerken, I., Goldenberg, S.U., *et al.* 2018. Climate change could drive marine food web collapse through altered trophic flows and cyanobacterial proliferation. *PLOS Biology* 16, 1-21. *https://doi.org/10.1371/journal.pbio.2003446*

Vacquié-Garcia, J., Lydersen, C., Ims, R.A., *et al.* 2018. Habitats and movement patterns of white whales *Delphinapterus leucas* in Svalbard, Norway in a changing climate. *Movement Ecology* 6, 21. *https://doi.org/10.1186/s40462-018-0139-z*

van den Berg, G.L., Vermeulen, E., Valenzuela, L.O., *et al.* 2021. Decadal shift in foraging strategy of a migratory southern ocean predator. *Global Change Biology*. 27, 1052-1067. *https://doi.org/10.1111/gcb.15465*

VanWormer, E., Mazet, J.A.K., Hall, A. *et al.* 2019. Viral emergence in marine mammals in the North Pacific may be linked to Arctic sea ice reduction. *Science Reports*, 10, 15569. *https://doi.org/10.1038/s41598-019-51699-4*

Weelden, C. van, Towers, J.R. and Bosker, T., 2021. Impacts of climate change on cetacean distribution, habitat and migration. *Climate Change Ecology* 1, 100009. *https://doi.org/10.1016/j.ecochg.2021.100009*

Wild, S., Krützen, M., Rankin, R.W., *et al.* 2019. Long-term decline in survival and reproduction of dolphins following a marine heatwave. *Current Biology* 29, PR239-R240. *https://doi.org/10.1016/j.cub.2019.02.047*

Williams, R., Lact, R.C., Ashe, E., *et al.* 2021. Climate change complicates efforts to ensure survival and recovery of St. Lawrence Estuary beluga. *Marine Pollution Bulletin* 173(B): 113096. *https://doi.org/10.1016/j.marpolbul.2021.113096*

Williamson, M.J., ten Doeschate, M.T.I., Deaville, R., *et al.* 2021. Cetaceans as sentinels for informing climate change policy in UK waters. *Marine Policy* 131, 104634. *https://doi.org/10.1016/j.marpol.2021.104634*

Woo-Durand, C., Matte, J.-M., Cuddihy, G., *et al.* 2020. Increasing importance of climate change and other threats to at-risk species in Canada. *Environmental Reviews*, 28(4), 449-456. *https://doi.org/10.1139/er-2020-0032*

Yeager, A. 2020. Clues Point to Climate Change as a Culprit in Gray Whale Deaths. *The Scientist*. *https://www.the-scientist.com/features/clues-point-to-climate-change-as-a-culprit-in-gray-whale-deaths-68066*

Yurkowski, D., Hussey, N.E., Ferguson, S.H., *et al.* 2018. A temporal shift in trophic diversity among a predator assemblage in a warming Arctic. *Proceedings of the Royal Society B*, 5, 180259. *https://doi.org/10.1098/rsos.180259*

Yurkowski, D., Brown, T.A., Blanchfield, P.J., *et al.* 2020. Atlantic walrus signal latitudinal differences in the long-term decline of sea ice-derived carbon to benthic fauna in the Canadian Arctic. *Proceedings of the Royal Society B*, 287, 20202126. *https://doi.org/10.1098.rspb.2020.2126*

Report of the Pollution 2025 - Cumulative Effects - Multiple Stressors IWC Intersessional Workshop

Virtual Meeting, 1-4 November 2021

Pollution 2025 – Cumulative Effects – Multiple Stressors IWC Intersessional Workshop[1]

Online, 1-4 November 2021 (19:30-23:30 UK time)

1. INTRODUCTORY ITEMS

1.1 Welcoming remarks

Holm welcomed participants to the workshop, acknowledging that they were calling in from various time zones. She looked forward to a lively and wide-ranging discussion on how the impacts of the cumulative effects of multiple stressors on cetacean populations could be investigated and potentially progressed with the support of the Scientific Committee's Sub-Committee on Environmental Concerns. Holm acknowledged that whilst it was very unlikely that the workshop would end with a 'blueprint' to solve all the questions on multiple stressors and cumulative effects, it should progress our understanding of this topic. This topic is very important to the IWC, due to it's the previous concerns voiced over the effect of environmental change on cetaceans, as noted in IWC Resolutions 1998-5, 2000-7 and 2009-1. The importance also follows on from former IWC workshops; for example, on 'Habitat Degradation' in 2004 (IWC, 2006) and on 'Assessing the Cumulative Effects of Multiple Stressors on Cetaceans at the Individual and Population Level' in 2018 (IWC, 2019).

1.2 Introduction of participants

A list of participants is provided as Annex A.

1.3 Election of Chair

Holm was elected chair of the workshop.

1.4 Appointment of Rapporteurs

Plön, Hosen, Mayaud, Allen and Gross were appointed as rapporteurs.

1.5 Adoption of Agenda

The draft agenda was adopted (see Annex B).

1.6 Available documents

Documents for this intersessional workshop were made available on the SharePoint site, under each associated agenda item. A list is provided as Annex C.

2. BACKGROUND AND GOALS OF POLLUTION 2025

Holm opened the workshop by drawing attention to the report of the earlier IWC workshop on the same topic and summarising its recommendations (IWC, 2019).

- Improve knowledge and enable quantitative assessments on the data available for cumulative effects.
- Develop a widely applicable approach for providing precautionary advice for populations in which cumulative effects are of concern.
- Establish cumulative effects as a standing item on the E agenda.
- Encourage additional efforts to identify the relevant threats in Important Marine Mammal Areas (IMMAs) in order to assist with the management of cumulative effects.
- Endorse the results of the IUCN/ACCOBAMS workshop entitled 'Towards understanding the overlap of selected threats and Important Marine Mammal Areas (IMMAs) across the Mediterranean Sea'.
- Encourage that such an effort – aimed at overlaying different sources of threat and pressure on existing Important Marine Mammal Areas (IMMAs) – be continued and carried out in more detail in the other marine regions where IMMAs have already been identified.
- Offer its assistance in such assessments.

The Scientific Committee at SC/68C **agreed** on the work plan of Pollution 2025, with a particular focus on the topic of 'cumulative effects' and 'multiple stressors/factors'. To further this issue, this intersessional workshop was suggested by the sub-committee, with the main objectives as follows.

- Discuss new results in this field.

[1]Presented to the Scientifc Committee as SC/68D/Rep/02.

- Discuss and evaluate new methods, techniques, and methodological approaches available for assessing the effects of stressors on cetaceans, both at the individual and at the population level. The primary focus is on cumulative effects and multiple stressors, one being chemical pollution, and to discuss how to evaluate the potential of such new methods in addressing these.
- Decide which study designs could be appropriate to address this topic.
- Evaluate cumulative effects with respect to their effects at the population level, taking into consideration the potential of various models, both individual models as well as population-based models.
- Discuss case studies on specific species and populations.
- Develop the criteria required for robust case studies.
- Discuss emerging issues of concern, including both emerging pollutants and other issues, such as direct and indirect effects of climate change.
- Discuss and suggest mitigation strategies.
- Recommend a strategy to progress this work and communicate the potential negative impact of multiple stressors on cetaceans to a wider audience.

3. FRAMEWORK FOR INTEGRATING DATA OF DIFFERENT SOURCES AND TYPES

3.1 Presentation of framework

Lori Schwacke, NMMF, Johns Island, USA

Schwacke provided a summary and background of the different types of conceptual frameworks that currently exist for integrating data of different sources and types and detailed two conceptual frameworks. She first described the Population Consequences of Disturbance (PCoD) framework, which was developed with the aim to consider how behavioural changes and/or physiological responses to disturbance ultimately may impact vital rates and dynamics of marine mammal populations (Pirotta *et al.*, 2018)2018; and the Adverse Outcome Pathways (AOP) framework, which has generally been applied for assessment of chemical stressors. It describes the activity of a chemical from an initial molecular interaction through intermediate key events at increasing levels of biological organisation, ultimately connecting to an organism level outcome or a population level outcome (Ankley *et al.*, 2010). Whilst the AOP framework is well suited to integrate information from in vitro studies, as well as outputs from emerging methodologies (e.g. omics *approaches or high throughput screening)*, AOPs to date have been described in qualitative terms rather than modeling quantitative relationships among organisational levels (Sewell *et al.*, 2018). In that respect, Schwacke discussed and used several studies that followed the PCoD framework to provide relevant examples of how to integrate data from varying levels of biological organisation to quantitatively assess population consequences of chemical pollutants for cetaceans.

Examples discussed included: (1) using an Effects of Pollutants on Cetacean Populations (SPoC) model to infer population consequences of PCB exposure on a number of species (bottlenose dolphin, humpback whale and killer whale), where different data types were integrated through physiological/ cellular responses through to health assessments and vital rates (Hall *et al.*, 2018); (2) population consequences of the *Deepwater Horizon* oil spill for Gulf of Mexico cetaceans, where the model integrated age-, sex- and exposure classes as well as included formal expert elicitation to better describe distributions of input parameters (Schwacke *et al.*, 2017); and (3) Veterinary Expert System for Outcome Prediction (VESOP) framework to estimate population survival rates from health data collected from a sample of individual animals (Schwacke *et al.*, 2019). In this case study, using such a VESOP framework has identified several key health parameters that predict survival (e.g. individuals diagnosed with inflammation and anaemia). Through exploring these various single stressor studies, it was demonstrated that a firm understanding of processes is needed before trying to develop a model to integrate data, and that often many contextual variables, such as sex, age, and reproductive status, complicate exposure characterisations. In addition, it was noted that a lack of baseline data is a large source of uncertainty, particularly for information regarding adult survival rates. The transitions involving the health of an individual can be particularly difficult to measure, and so studies often rely on data with high uncertainty, including information based on extrapolation from other species, however, it was then demonstrated through example 2, that expert elicitation may help in some of these circumstances to synthesise diverse information and sparse data. In addition, significant advances have been made through: (1) long-term monitoring studies; and (2) collection of standardised and consistent health measures that can be pooled across study sites covering a gradient of stressor exposure.

Integrating data across organisational levels is even more important when considering the combined effects of multiple stressors as different stressors with potential commonality in their effect pathways may combine and interact at various levels. An extension to the PCoD framework, the Population Consequences of Multiple Stressors (PCoMS), was proposed by an US National Academies Panel (National Academies of Sciences Engineering and Medicine, 2017). In addition to the multiple exposures to stressors included in the PCoD model, the PCoMS model also includes multiple doses specific to an individual. In this way, one can investigate how different individual doses may interact to cause different effects on physiological and behavioural responses in a particular individual. While research to implement initial PCoMS models is

just beginning, it may provide a useful conceptual framework to organise and understand the underlying processes for combined and potentially interacting effects of multiple stressors. Schwacke concluded by stating the need to monitor vulnerable populations now, before stressors are introduced, to better input parameters in such a framework, with priority given to monitor the most sensitive parameters, e.g. adult survival rates in long-lived species, such as cetaceans. The need for collaboration to build sufficiently robust datasets was also stressed.

The Workshop thanked Schwacke for presenting a range of case studies where multiple data sources were integrated to connect stressors to consequences for the population. The Workshop noted the potentially powerful tool the VESOP model offers for those who study and use biomarkers of chemical effects to evaluate the health of populations. In discussion, Schwacke confirmed that some of the markers identified in the VESOP example could potentially be useful to evaluate health across different species. However, given the uncertainty in reference ranges for many biomarkers in other species, the effectiveness of VESOP model approaches may be limited under such circumstances and should be used with caution. As income breeders bottlenose dolphins do not rely on energy reserves, which may explain the observed decoupling between body condition and 1-2 year mortality occurrence.

Therefore, some markers may be extrapolated, but not all. The Workshop also noted the importance of incorporating the level of uncertainty derived from the different steps in each section of the frameworks into the estimation of population consequences, so that managers can consider both variability and uncertainty and can therefore incorporate precautionary management if needed. To tackle this problem, Schwacke reaffirmed the implementation of expert elicitation workshops to improve parameters where uncertainty remains high.

Attention: SC/E, R
The Workshop identified several models with the potential to integrate data on combined effects of multiple stressors. Long-term monitoring studies, to provide base line data and investigate temporal variations, are vital to these models and the Workshop **recommended** *that researchers/Scientific Committee:*

(1) *monitor vulnerable populations as much as is practical BEFORE potential stressors occur or as soon as possible after stressors become a factor;*
(2) *archive samples collected opportunistically from potentially vulnerable populations for future assessment;*
(3) *monitor the most sensitive sub-lethal parameters (e.g. body condition and reproduction); and*
(4) *build comparable datasets across sites or even species, noting potential ecological fallacy and/or interspecies differences.*

Attention: SC/E, R
The Workshop **noted** *the importance of incorporating the level of uncertainty derived from the different steps in each section of the conceptual framework (National Academies of Sciences Engineering and Medicine, 2017) into the estimation of population consequences, so that managers can consider both variability and uncertainty and can therefore incorporate precautionary management if needed. Interim but formal statistical methods such as expert elicitation can help to fill gaps where current information is lacking.*

4. NEW METHODS/METHODOLOGICAL APPROACHES FOR ASSESSING CUMULATIVE EFFECTS

4.1 Markers of toxicological pathways

Christina Fossi, University of Siena, Italy

Fossi presented case studies and methods available for the assessment of cumulative effects in the Mediterranean Sea, which was identified as a biodiversity hotspot, but also an area impacted by multiple direct and indirect stressors, including ship strikes, POPs, emerging pathogens, climate change, food depletion and marine litter. Any one factor alone can impact cetaceans differently, decreasing survival, reproductive success or recruitment. However, cumulative, and interactive impacts can be far greater than any one factor alone, potentially affecting population stability of cetaceans in the Mediterranean Sea.

Three case studies were presented to illustrate the effects of multiple stressors. A study on striped dolphins as sentinels of marine health in the Mediterranean Sea showed that this species is most impacted by multiple contaminant loads, and genetic variability was linked to resilience (Fossi *et al.*, 2013). A study comparing fin whale exposure to ingestion of microplastics, POPs and emerging contaminants in the Mediterranean Sea and the Sea of Cortez showed a significant difference between the two sites, with a much higher microplastic load in the Mediterranean Sea (Fossi *et al.*, 2016). A model confirmed an overlap of fin whale feeding areas with microplastic hot spots in the Mediterranean Sea, which has a microplastic load that is nearly as high as in the North Pacific Gyre (Fossi *et al.*, 2016). Metabolomic approaches, which determine individual pathways impacted by microplastic exposure, were successfully applied in both fin whales

and striped dolphins (unpublished data). A third case study of Cuvier's beaked whale population in the Pelagos Sanctuary, Mediterranean Sea, investigated correlations between demographic data and ecotoxicological responses (Baini *et al.*, 2020). There was a clear trend of increasing POP levels with age and more than 80% of the population exceeded the generally-accepted threshold for impacts on longevity or reproductive output (Jepson *et al.*, 2016), while 50% exceeded the high threshold. It is believed that the massive ingestion of marine litter led to cumulative effects of contaminants in this population (Baini *et al.*, 2020).

A need to develop new tools to quantitatively monitor and study highly synergistic effects of independent stressor combinations was highlighted. New 'omics' developments and epigenetics can contribute to the field of cumulative contaminant effects. It was proposed that baleen whale species, specifically fin whales, could be potential indicator species of microplastics and marine litter in the environment (Fossi *et al.*, 2018). The value of an interface between science and policy to consider multiple sources of morbidity and mortality when developing conservation and management plans was emphasised.

The Workshop thanked Fossi for the detailed presentation of the use of sensitive biomarkers in the study of cumulative effects. In discussion, it was recommended that the identification of hot spot areas like the Mediterranean Sea can be useful in impact assessments of threatened species. Monitoring of cetacean microplastic ingestion was also recommended to define categories of marine litter and to suggest mitigation strategies for identified litter. The Workshop acknowledged that the 2019 IWC workshop 'Marine Debris: The Way Forward' (IWC, 2021) had already recommended the formation of an international treaty for marine debris mitigation, which is currently being realised through the United Nations. The IWC Marine Debris workshop suggested that to avoid duplication of resources, the current workshop would support the previous IWC recommendation on developing an international treaty, and **agreed** that the current workshop could provide new elements for consideration in the mitigation of marine debris to the UN initiative.

Attention: S
The workshop **reiterates** *previous recommendations (SC19195) made by the 2019 IWC Marine Debris workshop on the development of an international treaty for the management and mitigation of marine debris and* **recommends:** *(a) the report of this Pollution 2025 workshop be shared with the UN initiative (UNEA); and (b) where possible workshop participants continue to provide input in the form of new research/elements to the initiative regarding mitigation of marine debris.*

Attention: SC/E
Recalling **recommendation** *SC19193 the Workshop reiterated the need to identify potential indicator species in each sea (e.g., fin whale in the Mediterranean) for microplastics and marine litter in the environment.*

4.2 Toxic effects of POPs on marine mammals

Kelly Robinson, University of St. Andrews, UK

Robinson introduced a method which allows researchers to use tissue culture approaches (specifically adipose tissue culture) to study multi-level POP effects on marine mammals in remote field locations. Adipose tissue is important, especially in marine mammals, as it provides essential resources involved in foraging ability, accumulation of contaminant loads, and affects both body condition and thermoregulatory ability. Adipose tissue culture techniques are incredibly powerful tools to investigate how the adipose tissue functions, especially in relation to different hormone levels, life history stages and pollutant exposures. Understanding how tissues function is essential to gaining a better idea of how stressors are affecting these tissues, which can then be used to inform what is occurring at the individual and population levels. Due to obvious constraints e.g. ethical constraints, logistical constraints, low sample sizes/technical repeats, limited experimental conditions, limited survival of cells, etc., such techniques are rarely used in the field. It was therefore desirable to develop a tissue culture approach to study live blubber tissue in wild marine mammals in a remote laboratory environment. Knowledge on tissue function has been achieved in a number of marine mammal species, but usually on skin fibroblast cells (Burkard *et al.*, 2015), and adipose tissue has remained a challenge. This study now demonstrates that a tissue culture protocol can be successfully adapted for use in field conditions (Robinson *et al.*, 2018).

Importantly, there are multiple opportunities for contamination in the field (during sample collection, processing for culture and active culture in the media). Typically, contamination is only detectable in the field with visual changes in culture media which can take several days. Robinson explained that while only 5% of their samples were contaminated, they wanted to develop a way to detect contamination in real time while in a remote location. They discovered that a PreSens (Precision Sensing GmbH) planar optode system to detect oxygen changes, typically used in the food industry, worked well to detect contamination in cell culture media in real time. Such oxygen detecting optodes not only allow detection of possible contamination, but can also be used to collect physiological data by looking at, inter alia, oxygen use rates from the blubber tissue in culture. Establishing such a robust protocol for conducting tissue culture in remote

settings enabled data colelection and experiments to be conducted over multiple seasons. Using this in-field tissue culture approach, it was possible to conduct in vitro experiments on blubber tissue from biopsies of wild seals to explore the effects of bioaccumulated POPs and acute POP exposures on adipose tissue function. POP burdens are high enough in seal pups to alter adipose function early in life (Robinson *et al.*, 2018). By analysing data from *in vitro* experiments alongside *in vivo* measurements, it was also demonstrated that POPs may disproportionately affect smaller individuals (individuals at the lower end of the mass ranges seen in seal pups) and could continue to have population-level impacts even when levels are relatively low compared to historical values (Bennett *et al.*, 2021).

The Workshop thanked Robinson for this interesting, exciting and impressive technique, which the Workshop acknowledged would be beneficial for cetacean fieldwork. Robinson strongly believes this method could be applied to cetacean species and various fieldwork locations with a few adaptations. In discussion, Robinson offered to discuss with any workshop participants how this method might be progressed or adapted for cetaceans. The possibility of taking tissue samples from individuals that had recently died was also discussed, and by using the oxygen sensing optode, this would give a good indication whether tissues are useable, although this is an area which needs further development. It was emphasised that there is a possibility for more work and research to be conducted on longevity of live samples, beyond the 24 hours achieved in this study. As the process involves generating trauma to the blubber tissue, however, the life span of the tissue is reduced compared to other tissue culture techniques. Workshop participants acknowledged that cell culture in cetaceans is often not as successful as pinnipeds. The Workshop **agreed** that this approach shows strong promise.

4.3 Biologging, telemetry

Kagari Aoki, University of Tokyo, Japan

Aoki offered updates on the use of aerial photogrammetry and tag-derived tissue density for the assessment of body condition of humpback whales (Aoki *et al.*, 2021). Tag-derived tissue density estimates for body condition determination is based on the concept that fatter animals are more buoyant than thinner animals, and hence sink more slowly (Biuw *et al.*, 2003). This method was initially applied to determine body density of elephant seals during drift dives (Aoki *et al.*, 2011), but this technique was also used successfully to determine body condition of humpback whales during gliding, which is observed in most cetacean species. Humpback whales that had a larger length-standardised surface area (calculated through the analysis of overhead images collected by UAVs) also had lower estimated tissue body density, which is indicative of a greater lipid store and hence better body condition. A Bayesian hierarchical model showed that the underlying tissue density decreased during the feeding season, adding confidence to the effectiveness of estimating body condition using this method. It was highlighted that future monitoring of energy stores at sea through on-board processing of dive data during longer term tag deployments can be used to assess where and how energy stores are gained or lost, and should be implemented. This will provide insights to assess trends in cetacean body condition in response to human activity and climate change, which can be used as an indicator for population and ecosystem health.

The Workshop thanked Aoki for the presentation and in discussion, highlighted the presentations recommendation that assessing body condition can be a tool to document climate change impacts.

4.4 Use of drones for cetacean research to estimate body condition and health

Fredrik Christiansen, Aarhus University, DK

Christiansen provided an overview of the advances made in the use of Unmanned Aerial Vehicle (UAV) photogrammetry to study the physiology and bioenergetics of free-living cetaceans. The steps required when conducting UAV photogrammetry were: (1) image quality control; (2) identifying the metabolically active areas of the species; and (3) calculating body condition from the residual of the relationship between body volume (or any other metric relating to the energy reserves of the animal) and body length. Changes to the body condition of whales during migration, pregnancy and lactation can be quantified to inform the energetic cost of different stages in the reproductive cycle of whales. Several case studies were used to illustrate how measures of body condition can evaluate multiple anthropogenic stressors on individuals and populations. A study of southern right whales (*Eubalaena australis*, SRW) in South Australia showed that female body volume declined proportionally to the growth in body volume of their dependent calf, indicating energetic transfer (investment) between the mother and calf. A subsequent cross-population comparison of three healthy SRW populations with the declining North Atlantic right whale (*Eubalaena glacialis*, NARW) population showed that NARW were in comparatively poorer condition and that the NARW somatic growth rate had decreased over time. A study of survival in gray whales (*Eschrichtius robustus*) during a recent unusual mortality event (UME) in 2019-20, showed that all age classes, except calves, declined in body condition during the UME. The study further showed that emaciated stranded animals had a body condition of approximately -45% (45% lower body volume than the population average), which could be the lower threshold for survival for this species. A limitation of the method is that once an animal reaches a very poor condition it is not possible to visually detect a further decline in body condition (a further reduction in lipid or protein concentrations in various tissues). A third case study on Western Australian humpback whales showed a decrease in juvenile and adult body condition from the start to the end of the migration period (June-October) using absolute changes in body condition.

The Workshop thanked Christiansen for his presentation. In discussion, it was suggested that this method should be applicable across species regardless of size, because it is standardised for body length, although it may be difficult for species, such as dolphins, that do not linger (and hence provide opportunity to measure stretched-out body length) at the surface. Long-term impacts on body condition due to chronic stressors, such as climate change, may best be studied through inter-population comparisons across several years (to increase sample size). As the technology develops, cheaper UAV systems with good cameras have the potential to make the method more accessible. Several limitations were acknowledged, including: (1) the lack of long-term data due to the novelty of the technique; (2) fat reserves that cannot be seen in dorsal view with the drone; and (3) visibility limits due to turbidity in the water. Potential ways of addressing these limitations included reiterating the requirement for high quality images in which the animal is straight and completely visible at the surface, as well as capturing video footage from which images can be selected. It was acknowledged that lipid and protein content in different tissues cannot yet be measured with this method, but that it is a likely next step.

4.5 New 'omics approaches to investigate cetacean health and responses to multiple stressors

Jo Kershaw, Plymouth, UK

Recent developments in high-throughput nanotechnologies and bioinformatics have enabled the examination of biological systems in increasing detail, which have allowed a more mechanistic understanding of complex cellular functions, cellular networks and signalling, organ homeostasis and whole organism physiological functioning. Collectively, these have been referred to as 'omics technologies', and, overall, the application of these new technologies and techniques aims to understand a complex biological system, considered as a whole. To date, the genomes of only nine marine mammal species have been fully sequenced and annotated. Kershaw described three main themes where these technologies are particularly important and being used in current research: to investigate overall individual health, to understand and measure stress responses (both acute and chronic stress) and how to investigate physiological changes associated with contaminant exposure. 'Omics' approaches to address such themes are being used to develop biomarkers that can then be applied to marine mammal populations.

After a brief description of the different levels of organisation (e.g. genomics: universal detection of genes; transcriptomics: the totality of the mRNA transcript; proteomics: the study of the entire set of peptides and proteins; and metabolomics: the study of all the intermediate products of metabolism), Kershaw described some of the challenges associated with 'omics approaches that are common across other cetacean research studies. For example, challenges include sample collection (blood, biopsies and breath), as well as the requirement for good baseline information to allow for interpretation of samples to assess between individual variation, as well as temporal changes within individuals. Examples of different 'omics approaches using different case studies were provided.

Kershaw presented the paper of Trego *et al.* (2019) who used transcriptomics to investigate overall individual health of bottlenose dolphins in the Southern California Bight using biopsied skin samples. This study is a good example of the importance of the ecological context when trying to characterise transcriptome variability between individuals, and demonstrates the use of transcriptomics as a tool to understand how physiological responses shift with changing environmental conditions or demographic states. Deyarmin *et al*. (2020) used northern elephant seals as a model species to investigate the downstream effects of both single and repeated stress responses on blubber tissue homeostasis. This experimental study administered adrenocorticotropic hormone (ACTH) to stimulate the production of glucocorticoids by the adrenal glands, i.e. essentially stimulate a stress response in order to identify proteins that were expressed under various stress scenarios. The study found that distinguishing between single and repeated responses to stress was captured in blubber protein profiles. The changes in expressed proteins (e.g. heat shock proteins, metabolic enzymes, and metabolite transporters) suggest that repeated stress may affect blubber tissue proteostasis, mitochondrial activity, adipogenesis and metabolism in marine mammals. Hence, this study is one of the first to demonstrate that proteomics can be used as a novel method to identify chronically stressed animals, through differentially expressed proteins in adipose tissue. Simond *et al.* (2020) aimed to investigate the potential mechanisms of toxicity as a result of exposure to a wide range of organohalogen contaminants through metabolic profiling of the endangered beluga whale population in the St. Lawrence Estuary, Canada. A targeted metabolomic approach was used to characterise profiles of amino acids, biogenic amines and fatty acids in the skin of male belugas, and their relationships with blubber concentrations of major organohalogens were examined while accounting for differences in habitat use in the estuary. Although the mechanisms of toxicity of these organohalogens cannot be identified using the correlative approach used here, these results suggest that SCCP exposure in particular could alter lipid metabolism. These results highlight the important of considering ecological factors, like diet and habitat use, in metabolomic studies.

In discussion, the future of these 'omics approaches was considered, highlighting that as an increasing number of the health and stress biomarkers are identified, it would be advantageous to apply different biomarkers to at-risk populations and those that face multiple stressors. Combining the study of multiple genes, proteins and metabolites can produce a multiomics approach that provides a more holistic understanding of individual health. In line with that, the examination of

multiple tissues or body fluids will provide a better understanding of the whole organism's physiology and the consequences of changing environmental conditions. Further work into 'metagenomic' studies of marine mammals could be focused on the viral and microbial communities in these species, which will be valuable in identifying emerging diseases of potential concern.

The Workshop thanked Kershaw for a comprehensive overview of these new methods and the possibilities they open up for health assessment of cetaceans. It was acknowledged that one of the barriers facing the 'omics' field is the cost of sample analysis. However, cost is decreasing and thus 'omics approaches will likely see more use in wildlife research. It was noted that moving from the 'shotgun' approach of looking at everything towards a more targeted approach, such as focusing on specific, validated biomarkers indicative of immune system function, chronic stress responses, or contaminant exposure, for example, will bring down cost as well. Concerns were raised regarding the storage of samples for 'omics work; as such samples are very sensitive to degradation. It was explained that mRNA is more unstable than proteins and trancriptomics work therefore requires placing of samples as quickly as possible into temperature-stable storage media such as RNA-later. The need for studies to distinguish between pre- and post-sampling changes in gene expression, especially for samples collected from dead animals, was highlighted. Storing the tissues appropriately and as quickly as possible is critical to preserve that snapshot in time.

Attention: SC
The Scientific Committee is **encouraged** *to continue investigating new 'omics approaches as a means of screening for new biomarkers.*

4.6 Sentinel parameters

Susan Bengtson Nash, AUS

An overview of the humpback whale sentinel program, which provides a reliable and consistent monitoring opportunity of the Antarctic sea-ice ecosystem through studying biopsied tissue samples of free-roaming humpback whales was presented (Bengtson Nash *et al.*, 2018). Various sentinel parameters (adiposity, diet and fecundity) have been identified and developed for humpback whales over the years, and seem to follow trends of Antarctic environmental variability. Some of the ecological tracer techniques to measure these sentinel parameters were described, e.g. the Adipocyte Index, which measures the change in volume of adipocyte cells, giving an indication of the individual's lipid reserves and thus body condition (Castrillon *et al.*, 2017), as well as the use of lipophilic POP burdens measured in adult male outer blubber layers. A few months of seasonal fasting resulted in an increase in chemical burdens in outer blubber layers of humpback whales - up to a 500-fold increase Bengtson Nash *et al.* (2013). As the outer blubber layer supports a number of vital functions (e.g. thermoregulation and buoyancy), this layer represents an increasing proportion of the individuals' remaining lipid stores during fasting, and so accumulates greater pollutant loads. Therefore, measuring POP burdens in the outer blubber layer of adult males can provide an indication of adiposity (Bengtson Nash *et al.*, 2018). Diet is measured through traditional carbon and nitrogen Bulk Stable Isotope analysis and fatty acid analysis, whilst fecundity rates are measured through migratory sex ratio, as well as steroid hormone analysis for pregnancy. The need to include disease and toxicity as sentinel parameters was highlighted, and the usefulness of including steroid hormones (e.g. cortisol) to measure stress, as well as working towards 'omics approaches to contribute new biomarkers of toxicity and disease.

The longest record of annual measurements (13 years) is for the E1 migrating stock (east Australian migrating humpback whale population) and has captured two extreme climatic events in Antarctica: the La Niña event of 2010/11, and most recently, the anomalous climatic events of 2017. In these years, whales migrated in poorer body condition, fewer females participated in the migration, and higher calf mortalities were recorded. As such, this long-term monitoring and timeline of humpback whales provides confidence that, through standardised, consecutive, reliable and annual monitoring, it is possible to capture environmental trends in Antarctica's sea ice ecosystem. Through international collaboration, the sentinel program is able to capture samples of humpback whales from the Brazilian (A), western (D) and eastern (E1) Australian, New Caledonian (E2) and Colombian (G) breeding grounds, allowing for circumpolar surveillance of the Antarctic sea-ice ecosystem. The sentinel program offers a good approach to investigate cumulative stress through environmental monitoring by interrogating humpback whales for every signal that can be accessed and analysed through their blubber tissues.

The Workshop thanked Bengtson Nash for an excellent overview of the sentinel program and how the developing situation of climate change can both exacerbate known stress factors and lead to new ones, creating additional burdens to humpback whales. The limitations of using lipophilic POP burdens as markers of adiposity in delphinid species that may feed on multiple prey sources was discussed. As prey source affects POP accumulation and contamination, feeding on multiple prey sources could lead to regional variability in POP burdens. Concomitantly, the humpback whale, which feeds on one prey item and in one location, provides greater confidence that the variability in POPs is due to a change in diet or body condition. Nevertheless, if there is substantial variation in POPs within a population over time, body condition is the

first factor that should be investigated. The Workshop also noted alternatives to measuring body condition, such as visual health assessments, which may not be as accurate as other techniques, including the adipocyte index. It was noted that further work is planned to compare the adiposity index with other body condition matrices, such as photogrammetry. It was also noted that it was as yet unknown whether the adipocyte index can work for species other than humpback whales. In addition, the adipocyte index only captures the outer blubber layer, an important functional layer (e.g. used in buoyancy and thermal regulation), and so animals are thought to be in really bad condition if they need to utilise this layer, which could be a limitation of the technique.

Attention: S
The workshop **requests** *the Secretariat to communicate with the Stockholm and Minamata Conventions to consider the explicit inclusion of cetacean blubber (of model species) as a core media for long-term (and retrospective) monitoring of chemicals of Arctic/Antarctic concern (CEACs) to demonstrate biomagnification potential and hereby facilitate expedited chemical regulation.*

4.7 Epigenetic approaches

Ashley Barratclough, National Marine Mammal Foundation, San Diego, USA

Barratclough introduced the concept of epigenetics to enable DNA methylation analysis of remotely collected skin samples to provide a chronological age estimate of cetaceans. Age is important to improve our understanding of population dynamics, for example to know how many animals are contributing to reproduction. In addition, age can provide an indication of the health status by investigating whether an individual is undergoing age acceleration, i.e. where biological age (defined as the functional capability of an organ) is higher than chronological age (defined as time since birth). As different species age at different rates, it is important to create a species-specific age clock. Therefore, Barratclough described their first phase of this study, which was to establish the chronological aging clock of bottlenose dolphins. By using samples from 34 bottlenose dolphins of known-age ranges (from 8 months-58 years) from the U.S. Navy Marine Mammal Program, Barratclough described how she and her co-authors created the first multi-tissue bottlenose aging clock (Barratclough *et al.*, 2021). Barratclough and her co-authors were able to examine the changes in DNA over a defined time frame (at least 5 years apart) of the same individuals and identified methylated CpG sites (cytosine-guanine nucleotides) associated with biological aging. An elastic net regression analysis and identification of 195 CpG sites strongly correlated with chronological age (R^2=0.95), thus showing the ability to predict the dolphins age within two and a half years of the actual age. This diagnostic tool is currently being applied to wild dolphins from different geographical locations to assess the effects of environmental stressors on biological aging. Identifying biological aging sites that could be associated with specific pathologies or environmental stressors can provide a good indication of the health status of that individual. By comparing the complete medical, nutritional, and environmental history of each dolphin from the Navy population, it is possible to identify biological age changes for each individual and relate this as a proxy for health status. Comparison of both chronological and biological age allows determination of the presence or absence of 'age acceleration'. Are environmental factors driving age acceleration? Are there differences in age acceleration between geographic location based on variation in environments? Being able to use epigenetics to quantify health status as well as just the age demographic within the population could be pivotal to our understanding of the overall health of such populations. Comparing the chronological ageing clock obtained from the Navy dolphins with wild dolphin populations will allow assessment of the presence or absence of age acceleration. Toxins and poor nutrition are known to affect the human genome; PCBs and reduced food availability could affect cetaceans similarly. Further work addressing these issues is currently being undertaken by Barratclough and colleagues.

The Workshop thanked Barratclough for sharing these initial results and discussing the next phases and future work in the field of epigenetics. In discussion, it was acknowledged that this technology is still in its early stages, and that ideally there needs to be a larger sample size, noting this could be achieved relatively quickly through collaborations with other long-term studies, if appropriately preserved tissue samples are available. The major limiting factor is the cost of using this technology due to its novelty, however, as it becomes more readily available, these studies can be conducted on a larger scale. Concern were raised regarding the state of preservation of a sample, which could restrict the method utilised in this study. Collaboration with NOAA is working towards addressing this question, but skin samples successfully used in current studies have been stored in a freezer at minus 80°C for 20 years. It is therefore believed this technique can be used with archived tissue samples. Further concerns were noted with regards to age estimation in cetaceans that have very low metabolic rates, such as baleen whales. Although this may affect the precision of age estimation, Barratclough believes that in animals with low metabolic rates there are more opportunities to learn as methylation changes occur over longer periods; this may not be picked up in animals with faster metabolism.

Attention: SC, Sec, IWC database group, Industry, Research Community
The workshop **recommended** *that an international database be established as well as sample archives, to analyse samples with new techniques.*

Furthermore, the workshop **requests** *the Secretariat to seek formalised arrangements with the global network of Environmental Specimen Banks (ESBs) to ensure the routine collection and archiving of cetacean tissues according to standardised protocols. ESB are the time capsules of the environment and allow for retrospective analysis as new information is gained. They also limit loss of valuable archived materials through e.g. researcher movement, freezer failures, unsuitable collection or storage etc.*

5. CASE STUDIES

5.1 *Deepwater Horizon* oil spill

Teri Rowles, NOAA Fisheries, and Cynthia Smith, National Marine Mammal Foundation

The *Deepwater Horizon* oil spill exposed marine mammals to impacts through multiple significant routes, including inhalation, aspiration and ingestion. This susceptibility is largely due to their living at the air-surface interface; evaporated oil compounds created toxic fumes at the sea surface, and droplet size can be decreased by dispersants and potentially become more toxic. A case study of the Barataria Bay bottlenose dolphin population, in which injury was assessed between 2010 and 2015 during an unusual mortality event following the spill, was presented (Smith *et al.*, 2017). Poor health was indicated in 'oiled' individuals found within the spill footprint. There were significantly higher instances of lung disease, adrenal cortical thinning, and perinatal loss for oiled *vs* non-oiled individuals. Lung disease is likely to impact both individual and population health. Cortical thinning is of particular concern due to its importance in adrenal health, which is needed to adapt to environmental changes and for parturition. Perinatal loss, severe fetal broncho-pneumonia, and high perinatal stranding rates, along with high rates of maternal illness and placental dysfunction, overall indicate reproductive failure within the population. The long-term population trajectory will rely on metrics, such as maximum proportional decrease, years to recovery and lost cetacean years. The scientific community needs to learn from each spill in every country, as well as improve measurement of exposure, assessment, quantification and integration of live and dead animal data. To do this, there have been attempts to use expert elicitation to fill data gaps and improvements have been made to the understanding of aspiration/inhalation risks. Rowles and Smith emphasised that the Gulf of Mexico is a high-risk area due to continued oil and gas development. Overall, the *Deepwater Horizon* oil spill may have significant and long-lasting impacts on individuals, populations and habitats.

The Workshop thanked Rowles and Smith for their update and acknowledged that it is difficult to identify which components or types of oil are most responsible. Areas that need more investigation are: (1) the pathway of volatile organic compounds in droplets, specifically dosage; and (2) the mechanism of injury with adrenal cortical thinning. Comparative studies with human responders were suggested, specifically the Coast Guard response to *Deepwater Horizon* and previous work on 9/11 responders. These may provide a path forward in terms of long-term health and possible treatments. Suggestions for mitigation pathways included identifying means of effectively cleaning the surface water during spills without exacerbating conditions for cetaceans, as current dispersants can break down the oil in a way that is potentially more harmful.

Attention: I, SC, S, CG,G
The Workshop **agreed** *that current dispersants can break down oil in a way that is potentially harmful to cetaceans (see also previous recommendation SC1608). It therefore* **encouraged** *the oil spill response community, National Governments, maritime industry, oil and gas extraction industry to:*

(a) *consider the impacts on the physiology and health of cetaceans and other marine life of their surface oil response activities; and*
(b) *identify means of effectively cleaning the surface water during spills without exacerbating conditions for cetaceans (and other marine species).*

Attention: SC
Given the threat to cetaceans from oil spills the Scientific Committee is **encouraged** *to: (a) study effects of multiple stressors; (b) identify areas of high risk for spills and high risk for cetaceans by establishing heat map and early warning systems; (c) follow existing guidelines and principles (e.g. NOAA guideline on oil spill response; and (d) on assessing exposure and impacts of oils spills on MarMam) (e.g. IPIECA/IOGP key principles for the protection, care and rehabilitation of oiled wildlife; wildlife response preparedness, etc.).*

Attention: CG, I
The workshop recalled recommendation SC1609 calling on Contracting Governments and industry to share information on exposure of, and impacts to, cetaceans; increase efforts on prevention of spills; and focus research to improve tools to detect exposure and evaluate impacts of oil spills on cetaceans. Building on this, the Workshop **urged** *industry to establish precautionary measures to prevent oil spills., e.g. by properly maintaining their current equipment and facilities, and increase efforts to contain oil in case of oil spills rather than the use of dispersants.*

Attention: S, I, CG, SC, C, R
The workshop **requests** *the:*

(a) *IWC Secretariat: (i) circulate the report of this workshop to appropriate entities to communicate the workshop discussions; and (ii) draw the attention of the Commissioners to the report of the workshop and, in particular, the finding that oil exposure can lead to significant adverse acute and chronic pathologies (i.e. respiratory diseases, immunological disorders, endocrine disruption, reproductive disorders) threating cetacean life with population effects; and*
(b) *Commissioners bring this information to the attention of their relevant national authorities.*

5.2 Arctic monitoring, real time emerging cumulative issues

Raphaela Stimmelmayr North Slope Borough, Alaska, and Gay Sheffield, University of Alaska Marine Advisory Program

Stimmelmayr presented a characterisation of multiple external stressors on Arctic marine mammal species through harvest monitoring and ongoing health assessments of landed Bering-Chukchi-Beaufort (BCB) bowhead whales. Overall, this has provided solid baseline data on population status and general health status, which are considered to be positive. Ongoing risk surveillance of bowhead whale habitat and increasing understanding about direct and indirect climate change impacts on the Arctic-subarctic marine ecosystem indicates an increasing complexity of environmental, ecological and anthropogenic stressors. For example, ongoing environmental and ecological changes are numerous, ranging from dynamic northward distribution shifts of Bering Sea Pacific cod and pollock; extended residence time and further northward movement of subarctic baleen whales; changes in timing of bowhead whale spring and fall migration, as well as novel overwintering in the Beaufort Sea; increasing killer whale-baleen whale predation; multi-year sea surface temperature departures from normal; continued decline in sea ice coverage; increasing presence of harmful algal toxins; ongoing unusual mortality events in gray whales, seals and seabirds.

With respect to human impacts, since 2019/20 novel fishing for Pacific cod and pollock has successfully expanded northward in the Bering Strait and into the southern Chukchi sea. Within the same time frame, maritime traffic along the Northern Sea route has significantly increased and traffic is anticipated to become year-round by 2022. In 2020/21, several foreign marine debris events, likely associated with northern fishing and commerce vessel traffic, have occurred along the Alaskan coastline within the Bering Strait region. Taken together, this indicates that a real-time status change of the Arctic-subarctic marine habitat is occurring from a low-level stressor exposure regime to a novel habitat with potentially concurrent high-level stressors. Given the current evolving dynamic landscape of known and emerging stressors within core areas of bowhead whale habitat, there is much urgency for federal co-management partners and coastal communities to engage in targeted research. Real-time Arctic stressor identification and impact characterisation is needed to develop actionable transboundary mitigation strategies. It was suggested that the accumulated ecological and biological knowledge about the bowhead whale can provide valuable, relevant and transferable information to manage core large whale habitats in the Arctic-subarctic and devise realistic management strategies for a multi-user/multi-cetacean species Arctic seascape.

The Workshop thanked Stimmelmayr for the overview and **agreed** that mitigations should be a priority for this workshop. These included identifying the source of marine debris, so that responsible parties could be identified and the problem addressed legally. Furthermore the future use of polycyclic aromatic hydrocarbon (PAH) fingerprinting (provided the source oil is on file) was suggested, which would allow a determinination of exposure and oil source in case of unknown oil spill exposure (e.g. 2006 oil exposure in bowhead whales as evidenced by retrospective PAH tissue screening). It was further acknowledged that any mitigations need to be in a bilateral or transboundary capacity, and that change is needed quickly. This was emphasised as the Arctic is interconnected with other habitats and other nations. It was suggested that lessons learned from other areas be applied to better protect the Arctic.

Attention: CG, I
The workshop **strongly encouraged** *governments to implement preventive policies and producers responsibility, and reiterated recommendation CC1406 asking the IWC (and other IGOs) to encourage their member states to review national level implementation of MARPOL and other conventions relevant to prohibition of dumping of waste/marine debris etc.*

Attention: S, SC/E, CG, I
The Workshop **requests** *the Secretariat and members of the Sub-Committee on Environmental Concverns and the marine debris ICG to continue international engagement on debris tracing and prevention (e.g. via monitoring of cetacean microplastic ingestion, Extended Producer Responsibility polycyclic aromatic hydrocarbon (PAH) fingerprinting), to pursue solutions on marine debris and to suggest mitigation strategies.*

Attention: S, SC/E, CG, I
The Workshop **requests** *the Secretariat and members of the Sub-Committee on Environmental Concverns and the marine debris ICG to continue international engagement on debris tracing and prevention (e.g. via monitoring of cetacean microplastic ingestion, Extended Producer Responsibility polycyclic aromatic hydrocarbon (PAH) fingerprinting), to pursue solutions on marine debris and to suggest mitigation strategies.*

Attention: S
The workshop endorses the importance of precautionary areas in Bering sea and Arctic waters as outlined in the Polar Code of the IMO at its MSC99 meeting 2018 (https://www.imo.org/en/MediaCentre/HotTopics/Pages/Polar-default.aspx Ship routeing in the Arctic).

5.3 Pollutants in cetaceans in Spain

Graham Pierce, Instituto de Investigaciones Marinas (CSIC), Spain

Pierce summarised the progress of the Transfers of Anthropogenic and Natural Stressors Involving Trophic Interactions of Ocean Nekton (TRANSITION) project. The project's aim is to model the effects of PCB ingestion on cetaceans at individual and population levels, and consequences for the ecosystem, with a focus on Galicia in Northwest Spain. POPs data were collected in fish and three cetacean species (common dolphins, bottlenose dolphins, and harbor porpoise (Pierce *et al.*, 2008)). Levels were substantially higher in cetaceans compared to fish, with the highest concentrations in males. A case study of common dolphins showed a downward trend in concentrations over time. Additionally, concentrations in males showed a positive correlation with body length. Comparisons across France, Galicia, and the Netherlands showed that concentrations varied across countries, although overall these remain high across Europe. A Leslie-matrix simulation model has been developed using mortality, reproduction, and PCB bioaccumulation, although it is still being validated at a basic level. A GADGET ecosystem model has also been developed using diet and prey consumption (Saavedra, 2017). It was emphasised that these models are preliminary and do not currently look at mechanisms. There is a need for more data from foetuses, calves and pregnant/lactating females. Future work also aims to extend the models to include relevant pathogens.

The Workshop thanked Pierce for presenting these TRANSITION project updates. It was noted that the project is still at an early stage, as it began in 2019 and was interrupted by the COVID-19 pandemic. PCB concentrations are used as a proxy for total PCB burden, but this may be skewed for animals in poor condition, where concentrations will increase. Future directions for the project include incorporating the relationship between PCB burdens and diet, as all study animals are known individuals, so dietary information is available, and looking at contaminants for transition through the food chain.

5.4 Multispecies PFAS assessment

Karen Stockin, New Zealand

Stockin presented an initial review on the magnitude and impacts of Per- and Polyfluoroalkyl Substance (PFAS) occurrence in stranded individuals from 12 odontocete species in New Zealand waters, including coastal species, such as Hector's, Maui's and bottlenose dolphins, as well as offshore species, such as Gray's beaked and pygmy sperm whales. The highest PFAS levels were found in Southern Ocean species frequenting New Zealand waters. In addition, offshore species had higher PFAS levels than coastal species. These findings were contextualised with a focussed discussion of a recently published paper (Stockin *et al.*, 2021) on common dolphins. Most PFAS were below the level of reporting in common dolphins, but the authors found PCBs and DDT above threshold levels despite both toxins having been banned in New Zealand since 1996. Common dolphin PFAS profiles did not vary significantly by body condition, life history or location, but a positive correlation between PFAS and trace elements was observed. The predominant PFAS compounds found in common dolphins were long-chain PFAS, including Perfluorooctyl Sulfonate (PFOS). Stockin also noted that a decline in PCB levels has not yet occurred in orcas feeding on stingrays and marine mammals in New Zealand waters. Next steps in the project will include the examination of toxins in a large dataset of common dolphins and pilot whales, as well as investigating contaminant burdens in a nutritional context.

The Workshop thanked Stockin for presenting these initial findings of PFAS patterns and profiles in New Zealand cetaceans. In discussion, Stockin recommended that future research should focus on multiple sampling opportunities of

the same individual and species to inform mechanisms of PFAS exposure. Discussion focused on how baselines can be determined, considering that stranded cetaceans may not represent a healthy population. In New Zealand, not enough species have been examined for contaminant levels and large datasets for baseline considerations currently only exist for the endemic Hector's and Maui's dolphins. It was argued that live stranded cetaceans may be representative of a healthy population, and it was highlighted that non-healthy population members need to be examined more closely for baseline evaluations.

Attention: SC/E
The Workshop **recommended** *that in order to inform mechanisms and trends in legacy chemicals and exposure and effects to emerging contaminants of concern, future research should focus on multiple sampling opportunities of the same individual and species.*

5.5 Baltic Sea – an ecosystem with multiple stressors

Ursula Siebert, Veterinary School Hannover, Germany

Siebert provided an update on the monitoring of harbour porpoises in the Baltic Sea, an ecosystem affected by multiple anthropogenic activities, such as shipping, fisheries, offshore construction, marine litter, chemical pollution, military and seismic activities. Due to the multitude of stressors, cumulative assessments and interdisciplinary approaches are required to understand ecosystem processes and impacts on harbour porpoises, especially the endangered southern sub-population, estimated at 600 individuals. Long-term study results on chemical pollution through necropsy, histology, microbiology, virology, parasitology, age structure, reproduction biology and genetics revealed that harbour porpoises had lower PCB loads than other marine mammals in the Baltic Sea, but that their livers had higher pentabromodiphenyl ether (PentaBDE) levels due to cumulative effects of contaminants. The highest number of lesions was found in the respiratory tract, decreasing lung capacity and reducing the ability to compensate stress and feeding interruption. There were higher incidences of parasitic infections, pneumonia and chronic disease compared to Arctic marine mammal species. It was concluded that Baltic Sea harbour porpoises were more susceptible to infectious diseases, and impacts on the endocrine and immune system when compared to animals from the Arctic area where animals experience less human pressure (Siebert *et al.*, 2020). Another study showed that many harbour porpoises, especially females, have a decreased life expectancy, with many dying prior to reaching sexual maturity (Dietz *et al.*, 2021).

In discussion, it was noted that there is a need for more interdisciplinary research on Baltic Sea harbour porpoises at the national and international level, as well as for long-term datasets to investigate temporal variations. The Workshop also noted the need for a systematic health investigations and interpretations by trained experts. It was proposed that such needs could be addressed by securing funding for Baltic Sea projects for transnational (rather than national) areas inhabited by marine mammal species. Additionally, it was recommended that an international database as well as sample archives, to analyse samples with new techniques, be established. The need for cooperation with international partners was emphasised, using new investigation possibilities to establish sensitive indicators for cumulative effects and to formulate a definition for international threshold levels, securing good environmental practices. Suggestions for mitigation included reduction of chemical pollutants, marine litter, underwater noise and bycatch.

The Workshop thanked Siebert for her presentation, particularly for the detailed list of recommendations. In discussion, the need to define sensitive indicators that are likely to be specific to areas and populations was further highlighted. It was emphasised that lung health is an important health indicator for the porpoises of the North Atlantic, because the lung tells much about other chronic conditions. The health of the hearing system also needs to be investigated which is essential for the vital echo location. In addition, for those non-target analyses, the immune system has potential for measuring chronic stressors, and genetics investigations are very promising for understanding exposure to multiple stressors. A combination of relevant indicators has to be assessed for future monitoring of populations, e.g. health of the respiratory tract, life expectancy, immune competence.

Attention: SC/E, R, CG
The Workshop **highlighted the need** *for:*

(1) *interdisciplinary research on Baltic Sea harbour porpoise populations at the national and international level (Baltic Range states, ASCOBANS, HELCOM);*
(2) *the continuation of long-term datasets (and the creation of new datasets) to investigate temporal variations; and*
(3) *systematic health investigations and interpretations by trained experts.*

The workshop **suggested** *that funding for Baltic Sea projects should be secured for marine mammal species – which may be transboundary- rather than for national areas, which may only hold part of a species' population.*

Attention: SC/E
To assess the impacts of cumulative stressors the workshop **proposed** *that at least five different health indicators be monitored (lung and ear status are the best early indicators of overall animal health).*

Attention: SC/E
The Workshop **recommended** *the Scientific Committee, in cooperation with international partners, formulate a definition for international threshold levels for indicators and, using new investigation possibilities, establish sensitive indicators for cumulative effects.*

6. MODELLING THE POPULATION CONSEQUENCES OF EXPOSURE TO MULTIPLE STRESSORS

6.1 PCOMS and other models

Enrico Pirotta, St. Andrews/CREEM, UK

Pirotta presented recent work on assessing, predicting and managing the combined effects of multiple stressors on individuals and populations using the population consequences of multiple stressors (PCoMS) conceptual model. This model captures and connects multiple scales, targets and organisational levels. Quantifying interactions between stressors is a cross-disciplinary goal, but the definition of interactions and methods to detect them are inconsistent within and between disciplines. The dose-response function of a stressor is generally non-linear, which implies that traditional factorial studies, analysed using linear models, are inappropriate to detect interactions between stressors. All existing approaches lie along a spectrum of increasing assumptions on the underlying mechanisms. This assumption spectrum can be used to reconcile cross-disciplinary methodological differences for the analysis of combined effects. Mechanistic assumptions will often be necessary, because we generally do not have sufficient data to rely on data-driven approaches. The choice of the analytical approach to use in each scenario should take into account the management goals and associated predictive needs. Stakeholders should find a shared framework for assessing combined effects of multiple stressors. Population Consequences of Disturbance (PCoD) models, extended to multiple stressors (PCoMS), offer a unifying framework to achieve this goal.

The Workshop thanked Pirotta for his presentation. In discussion, it was noted that current knowledge of many of the mechanistic pathways in the PCoMS framework (e.g. changes in immune status) is mainly theoretical. The bioenergetic pathway is very useful in many cases, because even stressors that are not operating intuitively along this pathway ultimately result in energetic costs to the individual animal. However, other currencies might be needed in some cases. For example, health assessments on bottlenose dolphins exposed to the *Deep Water Horizon* oil spill have shown that body condition is not a good metric for assessing the health status of these animals; their survival probability and reproductive output are better predicted using other health indicators such as adrenal function and lung status. This case study will thus explore other currencies to integrate combined effects.

6.2 News of SPOC and contamination mapping tool

Jo Kershaw, Plymouth, UK

Kershaw presented the use of two publicly accessible R Shiny online tools, hosted by the Sea Mammal Research Unit at the University of St Andrews, Scotland *The Contaminant Explorer*[2], is a global mapping tool, which can display published data on the concentration of POPs and mercury in cetacean tissues. Researchers can choose individual species and contaminant classes. By zooming in on a specific area, local studies are displayed for the chosen species and contaminant class.

The Effects of Pollutants on Cetacean Populations (SPoC) model[3] can be used to explore the effects of pollutants on cetacean populations using an individual based model approach. Dose-response functions to simulate impacts on calf survival and calf immunity, population structure, population specific vital rates and number of simulations can be adjusted for a given species using a Leslie Matrix Model. Model outputs include simulated population trajectories, population growth rates and maternal contaminant loads. The model has been used to study the effects of PCB exposure on global orca populations (Desforges *et al.*, 2017; Murray *et al.*, 2021) and highly vulnerable Indo-Pacific humpback dolphins (Guo *et al.*, 2021).

The Workshop thanked Kershaw for her presentation and **agreed** that the Contaminant Explorer is a useful tool. It was recommended that the resource should be updated and funds may be sought within IWC to do so. It was highlighted that as open-source tools, the model and the map: (1) provide good opportunities for outreach; (2) are useful for graduate students; (3) are excellent risk communication tools; (4) are accessible to lay-people; and (5) are useful for research

[2] *http://www.smru.st-andrews.ac.uk/IWC_Contaminant_Explorer/.*
[3] *http://www.smru.st-andrews.ac.uk/IWC_PCB_Cet_Pop_Model_v8/.*

if population parameters are well understood for a given species. It was noted that the IWC Scientific Committee had already recommended the maintenance and updating of the mapping tool. The Workshop recommended that funding requirements should be assessed to facilitate the update of the tool moving forward.

Attention: SC, NI
The workshop **recommended** *that Kershaw assess the funding requirements to facilitate the update and maintenance of the Contaminant Explorer tool and submit an application to the SC Research fund.*

6.3 *In vitro* and *in silico* methods to investigate multiple stressors in marine mammals

Jean-Piere Desforges, University of Winnipeg, Canada

Desforges presented novel *in vitro* and *in silico* methods for investigating the multitude of chemical, environmental and anthropogenic stressors on marine mammals. Single chemical testing provides a means of better understanding which pollutants should be focused on, given how many there are. However, individuals are exposed to hundreds of chemicals at a time, making single chemical testing somewhat irrelevant for wildlife risk assessment. To address this issue, concentrated blubber extracts were used to develop complex and realistic chemical cocktails based on killer whale and polar bear carcasses (Desforges *et al.*, 2017). Immunotoxicological results in vitro were extrapolated to *in vivo* impacts, and overall results suggested that toothed whales are the most at-risk marine mammal group for POP toxins. While this method is targeted and presents chemical mixtures for more realistic scenarios, the species and extraction methods are limiting and it cannot account for non-chemical stressors. In silico risk-quotient modelling was explored as a means of extrapolating individual-level chemical impacts in causative laboratory studies to population-level impacts in marine mammals (Dietz *et al.*, 2018). This model translates critical daily doses (CDD) taken during laboratory studies and converts them to critical body residues (CBR), which can be calculated for marine mammals. Results found that in all study polar bear populations across the Arctic, cumulative chemical risk was above the no effect threshold (risk-quotient >1) and that PCBs accounted for ~90% of all risk. This type of model is easy to disseminate and to identify cumulative impacts, but it relies on laboratory animals and is semi-qualitative in terms of risk of effects.

Finally, dynamic energy budget (DEB) modelling was presented as a means of incorporating how energetics is used for an agent-based model that captures species-specific life history, ecology and population dynamics. It allows for different combinations of stressors and simulation scenarios to be used, such as food limitation, chemical pollution and infectious disease. The drawback is that DEB Theory is complex and thus difficult to learn and disseminate, and also requires a substantial amount of data. However, it is a universal theory that can be applied to any species and integrates multiple stressors into a single currency and modeling framework. Thus it is proposed as the ultimate integrating tool that can be used to explore multiple stressor impacts in individuals and populations across spatio-temporal boundaries. Overall, it was concluded that a broad toolbox is needed to study chemical and other stressors, as well as integrative modelling to incorporate multiple stressors into a common research framework.

The Workshop thanked Desforges for his presentation. In discussion, several cell types were suggested for *in vitro* impact analyses, such as brain tissue, to examine neurological function and adrenal glands to assess endocrine effects. It was noted that the inclusion of other stressors, such as shipping and noise, would be difficult to include *in vitro*. Exploration of a method that would include these stressors via a means of simulating these effects at a cell level was suggested. Concerns were raised over the inclusion of a mouse model, as this was not comparable to cetaceans for *in silico* modeling approaches like risk quotient analysis. It was noted that the inclusion of such models were justified as these are used in human toxicology studies, however, it was acknowledged that such data are unlikely to represent wildlife in terms of critical body residues. Exploring possible means of addressing this issue were suggested, such as scaling for body size.

Attention: SC/E,R
The workshop **recommended** *further development of a broad toolbox (including in vitro and in silico methods, and other sensitive bioindicators) to study the effects of chemical and other stressors, as well as integrative modelling (such as dynamic energy budget) to incorporate multiple stressors into a common research framework.*

Attention: SC/E
The workshop **agreed** *that the use of cell and tissue culture and other in vitro approaches showed strong promise for allowing effect assessment and can be used to collect physiological data by looking at, inter alia, oxygen use rates from the blubber tissue in culture. The Workshop therefore* **encouraged** *the continued development and application of these (in vitro and in silico) techniques.*

7. CONCLUSIONS AND OUTLOOK: EMERGING CONTAMINANTS, EMERGING ISSUES OF CONCERN DUE TO CLIMATE CHANGE

During the discussion on future work, it was highlighted that the workshop spent a considerable amount of time on methods and method improvements, but did not devote sufficient time for discussions of mitigation strategies, other than those recommended by Stimmelmayr and Siebert (see Item 5.1). The need for mitigation planning to prevent broad impacts due to future disasters, such as those documented after the *Deepwater Horizon* oil spill, was discussed. It was **agreed** that recommendations for the mitigation of individual pollutants are straightforward, but recommendations for cumulative stressors are more difficult and warrant further discussions. Whether the IWC has the remit to address mitigation measures specifically or should contribute to these matters at meetings of the United Nations or the Arctic Council was discussed, but no conclusions on which was most appropriate could be reached by this workshop. It was **agreed** that the IWC has been successful previously when recommending mitigation measures to different countries and that there are existing channels to move mitigation suggestions forward.

Attention: SC/E
Scientists across disciplines are **encouraged** *to find a shared language and methodology to assess the combined effects of multiple stressors as it is a cross-disciplinary problem.*

Attention: SC, R
The workshop encouraged the SC and wider Research Community to continue the investigation, and improve the understanding, of the cumulative impacts of human activity-induced stressors on marine ecosystems. These include, inter alia, climate change, ocean acidification, marine litter, noise, eutrophication, biomass overharvesting.

8. RECOMMENDATIONS

Attention: CG, S, SC/E, CC, I, R
The workshop emphasised the value of an interface between science and policy to consider multiple sources of morbidity and mortality when developing conservation and management plans and address the geopolitical importance.

The Workshop therefore **recommends:**

(1) *the Secretariat and the wider Commission continue communication and cooperation with range states and appropriate bodies e.g. NOAA, ASCOBANS; ASCOBAMS, etc. which develop management plans; and*
(2) *improve, synthesise, and respond to emerging knowledge across all disciplines and sectors to include government, academic and industry information, and traditional and local knowledge.*

Attention: S
The workshop **reiterates previous recommendations** *for IWC to continue collaboration with the Arctic Council (SC1403), CCAMLR (CO1833) and other policy bodies to effectively communicate their expertise and the relevant parts of its annual SC report. The Secretariat is* **requested** *to establish observer status at these and other relevant organisations to expand the IWC's reach with policy makers.*

Further, the Workshop **encourages** *the IWC to work with these bodies and funding organisations (e.g. National Science Foundation (NSF)) in their aim to strengthen scientific cooperation and joint monitoring among the Arctic states, and with other states, organisations and stakeholders involved in Arctic research or traditional and local knowledge, with a focus on: (a) prioritising research issues, filling knowledge gaps, and developing mechanisms to share and exchange observational data; (b) real-time identification of arctic stressors and impact characterisation to develop actionable transboundary mitigation strategies; and (c) devise realistic management strategies for a multi-user/multi-cetacean species Arctic seascape.*

Attention: S, SC
The Workshop **encourages** *the Arctic Council and CCAMLR to consider the implementation of the great whales as sentinels of polar climate change and transboundary pollution.*

Attention: SC
The workshop endorses the importance of precautionary areas in Bering sea and Arctic waters as outlined in the Polar Code of the IMO at its MSC99 meeting 2018: https://wwwcdn.imo.org/localresources/en/MediaCentre/HotTopics/Documents/POLAR%20CODE%20TEXT%20AS%20ADOPTED.pdf (accessed 15/03/2022).

9. CLOSING STATEMENT

Holm thanked all participants, Working Group leaders and rapporteurs. Staniland, on behalf of the IWC, thanked all participants for their contributions to the workshop. In particular, he thanked Holm for the organisation and smooth running of the workshop. The meeting closed at 23.20, Thursday 4 November 2021. The report was adopted by correspondence on 12 December 2021.

REFERENCES

Ankley, G.T., Bennett, R.S., Erickson, R.J., Hoff, D.J., Hornung, M.W., Johnson, R.D., Mount, D.R., Nichols, J.W., Russom, C.L., Schmieder, P.K., Serrrano, J.A., Tietge, J.E. and Villeneuve, D.L. 2010. Adverse outcome pathways: A conceptual framework to support ecotoxicology research and risk assessment. *Environ. Toxicol. Chem.* 29(3): 730-41. [Available at: *https://doi.org/10.1002/etc.34*].

Aoki, K., Isojunno, S., Bellot, C., Iwata, T., Kershaw, J., Akiyama, Y., Martín López, L.M., Ramp, C., Biuw, M., Swift, R., Wensveen, P.J., Pomeroy, P., Narazaki, T., Hall, A., Sato, K. and Miller, P.J.O. 2021. Aerial photogrammetry and tag-derived tissue density reveal patterns of lipid-store body condition of humpback whales on their feeding grounds. *Proc. R. Soc. B Biol. Sci.* 288. [Available at: *https://doi.org/10.1098/rspb.2020.2307*].

Aoki, K., Watanabe, Y.Y., Crocker, D.E., Robinson, P.W., Biuw, M., Costa, D.P., Miyazaki, N., Fedak, M.A. and Miller, P.J.O. 2011. Northern elephant seals adjust gliding and stroking patterns with changes in buoyancy: validation of at-sea metrics of body density. *J. Exp. Biol.* 241: 2973-87. [Available at: *https://doi.org/10.1242/JEB.055137*].

Baini, M., Panti, C., Fossi, M.C., Tepsich, P., Jiménez, B., Coomber, F., Bartalini, A., Muñoz-Arnanz, J., Moulins, A. and Rosso, M. 2020. First assessment of POPs and cytochrome P450 expression in Cuvier's beaked whales (*Ziphius cavirostris*) skin biopsies from the Mediterranean Sea. *Sci. Rep.* 10(1): 1-13. [Available at: *https://doi.org/10.1038/s41598-020-78962-3*].

Barratclough, A., Smith, C.R., Gomez, F.M., Photopoulou, T., Takeshita, R., Pirotta, E., Thomas, L., Mcclain, A.M., Parry, C., Zoller, J.A., Horvath, S. and Schwacke, L.H. 2021. Accurate epigenetic aging in bottlenose dolphins (*Tursiops truncatus*), an essential step in the conservation of at-risk dolphins. *J. Zool. Bot. Gard.* 2(3): 416-20. [Available at: *https://doi.org/10.3390/jzbg2030030*].

Bengtson Nash, S., Castrillon, J., Eisenmann, P., Fry, B., Shuker, J.D., Cropp, R.A., Dawson, A., Bignert, A., Bohlin-Nizzetto, P., Waugh, C.A., Polkinghorne, B., Dalle Luche, G. and McLagan, D. 2018. Signals from the south; humpback whales carry messages of Antarctic sea-ice ecosystem variability. *Global Change Biology* 24(4): 1500-10. [Available at: *https://doi.org/10.1111/gcb.14035*].

Bengtson Nash, S.M., Waugh, C.A. and Schlabach, M. 2013. Metabolic concentration of lipid soluble organochlorine burdens in humpback whales through migration and fasting. *Environ. Sci. Technol.* 47: 9404-13. [Available at: *https://doi.org/10.1021/es401441n*].

Bennett, K.A., Robinson, K.J., Armstrong, H.C., Moss, S.E., Scholl, G., Tranganida, A., Eppe, G., Thomé, J.-P., Debier, C. and Hall, A.J. 2021. Predicting consequences of POP-induced disruption of blubber glucose uptake, mass gain rate and thyroid hormone levels for weaning mass in grey seal pups. *Environ. Int.* 152: 106506. [Available at: *https://doi.org/10.1016/j.envint.2021.106506*].

Biuw, M., McConnell, B., Bradshaw, C.J.A., Burton, H. and Fedak, M. 2003. Blubber and buoyancy: monitoring the body condition of free-ranging seals using simple dive characteristics. *J. Exp. Biol.* 206: 3405-23. [Available at: *https://doi.org/10.1242/JEB.00583*].

Burkard, M., Whitworth, D., Schirmer, K. and Nash, S.B. 2015. Establishment of the first humpback whale fibroblast cell lines and their application in chemical risk assessment. *Aquat. Toxicol.* 167: 240-47. [Available at: *https://doi.org/10.1016/j.aquatox.2015.08.005*].

Castrillon, J., Huston, W. and Bengtson Nash, S. 2017. The blubber adipocyte index: A nondestructive biomarker of adiposity in humpback whales (*Megaptera novaeangliae*). *Ecol. Evol.* 7(14): 5131-39. [Available at: *https://doi.org/10.1002/ece3.2913*].

Desforges, J.-P., Levin, M., Jasperse, L., De Guise, S., Eulaers, I., R.J., L., Acquarone, M., Nordoy, E., Folkow, L.P., Hammer Jensen, T., Grondahl, C., M.F., B., St Leger, J., Almunia, J., Sonne, C. and Dietz, R. 2017. Effects of polar bear and killer whale derived contaminant cocktails on marine mammal immunity. *Environ. Sci. Technol.* 51: 11413-39.

Deyarmin, J., Hekman, R., Champagne, C., McCormley, M., Stephan, A., Crocker, D., Houser, D. and Khudyakov, J. 2020. Blubber proteome response to repeated ACTH administration in a wild marine mammal. *Comp. Biochem. Physiol. Part D Genomics Proteomics* 33: 100644.

Dietz, R., Desforges, J.-P., Gustavson, K., Rigét, F.F., Born, E.W., Letcher, R.J. and Sonne, C. 2018. Immunologic, reproductive, and carcinogenic risk assessment from POP exposure in East Greenland polar bears (*Ursus maritimus*) during 1983-2013. *Environ. Int.* 118: 169-78. [Available at: *https://doi.org/10.1016/j.envint.2018.05.020*].

Dietz, R., Sonne, C., Jenssen, B.M., Dasc, K., de Wit, C.A., Harding, K.C., Siebert, U. and Olseng, M.T. 2021. The Baltic Sea: An ecosystem with multiple stressors. *Environment International* 147: 106324. [Available at: *https://doi.org/10.1016/j.envint.2020.106324*].

Fossi, M.C., Baini, M., Panti, C. and Baulch, S. 2018. Impacts of Marine Litter on Cetaceans: A Focus on Plastic Pollution. pp.147-84. *In*: Fossi, M.C. and Panti, C. (eds). *Marine Mammal Ecotoxicology. Impacts of Multiple Stressors on Population Health*. Elsevier Academic Press. ISBN: 978-0-12-812144-3.

Fossi, M.C., Marsili, L., Baini, M., Giannetti, M., Coppola, D., Guerranti, C., Caliani, I., Minutoli, R., Lauriano, G., Finoia, M.G., Rubegni, F., Panigada, S., Berube, M. and Ramirez, J. 2016. Fin whales and microplastics: The Mediterranean Sea and the Sea of Cortez scenarios. *Environ. Pollut.* 209: 68-78.

Fossi, M.C., Panti, C., Marsili, L., Maltese, S., Spinsanti, G., Casini, S., Caliani, I., Gaspari, S., Muñoz-Arnanz, J., Jimenez, B. and Finoia, M.G. 2013. The Pelagos Sanctuary for Mediterranean marine mammals: Marine Protected Area (MPA) or marine polluted area? The case study of the striped dolphin (*Stenella coeruleoalba*). *Mar. Poll. Bull.* 70(1-2): 64-72. [Available at: *https://doi.org/10.1016/j.marpolbul.2013.02.013*].

Guo, L., Zhang, X., Luo, D., Yu, R.Q., Xie, Q. and Wu, Y. 2021. Population-level effects of polychlorinated biphenyl (PCB) exposure on highly vulnerable Indo-Pacific humpback dolphins from their largest habitat. *Environ. Pollut.* 286(4): 117544. [Available at: *https://doi.org/10.1016/j.envpol.2021.117544*].

Hall, A., McConnell, B.J., Schwacke, L.H., Ylitalo, G.M., Williams, R. and Rowles, T. 2018. Predicting the effects of polychlorinated biphenyls on cetacean populations through impacts on immunity and calf survival. *Environ. Pollut.* 233: 407-18. [Available at: *https://doi.org/10.1016/j.envpol.2017.10.074*].

International Whaling Commission. 2006. Report of the IWC Scientific Committee Workshop on Habitat Degradation, 12-15 November 2004, Siena, Italy. *J. Cetacean Res. Manage. (Suppl.)* 8:313-35.

International Whaling Commission. 2019. Report of the Workshop on Assessing the Cumulative Effects of Multiple Stressors on Cetaceans at the Individual and Population Level, 23-24 April 2018, Bled, Slovenia. *J. Cetacean Res. Manage. (Suppl.)* 20:661-75.

International Whaling Commission. 2021. Report of the IWC Workshop on Marine Debris: The Way Forward. 3-5 December 2019, La Garriga, Catalonia, Spain. *J. Cetacean Res. Manage. (Suppl.)* 22:273-310. [Available at: *https://archive.iwc.int/*].

Jepson, P.D., Deaville, R., Barber, J., Aguilar, A., Borrell, A., Murphy, S., Barry, J., Brownlow, B., Barnett, J., Berrow, S., Cunningham, A., Davison, N., Esteban, R., Ferreira, M., Foote, A., Genov, T., Gimenez, J., Loveridge, J., Llavona, A., Martin, V., Maxwell, D., Papachlimitzou, A., Penrose, R., Perkins, M., Smith, B., de Stephanis, R., Tregenza, N., Verborgh, P., Fernandez, A. and Law, R.J. 2016. PCB pollution continues to impact populations of orcas and other dolphins in European waters. *Sci. Rep.* 6: Article number: 18573. [Available at: *https://doi.org/10.1038/srep18573*].

Murray, C.C., Hannah, L.C., Doniol-Valcroze, T., Wright, B.M., Stredulinsky, E.H., Nelson, J.C., Locke, A. and Lacy, R.C. 2021. A cumulative effects model for population trajectories of resident killer whales in the Northeast Pacific. *Biol. Conserv.* 257: 109124. [Available at: *https://doi.org/10.1016/J.BIOCON.2021.109124*].

National Academies of Sciences Engineering and Medicine. 2017. Approaches to Understanding the Cumulative Effects of Stressors on Marine Mammals. Washington, DC: The National Academies Press. [Available at: *https://doi.org/10.17226/23479*].

Pierce, G.J., Santos, M.B., Murphy, S., Learmouth, J.A., Zuur, A.F., Rogan, E., Bustamante, P., Caurant, F., Lahaye, V., Ridoux, V., Zegers, B.N., Mets, A., Addink, M., Smeenk, C., Jauniaux, T., Law, R.J., Dabin, W., Lopez, A., Alonso Farre, J.M., Gonzalez, A.F., Guerra, A., Garcia-Hartmann, M., Reid, R.J., Moffat, C.F., Lockyer, C. and Boon, J.P. 2008. Bioaccumulation of persistent organic pollutants in female common dolphins (*Delphinus delphis*) and harbour porpoises (*Phocoena phocoena*) from western European seas: geographical trends, causal factors and effects on reproduction and mortality. *Environ. Pollut.* 153: 401-15. [Available at: *https://doi.org/10.1016/j.envpol.2007.08.019*].

Pirotta, E., Booth, C.G., Costa, D.P., Fleishman, E., Kraus, S.D., Lusseau, D., Moretti, D., New, L.F., Schick, R.S., Schwarz, L.K., Simmons, S.E., Thomas, L., Tyack, P.L., Weise, M.J., Wells, R.S. and Harwood, J. 2018. Understanding the population consequences of disturbance. *Ecol. Evol.* 8(19): 9934-46. [Available at: *https://doi.org/10.1002/ece3.4458*].

Robinson, K.J., Hall, A.J., Debier, C., Eppe, G., Thomé, J.P. and Bennett, K.A. 2018. Persistent organic pollutant burden, experimental POP exposure, and tissue properties affect metabolic profiles of blubber from gray seal pups. *Environ. Sci. Technol.* 52(22): 13523-34. [Available at: *https://doi.org/10.1021/acs.est.8b04240*].

Saavedra, C. 2017. Multispecies population modelling of the common dolphin (*Delphinus delphis*), the bottlenose dolphin (*Tursiops truncatus*) and the southern stock of European hake (*Merluccius merluccius*). *Atlantic Waters of the Iberian Peninsula*.

Schwacke, L., Thomas, L., Smith, C., Bossart, G., Burt, L., DeGuise, S., Gomez, F., Mazzoil, M., Morey, J., Rowles, T., Stolen, E., Townsend, F. and Wells, R. 2019. Veterinary Expert System for Outcome Prediction (VESOP): A Bayesian model to predict changes in cetacean population vital rates from measures of individual health. *Society of Marine Mammalogy Biennial Conference*, Barcelona, Spain.

Schwacke, L.H., Thomas, L., Wells, R.S., McFee, W.E., Hohn, A.A., Mullin, K.D., Zolman, E.S., Quigley, B.M., Rowles, T.K. and Schwacke, J.H. 2017. Quantifying injury to common bottlenose dolphins from the *Deepwater Horizon* oil spill using an age-, sex- and class-structured population model. *Endanger. Species Res.* 33: 265-79. [Available at: *https://doi.org/10.3354/esr00777*].

Sewell, F., Gellatly, N., Beaumont, M., Burden, N., Currie, R., de Haan, L., Hutchinson, T.H., Jacobs, M., Mahony, C., Malcomber, I., Mehta, J., Whale, G. and Kimber, I. 2018. The future trajectory of adverse outcome pathways: a commentary. *Arch. Toxicol.* 92(4): 1657-61. [Available at: *https://doi.org/10.1007/s00204-018-2183-2*].

Siebert, U., Pawliczka, I., Benke, H., von Vietinghoff, V., Wolf, P., Pilāts, V., Kesselring, T., Lehnert, K., Prenger-Berninghoff, E., Galatius, A., Anker Kyhn, L., Teilmann, J., Hansen, M.S., Sonne, C. and Wohlsein, P. 2020. Health assessment of harbour porpoises (*Phocena phocena*) from Baltic area of Denmark, Germany, Poland and Latvia. *Environ. Int.* 143: 105940. [Available at: *https://doi.org/10.1016/J.ENVINT.2020.105904*].

Simond, A.E., Houde, M., Lesage, V., Michaud, R. and Verreault, J. 2020. Metabolomic profiles of the endangered St . Lawrence Estuary beluga population and associations with organohalogen contaminants. *Sci. Total Environ.* 717. [Available at: *https://doi.org/10.1016/j.scitotenv.2020.137204*].

Smith, C.R., Hart, L.B., Townsend, F.I., Zolman, E.S., Wells, R.S., Quigley, B., Ivančić, M., McKercher, W., Tumlin, M., Mullin, K., Adams, J.D., Wu, D., McFee, W., Collier, T.K., Rowles, T.K. and Schwacke, L.H. 2017. The slow recovery of Barataria Bay dolphin health in the years following the Deepwater Horizon oil spill (2013-2014), with evidence of persistent lung disease and impaired stress response. *Endanger. Species Res.* 33: 127-42. [Available at: *http://dx/doi.org/10.3354/esr00778*].

Stockin, K., Yi, S., Northcott, G.L., Betty, E.L., Machovsky-Capuska, G.E., Jones, B., Perrott, M.R., Law, R.J., Rumsby, A., Thelen, M.A., Graham, L., Palmer, E.I. and Tremblay, L. 2021. Per- and polyfluoroalkyl substances (PFAS), trace elements and life history parameters of mass-stranded common dolphins (*Delphinus delphis*) in New Zealand. *Mar. Poll. Bull.* 173: 112896. [Available at: *https://doi.org/10.1016/J.MARPOLBUL.2021.112896*].

Trego, M.L., Whitehead, A., Kellar, N.M., Lauf, M. and Lewison, R.L. 2019. Tracking transcriptomic responses to endogenous and exogenous variation in cetaceans in the Southern California Bight. *Con. Phys.* 7(1): 1-15. [Available at: *https://doi.org/10.1093/conphys/coz018*].

Annex A

List of Participants

Alex Aguilar, University of Barcelona
Andre Barreto, UNIVALI (Brazil)
Andrea Valcarcel, Ministry of Environment and Natural Resources of the Dominican Republic
Andrew Wright, Bedford Institute of Oceanography
Andrew Brownlow, University of Glasgow
Angela Recalde-Salas, Fundacion Yubarta (Colombia) and Curtin University (Australia)
Angela Zaccaron da Silva, Federal University of Paraná - Brazil
Antonio Fernández, Universidad de Las Palmas de Gran Canaria
Aoki Kagari, University of Tokyo
Ashley Barratclough, National Marine Mammal Foundation
Bárbara Piovani, UERJ
Britta Schmidt, Institute for Terrestrial and Aquatic Wildlife Research (ITAW)
Camila Domit, Federal University of Paraná
Carlos Vinícius Cordeiro dos Santos, Universidade do Estado do Rio de Janeiro
Chiharu Mori, NOAA
Clair Evers, Fisheries and Oceans Canada (DFO)
Cristiane Kolesnikovas, Associação R3 Animal
CT Harry, EIA
Cynthia Smith, National Marine Mammal Foundation
Daiane Santana Marcondes, Laboratório de Ecologia e Conservação - UFPR/Brazil
Danielle Grabiel, EIA
Dawn Noren, NOAA Fisheries Service NWFSC
Elanor Bell, Australian Antarctic Division
Ellen Hines, San Francisco State University
Enrico Pirotta, University of St Andrews
Fernanda Fecci, Universidade Federal do Paraná
Frances Gulland, Marine Mammal Commission
Frank Cipriano, California Academy of Sciences
Fredrik Christiansen, Aarhus Institute of Advanced Studies
Gabriel Fraga da Fonseca, Laboratório de Ecologia e Conservação - UFPR/Brazil
Gay Sheffield, UAF Alaska Sea Grant
Grace Ferrara, NOAA
Graham Pierce, IIM CSIC
Howard Rosenbaum, Wildlife Conservation Society
Iain Staniland, IWC
Inês Carvalho, Instituto Gulbenkian de Ciência - IGC
Isabel Avila, Universidad del Valle
Jasmin Gross, Griffith University
Jean-Eric Fonkou Chanou, Ministère des Relations Extérieures
Jean-Pierre Desforges, University of Winnipeg
Jenny Allen, Griffith University
Jens Currie, Pacific Whale Foundation
Joanna Kershaw, University of Plymouth
Jordan Yuri, Ministry of State - Bureau of Foreign Affairs and Trade
Jose Palazzo, Instituto Baleia Jubarte - Brazilian Humpback Whale Institute
Joy Ometere Boyi, ITAW, Büsum, Germany
Juan Jose Alava, Ocean Pollution Research Unit, Institute for the Oceans and Fisheries, University of British Columbia
Juliana Di Tullio, Universidade Federal do Rio Grande - FURG. Brazil
Karen Baird, Secretariat for the Pacific Environment Programme

Karen Stockin, Massey University
Kelly Robinson, University of St Andrews
Kristina Dauterman, NMFS
Lara Gama Vidal, UFPR
Laura Casali, NMFS
Lavrentios Vasiliades, Department of Fisheries and Marine Research (DFMR)
Leigh Torres, Marine Mammal Institute, Oregon State University
Len Thomas, University of St Andrews
Liana Rosa, UFPR
Lindsay Porter, IWC
Lindy Weilgart, OceanCare
Lori Schwacke, National Marine Mammal Foundation
Lucas Rodrigues Tovar, UERJ
Luís António de Andrade Freitas, Madeira Whale Museum
Marcela Uhart, University of California, Davis. Southern Right Whale Health Monitoring Program
Maria Cristina Fossi, University of Siena
Mariana Neves, Maqua
Mariana Ingles Santos, Universidade Federal do Paraná
Marianna Pinzone, University of Liège – ITAW
Marina Leite Marques, VIVA Instituto Verde Azul
Mark Simmonds, University of Bristol
Md Hafiz All Hosen, GU
Megan Wallen, NOAA Fisheries
Mel Cosentino, Aarhus University
Mikala Klint, Ministry of Environment, Denmark
Miriam Marmontel, Instituto Mamirauá
Naomi Rose, Animal Welfare Institute
Nara Oliveira-Ferreira, MAQUA/UERJ
Odei Garcia-Garin, University of Barcelona
Olga Shpak, Severtsov Institute, Russian Academy of Sciences
Patricia Holm, University of Basel
Pauline Gauffier, Madeira Whale Museum
Penny Ruvelas, US Federal Government NOAA-NMFS
Randall Wells, Chicago Zoological Society's Sarasota Dolphin Research Program
Raphael Mayaud, Griffith University
Raphaela Stimmelmayr, North Slope Borough Department of Wildlife Management
Renaldy Barnuty Navarro, Instituto Nicaraguense de Pesca y Acuicultura
Robert Deaville, Zoological Society of London/Cetacean Strandings Investigation Programme
Rodrigo del Rio do Valle, Instituto Biopesca
Rosie Williams, Institute of Zoology, Zoological Society of London
Salvatore Siciliano, GEMM-Lagos/Fiocruz
Silvia Frey, KYMA *Sea C*onservation *and R*esearch
Simone Panigada, Tethys Research Institute
Sonja Eisfeld-Pierantonio, Whale and Dolphin Conservation
Stephanie Stack, Pacific Whale Foundation
Stephanie Plön, Stellenbosch University
Stephen Raverty, British Columbia Ministry of Agriculture
Susan Bengtson Nash, Griffith University
Tara Van Belleghem, UFPR
Teri Rowles, NOAA
Tilen Genov, Morigenos - Slovenian Marine Mammal Society
Ursula Siebert, University of Veterinary Medicine Hannover
Victoria Caballero, Texas A&M University at Galveston

Annex B

Agenda

1. Introductory items
   - 1.1 Welcoming remarks
   - 1.2 Introduction of participants
   - 1.3 Election of Chair
   - 1.4 Appointment of Rapporteurs
   - 1.5 Adoption of Agenda
   - 1.6 Available documents
2. Background and Goals of Pollution 2025
   - 2.1 Pollution 2000 and 2020+ - achievements, open questions
   - 2.2 Pollution 2025 - goals and objectives
3. Framework for integrating data of different sources and types
   - 3.1 Presentation of framework - Lori Schwacke
4. New methods/methodological approaches for assessing cumulative effects
   - 4.1 Markers of toxicological pathways - Cristina Fossi, University of Siena, IT
   - 4.2 Toxic effects of POP's on marine mammals – Kelly Robinson, University of St. Andrews, UK
   - 4.3 Approaches on toxicological process and the respective pathways - Jean-Pierre Desforges, McGill University, CA
   - 4.4 Biologging, Telemetry - Kagari Aoki, University of Tokyo, JAP
   - 4.5 Use of drones for cetacean research to estimate body condition and health – Frederik Oscar Christiansen, Aarhus, DK
   - 4.6 Proteomics and other -omics biomarkers of use in cetacean physiology research to assess cumulative impacts – Jo Kershaw, Plymouth, UK
   - 4.7 Sentinel parameters – Susan Bengtson Nash, AUS
5. Case studies
   - 5.1 Deepwater Horizon oil spill – Teri Rowles
   - 5.2 Arctic monitoring, real time emerging cumulative issues – Raphaela Stimmelmayr, USA
   - 5.3 Pollutants in cetaceans in Spain – Graham Pierce, ES
   - 5.4 Multispecies PFAS assessment – Karen Stockin, NZ
   - 5.5 Baltic Sea – an ecosystem with multiple stressors – Ursula Siebert, Veterinary School Hannover, GER
6. Modelling the population consequences of exposure to multiple stressors
   - 6.1 PCOMS and other models - Enrico Pirotta, St. Andrews, CREEM, UK
   - 6.2 News of SPOC and contamination mapping tool, Jo Kershaw, Plymouth, UK
7. Conclusions and outlook: Emerging contaminants, emerging issues of concern due to climate change
8. Recommendations
9. Other
10. References
11. Adoption of Report

Annex C

Additional Literature[4]

A3.1 Additional Literature

Alava, J.J. 2020. Modeling the bioaccumulation and biomagnification potential of microplastics in a cetacean foodweb of the Northeastern Pacific: A prospective tool to assess the risk exposure to plastic particles. *Front. Mar. Sci.* 7:566101. [Available at: *https://doi.org/10.3389/fmars.2020.566101*].

Besseling, E., Foekema, E. M., Van Franeker, J.A., Leopold, M.F., Kühn, S., Bravo Rebolledo, E.L., Heße, E., Mielke, L., IJzer, J., Kamminga, P., Koelmans, A.A. 2015. Microplastic in a macro filter feeder: Humpback whale *Megaptera novaeangliae. Mar. Pollut. Bull.* 95(1): 248-52. [Available at: *https://doi.org/10.1016/j.marpolbul.2015.04.007*].

Burkhardt-Holm, P., 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.* 144: 224-34. [Available at: *https://doi.org/10.1016/j.marpolbul.2019.04.068*].

Denuncio, P., Gana, J.C.M., Giardino, G.V., Rodríguez, D.H., Machovsky-Capuska, G.E. 2021. Prey composition and nutritional strategies in two sympatric pinnipeds. *J. Exp. Mar. Biol. Ecol.* 545:151629. [Available at: *https://doi.org/10.1016/j.jembe.2021.151629*].

Hernandez-Gonzalez, A., Saavedra, C., Gago, J., Covelo, P., Begoña Santos, M., 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.* 137:526-32. [Available at: *https://doi.org/10.1016/j.marpolbul.2018.10.026*].

Lusher, A.L., Hernandez-Milian, G., Berrow, S., Rogan, E., 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.* 232:467-76. [Available at: *https://doi.org/10.1016/j.envpol.2017.09.070*].

Machovsky-Capuska G.E., and Raubenheimer, D. 2020. The Nutritional Ecology of Marine Apex Predators. *Ann. Rev. Mar. Sci.* 12:1, 361-87. [Available at: *https://doi.org/10.1146/annurev-marine-010318-095411*].

Machovsky-Capuska, G.E., Andrades, R., Santos, R. G. 2020. Debris ingestion and nutritional niches in estuarine and reef green turtles. *Mar. Pollut. Bull.* 153:110943. [Available at: *https://doi.org/10.1016/j.marpolbul.2020.110943*].

Machovsky-Capuska, G.E., von Haeften, G., Romero, M.A., Rodríguez, D.H., Gerpe, M.S. 2020. Linking cadmium and mercury accumulation to nutritional intake in common dolphins (*Delphinus delphis*) from Patagonia, Argentina. *Environ. Pollut.* 263(Part A):114480. [Available at: *https://doi.org/10.1016/j.envpol.2020.114480*].

Moore, R.C., Loseto, L., Noel, M., Etemadifar, A., Brewster, J.D., MacPhee, S., Bendell, L., Ross, P.S. 2020. Microplastics in beluga whales (*Delphinapterus leucas*) from the Eastern Beaufort Sea. *Mar. Pollut. Bull.* 150:110723. [Available at: *https://doi.org/10.1016/j.marpolbul.2019.110723*].

Nelms, S.E., Barnett, J., Brownlow, A., Davison, N.J., Deaville, R., Galloway, T.S., Lindeque, P.K., Santillo, D., Godley, B.J. 2019. Microplastics in marine mammals stranded around the British coast: ubiquitous but transitory? *Sci. Rep.* 9:1075. [Available at: *https://doi.org/10.1038/s41598-018-37428-3*].

Santos, R.G., Andrades, R., Demetrio, G.R., Kuwai, G.M., Sobral, M.F., de Souza Vieira, J., Machovsky-Capuska, G.E. 2020. Exploring plastic-induced satiety in foraging green turtles. *Environ. Pollut.* 265(Part B):114918. [Available at: *https://doi.org/10.1016/j.envpol.2020.114918*].

Santos, R.G., Machovsky-Capuska, G.E., and Andrades, R. 2021. Plastic ingestion as an evolutionary trap: toward a holistic understanding. *Science*. 373(6550):56-60. [Available at: *https://doi.org/10.1126/science.abh0945*].

Xiong, X., Chen, X., Zhang, K., Mei, Z., Hao, Y., Zheng, J., Wu, C., Wang, K., Ruan, Y., Lam, P.K.S., Wang, D. 2018. Microplastics in the intestinal tracts of East Asian finless porpoises (*Neophocaena asiaeorientalis sunameri*) from Yellow Sea and Bohai Sea of China. *Mar. Pollut. Bull.* 136:55-60. [Available at: *https://doi.org/10.1016/j.marpolbul.2018.09.006*].

Yong, M.M.H., Leistenschneider, C., Miranda, J.A., Paler, M.K., Legaspi, C., Germanov, E., Araujo, G., Burkhardt-Holm, P., Erni-Cassola, G. 2021. Microplastics in fecal samples of whale sharks (*Rhincodon typus*) and from surface water in the Philippines. *Micropl. Nanopl.* 1:17. [Available at: *https://doi.org/10.1186/s43591-021-00017-9*].

A3.3 Agenda Item 2

Burkhardt-Holm, P. 2021. Cumulative effects – multiple stressors in cetacean research. Paper SC/68C/E/01rev01 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 10pp. [Paper available from the Office of this Journal]. [Available at: *https://archive.iwc.int/?r=19152*]

International Whaling Commission. 2006. Report of the IWC Scientific Committee Workshop on Habitat Degradation, 12-15 November 2004, Siena, Italy. *J. Cetacean Res. Manage. (Suppl.)* 8: 313-335. [Available at: *https://iwc.int/document_1056*]

International Whaling Commission. 2019. Report of the Workshop on Assessing the Cumulative Effects of Multiple Stressors on Cetaceans at the Individual and Population Level, 23-24 April 2018, Bled, Slovenia. *J. Cetacean Res. Manage. (Suppl.)* 20: 661-675. [Available at: *https://archive.iwc.int/?r=9519*]

A3.5 Agenda Item 4

Burkard, M., Bengtson Nash, S., Gambaro, G., Whitworth, D., Schirmer, K. 2019. Lifetime extension of humpback whale skin fibroblasts and their response to lipopolysaccharide (LPS) and a mixture of polychlorinated biphenyls (Aroclor). *Cell Biol. Toxicol.* 35(4):387-98. [Available at: *https://doi.org/10.1007/s10565-018-09457-1*]. Epub 2019 Jan 10. PMID: 30627956; PMCID: PMC6757015.

[4]Available to the Workshop participants via a Sharepoint.

Godard-Codding, C.A.J., Fossi, M.C. 2018. Chapter 9 - Field Sampling Techniques and Ecotoxicologic Biomarkers in Cetaceans, Editor(s): Maria Cristina Fossi, Cristina Panti. *Marine Mammal Ecotoxicology*, Academic Press. pp.237-59 [Available at: *https://doi.org/10.1016/B978-0-12-812144-3.00009-7*].

Christiansen, F., Vivier, F., Charlton, C., Ward, R., Amerson, A.B., Burnell, S., and Bejder, L. 2018. Maternal body size and condition determine calf growth rates in southern right whales. *Mar. Ecol. Prog. Series.* 592, 267-81. [Available at: *https://doi.org/10.3354/MEPS12522*].

Christiansen, F., Dawson, S.M., Durban, J.W., Fearnbach, H., Miller, C.A., Bejder, L., Uhart, M., Sironi, M., Corkeron, P., Rayment, W., Leunissen, E., Haria, E., Ward, R., Warick, H.A., Kerr, I., Lynn, M., Pettis, H.M., Moore, M.J. 2020. Population comparison of right whale body condition reveals poor state of the North Atlantic right whale. *Mar. Ecol. Prog. Ser.* 640:1-16. [Available at: *https://doi.org/10.3354/meps13299*].

Mancia, A. 2018. Chapter 11 - New Technologies for Monitoring Marine Mammal Health, Editor(s): Maria Cristina Fossi, Cristina Panti. *Marine Mammal Ecotoxicology*, Academic Press, 2018, Pages 291-320. [Available at: *https://doi.org/10.1016/B978-0-12-812144-3.00011-5*].

Maner, J., Burkard, M., Cassano, J.C., Bengtson Nash, S.M., Schirmer, K. and Suter, M.J.-F. 2019. *RSC Adv.* 9: 39447. [Available at: *https://doi.org/10.1039/C9RA05352B*].

Segner, H. Schmitt-Jansen, M. and Sabater, S. 2014. Assessing the Impact of Multiple Stressors on Aquatic Biota: The Receptor's Side Matters. *Environ. Sci. Technol.* 48 (14), 7690-96. [Available at: *https://doi.org/10.1021/es405082t*].

A3.6 Agenda Item 5

Colegrove, K.M., Venn-Watson, S., Litz, J., Kinsel, M.J., Terio, K.A., Fougeres, E., Ewing, R., Pabst, D.A., McLellan, W.A., Raverty, S., Saliki, J., Fire, S., Rappucci, G., Bowen-Stevens, S., Noble, L., Costidis, A., Barbieri, M., Field, C., Smith, S., Carmichael, R.H., Chevis, C., Hatchett, W., Shannon, D., Tumlin, M., Lovewell, G., McFee, W., Rowles, T.K. 2016. Fetal distress and in utero pneumonia in perinatal dolphins during the Northern Gulf of Mexico unusual mortality event. *Dis. Aquat. Organ.* 119(1):1-16. [Available at: *https://doi.org/10.3354/dao02969*].

Kellar, N.M., Speakman, T.R., Smith, C.R., Lane, S.M., Balmer, B.C., Trego, M.L., Catelani, K.N., Robbins, M.N., Allen, C.D., Wells, R.S., Zolman, E.S., Rowles, T.K., Schwacke, L.H. 2017. Low reproductive success rates of common bottlenose dolphins *Tursiops truncatus* in the northern Gulf of Mexico following the *Deepwater Horizon* disaster (2010-2015). *Endanger. Species Res.* 33:143-58. [Available at: *http://dx.doi.org/10.3354/esr00775*].

Lane S.M., Smith, C.R., Mitchel, J., Balmer, B.C., Barry, K.P., McDonald, T., Mori, S.S., Rosel P.E., Rowles, T.K., Speakman, T.R., Townsend, F.I., Tumlin, M.C., Wells, R.S., Zolman, E.S. and Schwacke, L.H. 2015. Reproductive outcome and survival of common bottlenose dolphins sampled in Barataria Bay, Louisiana, USA, following the *Deepwater Horizon* oil spill. *Proc. R. Soc. B.*282. 20151944. [Available at: *http://doi.org/10.1098/rspb.2015.1944*].

Litz, J.A., Baran, M.A., Bowen-Stevens, S.R., Carmichael, R.H., Colegrove, K.M., Garrison, L.P., Fire, S.E., Fougeres, E.M., Hardy, R., Holmes, S., Jones, W., Mase-Guthrie, B.E., Odell, D.K., Rosel, P.E., Saliki, J.T., Shannon, D.K., Shippee, S.F., Smith, S.M., Stratton, E.M., Tumlin, M.C., Whitehead, H.R., Worthy, G.A., Rowles, T.K. 2014. Review of historical unusual mortality events (UMEs) in the Gulf of Mexico (1990-2009): providing context for the multi-year northern Gulf of Mexico cetacean UME declared in 2010. *Dis. Aquat. Organ.* 112(2):161-75. [Available at: *https://doi.org/10.3354/dao02807*]. PMID: 25449327.

Schwacke, L.H., Smith, C.R., Townsend, F.I., Wells, R.S., Hart, L.B., Balmer, B.C., Collier, T.K., De Guise, S., Fry, M.M., Guillette, L.J. Jr., Lamb, S.V., Lane, S.M., McFee, W.E., Place, N.J., Tumlin, M.C. Ylitalo, G.M., Zolman, E.S. and Rowles, T.K. 2014. Health of common bottlenose dolphins (*Tursiops truncatus*) in Barataria Bay, Louisiana, following the *Deepwater Horizon* oil spill. *Environ. Sci. Technol.* 48(1)93-103. [Available at: *https://doi.org/10.1021/es503862c*].

Takeshita, R., Bursian, S.J., Colegrove, K.M., Collier, T.K., Deak, K., Dean, K.M., De Guise, S., DiPinto, L.M., Elferink, C.J., Esbaugh, A.J., Griffitt, R.J., Grosell, M., Harr, K.E., Incardona, J.P., Kwok, R.K., Lipton, J., Mitchelmore, C.L., Morris, J.M., Peters, E.S., Roberts, A.P., Rowles, T.K., Rusiecki, J.A., Schwacke, L.H., Smith, C.R., Wetzel, D.L., Ziccardi, M.H. and Hall, A.J. 2021. A review of the toxicology of oil in vertebrates: what we have learned following the *Deepwater Horizon* oil spill. *J. Toxicol. Environ. Health Part B*, 24:8, 355-94. [Available at: *https://doi.org/10.1080/10937404.2021.1975182*].

Thomas, L., Marques, T., Booth, C., Takeshita, R. and Schwacke, L. 2021. Predicted population consequences of low salinity associated withthe proposed Mid-Barataria Sediment Diversion project onbottlenose dolphins in the Barataria Bay Estuarine System Stock. Report to the Marine Mammal Commission.

Venn-Watson, S., Colegrove, K.M., Litz, J., Kinsel, M., Terio, K., Saliki, J., Fire, S., Carmichael, R., Chevis, C., Hatchett, W., Pitchford, J., Tumlin, M., Field, C., Smith, S., Ewing, R., Fauquier, D., Lovewell, G., Whitehead, H., Rotstein, D., McFee, W., Fougeres, E., Rowles, T. 2015. Adrenal gland and lung lesions in Gulf of Mexico common bottlenose dolphins (*Tursiops truncatus*) found dead following the *Deepwater Horizon* oil spill. *PLoS ONE* 10(5): e0126538. [Available at: *https://doi.org/10.1371/journal.pone.0126538*].

Venn-Watson, S., Garrison, L., Litz, J., Fougeres, E., Mase, B., Rappucci, G., Stratton, E., Carmichael, R., Odell, D., Shannon, D., Shippee, S., Smith, S., Staggs, L., Tumlin, M., Whitehead, H., Rowles, T. 2015. Demographic clusters identified within the Northern Gulf of Mexico common bottlenose dolphin (*Tursiops truncates*) unusual mortality event: January 2010-June 2013. *PLoS ONE* 10(2): e0117248. [Available at: *https://doi.org/10.1371/journal.pone.0117248*].

A3.7 Agenda Item 6

Kershaw, J.L. Hall, A.J. 2019. Mercury in cetaceans: Exposure, bioaccumulation and toxicity. *Sci. Total Environ*. 694:133683. [Available at: *https://doi.org/10.1016/j.scitotenv.2019.133683*].

Orr, J.A., Vinebrooke, R.D., Jackson, M.C., Kroeker, K.J., Kordas, R.L., Mantyka-Pringle, C., Van den Brink, P.J., De Laender, F., Stoks, R., Holmstrup, M., Matthaei, C.D., Monk, W.A., Penk, M.R., Leuzinger, S., Schäfer, R.B., and Piggott, J.J. 2020. Towards a unified study of multiple stressors: divisions and common goals across research disciplines. *Proc. R. Soc. B* 287:20200421. [Available at: *http://dx.doi.org/10.1098/rspb.2020.0421*].

Silva, W.T.A.F., Harding, K.C., Marques, G.M., Bäcklin, B.M., Sonne, C., Dietz, R., Kauhala, K., Desforges, J.P. 2020. Life cycle bioenergetics of the gray seal (*Halichoerus grypus*) in the Baltic Sea: Population response to environmental stress. *Environ. Int.* 145:106145. [Avaiable at: *https://doi.org/10.1016/j.envint.2020.106145*].

A3.8 Outcomes and Recommendations

Previous recommendations are available from the IWC Database of Recommendations.

Report of the IWC POWER Planning Meeting 2021

Virtual Meeting, 9-10 December 2021

Report of the IWC-POWER Planning Meeting: 2021[1]

Virtual meeting, 9 and 10 December 2021

1. INTRODUCTORY ITEMS

1.1 Opening remarks and welcoming address including notes from the IT support team

Matsuoka (Convenor) opened the virtual meeting, welcomed the participants from Japan, Russian Federation, the USA, the Secretariat and IWC Scientific Committee and thanked them for their time particularly in the current COVID-19 situation. The List of Participants is given as Annex A. He noted the plan had been to hold this meeting in Tokyo but that had not been possible. Moronuki (Fisheries Agency of Japan) on behalf of the Government of Japan also welcomed the participants to the meeting. He noted the long history of the POWER programme with successful results and its importance to conservation and management of cetaceans. He hoped that the meeting 2022 would be a great success.

On behalf of the IWC and its Scientific Committee, Staniland (Head of Science, Conservation and Management at the IWC Secretariat) thanked Matsuoka for organising the meeting and to everyone for giving their time to support the IWC-POWER. He highlighted how important the programme has been to the work of the IWC and its Scientific Committee. He noted the international effort involved, and thanked Japan in particular for their support in providing a vessel and crew without which the important programme could not be run.

1.2 Election of the Chair

Matsuoka was elected Chair.

1.3 Adoption of the Agenda

The adopted Agenda is given as Annex B. Given the relatively short time available to the meeting and the hope that an in-person Technical Advisory Group meeting could be held in 2022, ideally before SC68D, the Chair noted that given the focus of the meeting was planning for the 2022 cruise, Items 2 and 3 would be dealt with relatively briefly and focus primarily on aspects relevant to 2022 rather than the programme as a whole.

1.4 Appointment of rapporteurs

Staniland, Donovan, Palka, Murase and Crance were appointed as rapporteurs.

1.5 Review of documents

The List of Documents is given as Annex C.

2. REVIEW OF CRUISE DISCUSSIONS AT SC68C AND THE TAG MEETING (SC/68C/REP01)

2.1 Review of Scientific Committee recommendations

The importance of the IWC-POWER data was reiterated at SC68C e.g. in its contributions to the Comprehensive Assessments of North Pacific humpback and sei whales (IWC, 2022a). In addition to abundance estimates obtained from the programme, the biopsy sampling component was of great value in understanding the stock structure of large whales in the North Pacific and further collection of samples, especially from blue and fin whales, was encouraged in future surveys.

The Scientific Committee had also thanked the Governments of Japan (ship, crew and researchers) and the USA (equipment and researchers) for their continued support to the programme. It commended the work undertaken by the Steering Group and Japan to ensure that the 2021 cruise went ahead, and strongly encouraged the efforts being made by Japan, Russia and the USA to enable international participation 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 more detailed plans for the post-2021 cruises. The results of the 2020 cruise (Matsuoka *et al.*, 2020) were welcomed and the Committee looked forward to receiving abundance estimates based on the data obtained. The plan for the 2021 cruise (IWC, 2022b) was endorsed (see Fig. 1).

2.2 Objectives and priorities

2.2.1 Long-term

The IWC agreed (IWC, 2012a) that the long-term IWC-POWER programme:

[1]Presented to the Scientific Committee as SC/68D/Rep/03.

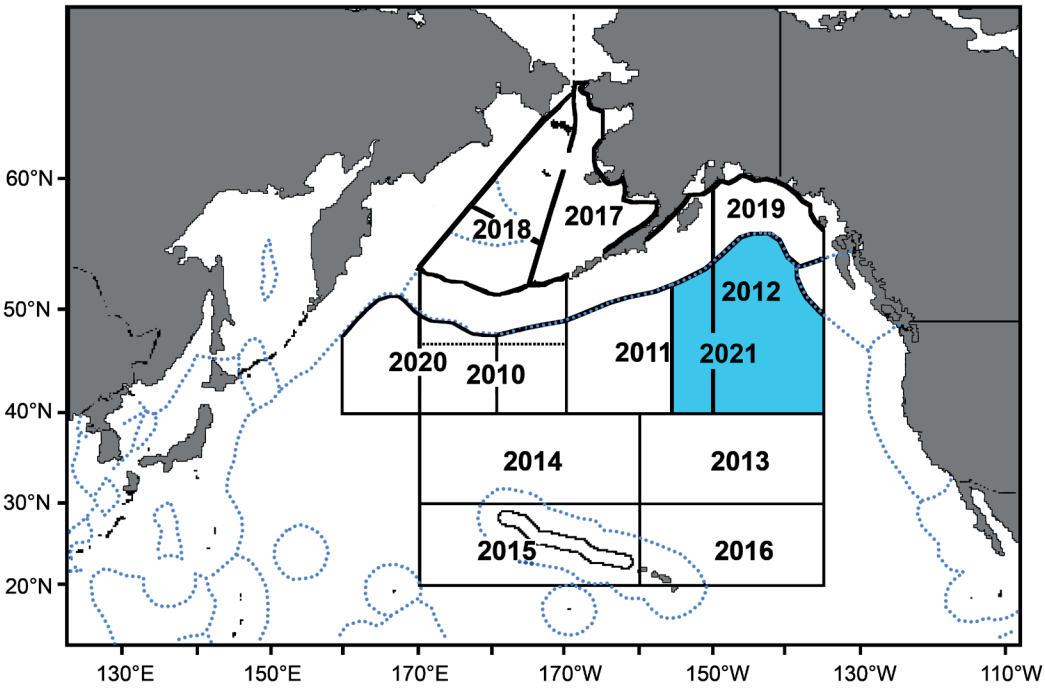


Fig.1. Research area and transit for the 2021 IWC-POWER cruise.

'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.'

2.2.2 Short-term

The identified 'least studied' areas of the central and Eastern North Pacific will soon have been covered under the IWC-POWER (pending permission to operate in Russian waters of the Bering Sea and east of the Kuril archipelago off Kamchatka), thereby completing the 'short-term' objectives (IWC, 2012b). Analyses of these data will form the basis of the medium-term plan and may also result in one or two more cruises aimed at filling specific knowledge gaps before implementing the medium-term programme.

2.2.3 Medium-term

The medium-term objectives were reviewed and updated by the TAG in January 2020 with regard to the results of the programme so far. These are given in table 1 of IWC (2021). These objectives may be reviewed and updated by the TAG in spring 2022 in light of the results obtained through the past research cruises, that will be presented at that time.

3. RESULTS OF THE 2021 CRUISE

The 12th annual IWC-POWER cruise was conducted between 2 August and 30 September 2021 in the high seas waters of the eastern North Pacific between 40°00'N and US and Canadian EEZ boundaries, 135°00'W and 155°00'W. Alexander Somov (VINRO, Russia) had been nominated as one of the international researchers but unfortunately could not participate at the last minute due to personal reasons. He would have been the first Russian researcher to participate in the IWC-POWER programme. Russia and the IWC had worked cooperatively in the process of the nomination and the meeting hoped that a Russian researcher would be able to participate in next year's survey.

3.1 Sightings

The 2021 survey was conducted aboard the Japanese R/V *Yushin-Maru No. 2* and despite poor weather, about 77% (1,563 n.miles) of the expected trackline was covered, some 53% in Passing with abeam closing mode (NSP) and 47% in Independent Observer passing mode (IO). Sightings of blue (6 schools/7 individuals), fin (79/115), sei (25/40), Bryde's (20/22), sperm (19/22) and killer (1/4) whales were made. Blue and fin whales were mainly in the north of the research area, sei whales in the middle and Bryde's whales in the southern part of the research area. The Angle and Distance Estimation Training Exercise and Experiment was conducted before commencing the sighting surveys. In addition, a total of 88 objects of marine debris were observed.

3.2 Biopsy sampling

A total of 19 biopsy (skin and sometimes blubber) samples were collected from 3 blue, 9 fin, 4 sei, 2 Bryde's and 1 killer whale.

3.3 Photo-identification

Photo-identification data were collected for: 7 blue, 31 fin, 15 sei 13 Bryde's and 3 killer whales. These data are preliminary, pending further processing and photo-identification confirmation.

3.4 Other

No acoustic survey was conducted during the cruise.

A feasibility satellite telemetry experiment to obtain dive data of potential use for correcting abundance estimates behaviour was conducted at the discretion of Japan. Tags (SPLASH10-F-333, Wildlife Computers, US) were deployed on two fin and two sei whales. The data collected have not yet been analysed. To improve data collection in future, Japan is considering installing a Mote (Wildlife Computers, US) stationary listening station on the vessel to allow continuous data logging. The results of the feasibility experiment will be presented to the IWC/SC in the future and the meeting strongly encouraged provision of a report on this important work to SC68D, including information on data availability as appropriate.

In conclusion, the Planning Meeting thanked the Cruise Leader (Murase) and the researchers (Gilpatrick and Yoshimura) for the prompt provision of the draft cruise report and thanked them and the crew for undertaking a successful cruise under difficult circumstances. It was confirmed that all sighting survey electric data including photographs in hard-drive were already sent to the IWC secretariat on 9 December by ICR (Matsuoka).

3.5 Recommendations from cruise team

A number of recommendations were provided by the researchers (see Annex D).

The meeting recognized the importance of the practical improvements suggested by the 2021 cruise researchers. Several related to the photo-ID work and some (e.g. validating the value of the photo-ID approach for the non 'traditional' species such as fin, sei and Bryde's whales) have been made previously but not yet completed, largely due to funding issues. It agreed that a small group of experts could undertake this work and a proposal could be developed for submission at SC68D. The problem of the large number of almost identical photographs in a short time that could be taken using the digital cameras was noted – if they are all imported into the IWC Lightroom catalogue this makes data processing unnecessarily time consuming. It was suggested that the researchers on board could select a limited number of high-quality images for import into the catalogue. The meeting agreed that Secretariat and Steering Group should ensure that the most recent version of Lightroom should be downloaded onto the cruise computer prior to each cruise along with updated manuals, and that a virtual training session on its use should be provided to researchers.

4. 2022 CRUISE: GENERAL ISSUES

4.1 Availability of research vessel(s) from Japan and elsewhere

For the 2022 survey, Japan provisionally offered the same type of vessel as used in the 2021 survey.

4.2 Budget (including accommodation and food costs)

Staniland reported that including unused funds from previous cruises, the total budget for the IWC-POWER programme was £32,320.

4.3 Research permit for Russian waters

In 2021, a research permit to survey waters East of the Kuril archipelago had been applied for 6 months prior to the cruise in accord with the Russian Government guidelines but this had not been granted. As unfortunately was also the case for previous applications to operate in Russian waters in the Bering Sea, to date no explanation had been received as to why the permit had been refused and further information would be sought. The representatives of VNIRO (Bizikov and Sidorov) stated that they would do as much as possible to assist with the application and **agreed** to work with the planning meeting participants upon receipt of a formal request letter addressed to VNIRO from the IWC Secretariat. In this case they suggested developing a letter of support that would be sent to the relevant authorities and that could also be attached to the Japanese permit application. Staniland also **agreed** to write a letter of support on behalf of the IWC to the Russian Commissioner that could be attached to the application. It was also suggested that the Japanese Embassy in Moscow could liaise with their counterparts in the relevant Russian ministry/ies in advance and after submission of the application.

The representatives of VNIRO noted that whilst they had not been involved with cases of foreign research vessels working in Russian EEZ, they had worked with a Japanese researcher in the Okhotsk Sea using a Russian vessel. They noted that the use of a Russian vessel might increase the chances of a successful receipt of permission. In discussion it was observed that a change of the style of vessel may have implications for the research methods used and also that the programme was heavily dependent on the donation by Japan of a vessel and crew; IWC funds only cover the costs of international participants and planning meetings - there is nowhere near enough money to fund a vessel and crew.

4.4 Research permit for US waters

The back-up plan will be within the US EEZ. As noted under Item 5, Iida will file the necessary documents, including the need for biopsy sampling, within the necessary time limit (at least six months prior to the cruise).

5. 2022 SURVEY -PRIORITIES AND CRUISE PLAN

5.1 Research priorities (Original and back-up plan)

The IWC POWER short-term plan identifies 'least studied' areas of the Eastern North Pacific that depend on permission to operate in Russian waters and these remain the current objectives (IWC, 2012b), although the need for a backup plan that contributes to the overall objectives of the programme (see Item 2.2) as in previous years is recognized and both the original and backup plans are discussed below.

5.2 Research area(s) (original and back-up plan)

The proposed areas for the 2022 cruise will focus on the collection of line transect data and biopsy/photo-identification/acoustic data in the area shown in Fig. 2 since the areas had either not been covered (original plan) or not covered for 12 years (back-up plan). In neither area are IO data available to allow for *g*(0) correction.

- These areas represent an important information gap for several large whale species.
- IO mode data are not available for these areas.

Table 1
Proposed plans for 2022.

Plan	No. of days	Research area	Home port	International researchers	Biopsy	Acoustic	Remarks
Original plan	60	East of Kuril archipelago and Kamchatka Peninsula (Russian EEZ) (No port call)	Shiogama/ Shiogama	Russia (2), Japan (2), US (1)	No*	No	Reapply following 2021. *If biopsy permission is given, biopsy samples will be analyzed on board within Russian EEZ.
Back-up plan	60	South of Aleutian Island (US EEZ)	Shiogama/ D.H./D.H./ Shiogama	US (2), Russia (1), Japan (1),	Yes*	Yes	Port calls twice in Dutch Harbor (D.H.) for Acoustic equipment (30 days for the research area). In case of one time port call in D.H., 38 days for research area. Average distance per day is reduced from 50 n.miles to 40 n.miles, and this is a little more room than in 2021 cruise.

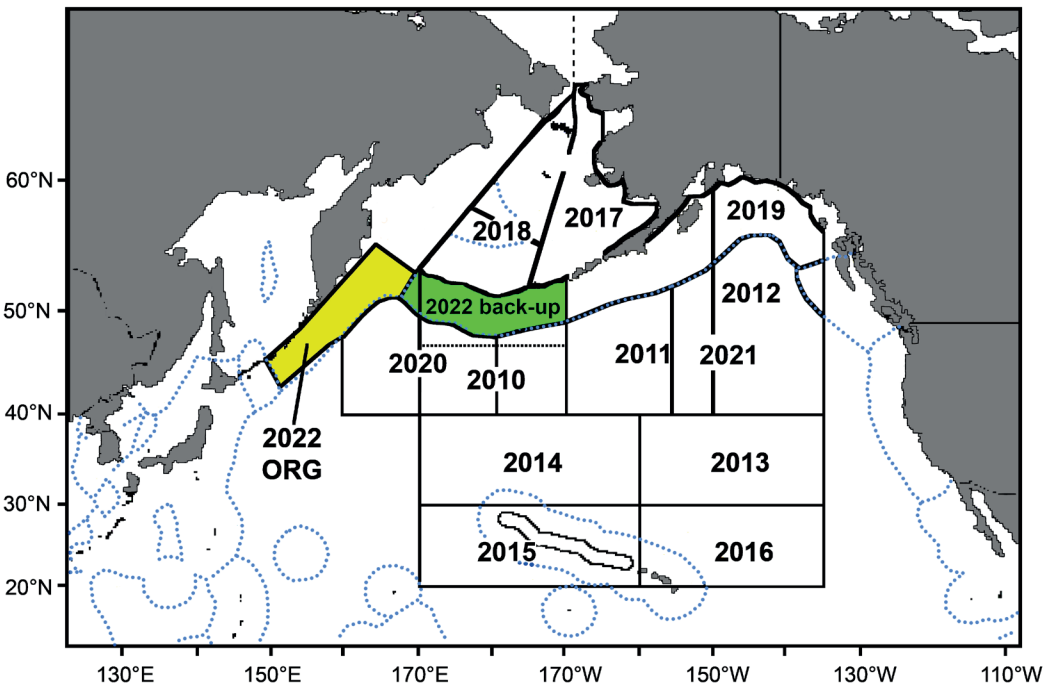


Fig. 2. Proposed 2022 plan with previous research area from 2010 to 2021.

5.3 Research vessel and days available (general itinerary)

For both proposed plans, a total cruise period of 60 days (including transit time) using home ports with refuelling/resupplying/researchers on-offboard has been allowed for (Table 1). Based on experience elsewhere in the North Pacific (e.g. north of 48°N), and allowing for expected poor weather conditions an average of around 40-50 n.miles per day (primary search effort) is expected. About six days is anticipated for 'experiments' - 1 day for the Distance and Angle Experiment and 5 days for photo-ID (and biopsy experiments in back-up plan only).

Table 2
Proposed cruise schedules for 2022.

Original plan		Back-up plan	
Date (ship's time)	Event	Date (ship's time)	Event
01 Aug. 2022	Pre-cruise meeting at Shiogama	01 Aug. 2022	Pre-cruise meeting at Shiogama
02 Aug. 2022	Vessel departs Shiogama	02 Aug. 2022	Vessel departs Shiogama
08 Aug. 2022	Vessel starts the survey in R.A.	10 Aug. 2022	Vessel arrives D.H.
27 Sep. 2022	Vessel completes the survey in R.A.	13 Aug. 2022	Vessel departs DH
30 Sep. 2022	Vessel arrives Shiogama	16 Aug. 2022	Vessel starts the survey in R.A (170W)
01 Oct. 2022	Post-cruise meeting at Shiogama	14 Sep. 2022	Vessel completes the survey in R.A. (168-09E)
		16 Sep. 2022	Vessel arrives D.H.
		19 Sep. 2022	Vessel departs D.H.
		(22 Sep. 2022)	(Vessel complete R.A. to Shiogama)*
		30 Sep. 2022	Vessel arrives Shiogama
		01 Oct. 2022	Post-cruise meeting at Shiogama

*One port call in (Dutch Harbor [D.H.]).

5.4 Cruise track design (original and back-up plan)

The cruise track for the original plan has already been approved by the IWC SC and no changes were needed. Coordinates delimiting the outline of the survey area (the green line in Fig. 3a) is shown in Table 3.

Table 3
Coordinates delimiting the outline of the survey area (the green line in fig. 3a).

	Latitude	Longitude		Latitude	Longitude
Point (see Fig. 3a)	(in degrees, minutes and fractions of minutes)		Point (see Fig. 3a)	(in degrees, minutes and fractions of minutes)	
1	53°13,'00	170°00,00'	8	45°17,'40	149°33,'24
2	51°25,'00	165°00,'00	9	47°05,'50	152°55,'60
3	48°48,'00	161°14,'00	10	47°23,'70	153°13,'90
4	47°37,'00	159°18,'00	11	49°43,'90	155°36,'40
5	45°30,'00	157°00,'00	12	51°01,'90	157°38,'00
6	44°48,'00	156°15,'00	13	53°54,'30	161°33,'20
7	42°43,'38	152°15,'36	14	55°10,'00	164°00,'00

In the case of the backup plan, whilst the overall area is agreed, the meeting **recommends** that flexibility as to the order in which an agreed cruise track is to be covered is required given the unpredictable weather in the area and that this should be at the discretion of the Captain and Cruise Leader. The importance of covering all parts of the research area with no large gaps in the transects was highlighted. Option 3 was suggested considering whale distribution and transit distance is reduced (Fig. 3b). The possibility of an initial port call at Dutch Harbor and returning directly to the home port in Shiogama rather than returning to Dutch Harbor was discussed. This would allow for 8 more survey days (average distance per day is reduced from 50 n.miles to 40 n.miles, and this is a little more room than in 2021 cruise) but this has some implications e.g., with permits for collecting and landing biopsy samples, acoustic buoy disposal, cruise track design and costs for foreign researchers. The meeting agreed that Matsuoka, Murase, Brownell, Crance and Staniland will investigate this and provide a final proposal for consideration by the Steering Group by the end of December.

5.5 Sighting survey (including transit)

5.5.1 Survey modes and allocation of effort (including number of crew, research speed)

For the 2022 survey, following previous advice from the Scientific Committee and the TAG, the survey will normally alternate modes between NSP and IO mode (*ca.* every 50 n.miles). However, use of IO mode should be flexible and at the Cruise Leader's discretion. If there are situations where the high density of whales causes problems for the observers in discriminating between different schools under IO mode, then the searching mode will be changed to NSP.

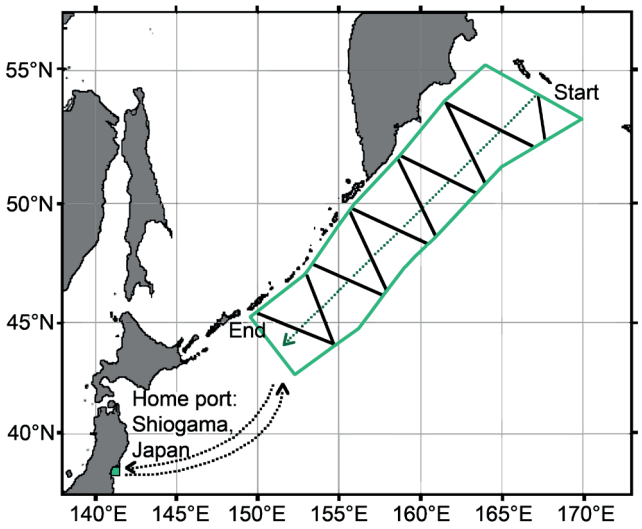


Fig. 3a. Proposed tracklines for 2022 original plan (East of Kuril archipelago).

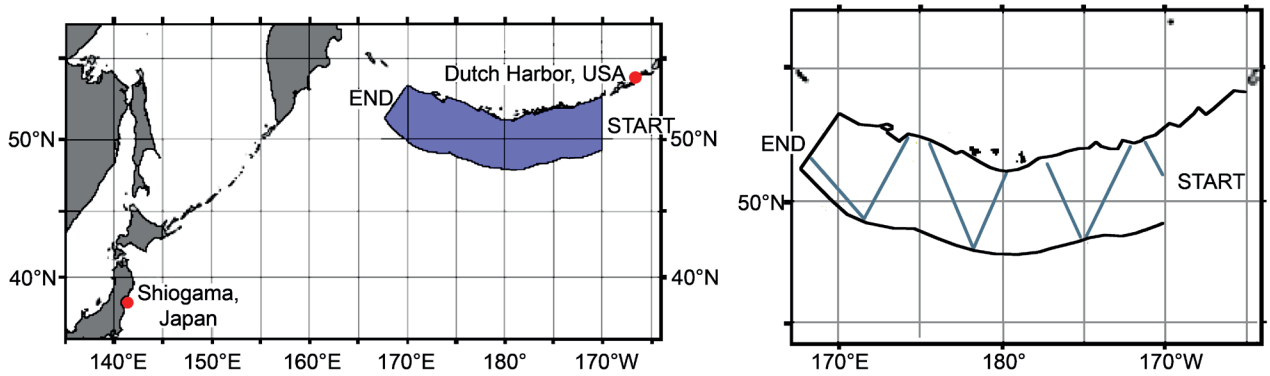


Fig. 3b. Proposed tracklines for 2022 buck-up plan (Southern Aleutian Islands).

Research hours during the cruise will be as in recent cruises (a maximum 12 hours per day between 06:00 and 19:00 (including 30 minutes meal times (lunch and supper) during only IO mode; beginning 60 minutes after sunrise and ending 60 minutes before sunset). For biopsy sampling/photo-identification work on priority species (blue, fin, sei, North Pacific right, and humpback are higher priority for these cruises) there may be occasions when it is beneficial to extend research outside the normal research hours. The basis for such special 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. Details of photo-identification and biopsy work are shown under Items 5.6 and 5.7.

During transit, the research day will begin 30 minutes after sunrise and end 30 minutes before sunset, with a maximum of a 12-hour research day. Time-zone changes will be in 30-minute intervals, coming into effect at midnight.

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 TOP barrel (and IOP barrel when IO mode) 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 reticules, 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.

5.5.2 Acceptable conditions

As in 2021, 11.5 knots (through the water) will be maintained during research. It was noted that in conditions of heavy swell, searching speed might have to be reduced. The usual guidelines for acceptable conditions will apply, i.e. visibility (to see a minke whale) is greater than 2.0 n.miles and wind speed is <21 knots; the sea state should be <Beaufort 6; the ultimate decision as to 'acceptable' is taken by the Cruise Leader.

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. Following the TAG recommendations, the experimental procedure was improved from that used in the 2015 cruise through the use of: (1) relatively inexpensive GPS technology on the buoy to improve detectability: (a) at greater distances; and (b) in more realistic sea/weather conditions than may be possible using the present radar system; (2) two buoys which can: (a) reduce the potential lack of independence with one buoy under the correct experimental protocols; and (b) allow increased efficiency and a greater distance range by including both researchers and crew in the experiment (multi-buoy experiments have been successfully conducted in the North Atlantic). With respect to the additional buoy, the TAG suggested that a smaller buoy than the one currently used (to simulate a whale's body rather than the blow) was provided on the vessel in 2015. The detailed protocol was discussed in the planning meeting and can be found in the Guide for Researchers.

5.5.4 Data recording and format

The survey will be conducted using the same data forms (see the Guide for Researchers) as the 2021 POWER cruise

5.6 Biopsy sampling

It was agreed that advice from Japan and Russian authorities about the CITES situation were necessary if the cruise takes place in Russian waters. It should be done by Iida and Bizikov. This includes advise from Russia on whether biopsy sampling onboard would be a better option.

Bizikov commented that permission for taking biopsy samples in Russian waters from species that are currently included in CITES and Russian Red list in the Russian EEZ is issued by the Ministry of Natural Resources and Ecology of Russia. He advised the inclusion of a biopsy sampling component in the 2022 research plan and that a formal request, together with the copy of application, should be sent to the Russian Commissioner to the IWC (I.B. Fominykh; Ministry of Natural Resources and Ecology) asking her for help in arranging permission for biopsy sampling.

5.6.1 Priority species

As appropriate and decided by the Cruise Leader, research time will be given for biopsy sampling of blue, fin, sei, common minke, humpback, North Pacific right and gray whales. Biopsy of killer and sperm whales will be attempted on an opportunistic basis.

5.6.2 Equipment

Projectile biopsies will be collected using the Larsen system. As noted in Item 5.5.1, the estimated daily number of miles to be steamed in searching mode has a built-in allowance for such work. 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 the option for five sample attempts is to allow for occasional low success rates. If signs of harassment such as rapid changes in direction, prolonged diving and other behaviours are observed from an individual or a group, the biopsy activities 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 main research vessel during normal survey operations. The projectile biopsy sample will be collected from animals within approximately 10 to 50m of the bow of the vessel.

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 will be thoroughly cleaned and sterilized with bleach. Biological samples may be collected from adults, juveniles, females with calves, and calves. The same size biopsy dart would be used for calves as for adults. No biological samples will be taken from newborn calves. The age of a calf would be determined by the subjective judgment of our field biologists who have up to 20+ years' experience in the field.

Murase and Matsuoka will investigate whether additional darts and/or tips are required and if so will liaise with Larsen on their supply and Staniland with respect to budget.

5.6.3 Sample storage

Samples collected for molecular genetic analyses are to be divided in half, with one half of the sample for IWC (to be sent to the SWFSC) and the other half for Japan (ICR). All samples will be frozen. In addition, when biopsy samples have a significant amount of blubber attached, the blubber is to be separated from the skin, wrapped in aluminium foil, and frozen. Details can be found in the 'Information for researchers'.

5.7 Photo-identification studies

5.7.1 Priority species

As appropriate and decided by the Cruise Leader, priority research time will be given for photo-identification and/or video taping of North Pacific right, blue, and humpback whales. As noted under Item 5.5.1, the estimated daily number of miles

to be steamed in searching mode has a built-in allowance for such work. It is also expected that fin, sei and Bryde's whales will also be photographed for possible photo-identification, at least when approached for biopsy sampling. Killer whales are 'non-target' species which are lower priority and will be photographed on an opportunistic basis. Photographs will be available under the standard IWC Guidelines. Generally, large whales will be approached within approximately 15-20 meters. Photo-identification of adult and juvenile males and females 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.

5.7.2 Equipment and collection

The rules for data availability, shipping and storage will be the same as for the previous IWC-POWER cruises. It also noted that existing IWC equipment used in the 2020 cruise could be used on the 2022 cruise if allowed/required. All records will be discharged in Japan and will be sent to the IWC Secretariat under the responsibility of the cruise leader and ICR.

5.7.3 Analysis and archiving

All photo-ID digital photographs of this cruise are to be sent to IWC and shared to Japan (ICR) as with previous IWC/SOWER and POWER cruises. As possible, researchers will incorporate photographs into the IWC Lightroom database during the cruise according to guidelines provided. In terms of data availability, Japan and the IWC share all the data from IWC-POWER cruises, and these are available to Scientific Committee members upon request.

5.8 Acoustic studies

It was agreed that within the original plan no acoustic survey would take place to avoid issues with permit applications. If the backup area is surveyed, passive acoustic monitoring using sonobuoys will occur (approval for their use from the Government of Japan was confirmed for the 2022 back up plan). Sonobuoys will be deployed every ~25 n.miles along the trackline to ensure even coverage within the survey area.

5.8.1 Priority species

The acoustic buoys will be able to pick up large and small cetacean calls. If high priority species are acoustically detected (i.e. North Pacific right and blue whales), the acoustician will alert the Chief Scientist, and at their discretion, the vessel will cease standard visual survey operations and break trackline. Additional sonobuoys will be deployed simultaneously to attempt to localize on the calling animal. If an estimated position is obtained, the acoustician will alert the Chief Scientist, and the vessel will proceed to that location.

5.8.2 Equipment

For the back-up plan, all necessary equipment will again be provided by the Alaska Fisheries Science Center (AFSC), including sonobuoys, laptop computer, antennae, cables, and analytical software. AFSC would also provide a dedicated, experienced acoustic observer to conduct all acoustic monitoring operations on the cruise (see Item 6.1). The general acoustic schedule will involve deployment of one sonobuoy every 3 hours, as well as one at night, leading to 6 buoys per day under good conditions. When drifting for fog, the vessel can remain in range of the sonobuoy for the full 8 hour lifespan of the buoy, so the number of buoys deployed will be less. Thus the maximum number of sonobuoys required will be around 180 (6x30 days) but given the likely prevailing conditions, will be somewhat less (usually average 4 per day). The sonobuoys are shipped in crates of 48 (1.3 m^2, 680kg); allowing for possible failures, three or possibly 4 crates will be sufficient. The Planning Meeting noted that it would be helpful if some solution could be found to the problem of trash generated through use of the sonobuoys, given that it is expensive to dispose of this in Dutch Harbor.

5.7.3 Analysis and archiving

Sonobuoys will be monitored and analysed in real time, and all recordings will be saved to an external hard drive that is backed up daily. Raw acoustic data will be stored at the Alaska Fisheries Science Center in Seattle, WA. Digitized datasheets of sonobuoy deployment, recording, and species detection information will be given to the Chief Scientist at the end of the survey.

5.9 Other studies

5.9.1 Marine debris

The protocol adopted for recording such material (15 minutes at the beginning of every hour) will continue in 2022 to prevent compromising cetacean sightings searching effort.

5.9.2 Oceanographic studies

Only basic oceanographic information (e.g. SST) is to be collected during the cruise. However, the TAG noted that oceanographic data from remote sensing has proved valuable in spatial modelling approaches.

5.9.3 Satellite tagging studies

As last year, the Scientific Committee had recognised the potential of carrying out satellite tagging studies to address specific questions, especially for the mid-term programme. It was agreed that such studies were voluntary and should be

at the discretion of Japan. The cruise leaders will decide whether such work should take place during the cruise with the understanding that the line transect survey is the highest priority. In 2021 satellite tags had been successfully deployed and collected dive data import to understand availability analyses (see Item 3.4).

6. 2022 CRUISE-LOGISTICAL ISSUES (ORIGINAL AND BACKUP PLAN)

6.1 International researchers and allocation of research personnel

It was agreed that under the original plan 2 Russian, 2 Japanese and 1 US researchers would participate and under the backup plan 2 US (Crance received permission to use sonobuoys), 2 Japanese and 1 Russian researcher would participate.

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 will be Takahashi. For the backup plan Crance will act as home port organizer in Dutch Harbor.

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. Within two months of the end of the cruise, all validated sightings data will be forwarded to IWC by the Cruise Leader and ICR (Matsuoka).

6.2.3 Biopsy: equipment, samples, permits and responsible persons

When biopsying is appropriate, the biopsy samples will be taken using the Larsen system. Matsuoka will ensure that the necessary equipment, including darts, plugs and vials are available (see Item 5.6.2). ICR (Taguchi and Matsuoka) will ensure that the IWC samples are sent to the SWFSC (the IWC repository) in accordance with CITES procedures. Issues related to CITES permits for both options are being worked upon by the relevant authorities in Russia, the USA and Japan depending on where the cruise takes place and whether permission to undertake biopsy sampling is given.

After issues in logistics imposed by Covid, all efforts to ship samples from previous cruises between Japan and the SWFC will be continued.

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. Staniland 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 three months of the cruise.

6.2.5 Acoustics: equipment, permits and responsible persons

Sonobuoys will be provided by the Alaska Fisheries Science Center. Iida has confirmed that when deployed in US waters, and brought aboard in a US port, the use of sonobuoys on a Japanese vessel is allowed. As such, sonobuoy use will proceed as it has in the past. However, importing sonobuoys to Japan, or deploying them in Japanese waters falls under Japanese law and requires the equipment to be certified by the Ministry of Internal Affairs and Communications. Crance has provided a wealth of data on this but the ministry has requested raw data on the sonobuoys including their frequency by each channel, occupied bandwidth and maximum antenna power output from actual measurements and not the general specifications in the manual. Crance has begun communication with a suitable laboratory in the US to obtain these data to ensure sonobuoys can be used in future POWER cruises. Iida and Crance will remain in contact to try and resolve this matter.

Crance will install antennae on the vessel as in previous years. Existing cables on the vessel are prone to damage and degradation over time; Yoshimura will be responsible for checking these and ensuring any repairs or replacements are carried out.

6.2.6 Other

There was no particular discussion.

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, 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 the designated Russian representative (Bizikov) will be responsible for contacting the relevant authorities. For the back-up the US researcher (Crance) will coordinate regular communication with the US Coast Guard when in the US-EEZ.

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 and sea temperature information

It was agreed that fog information will be required and this will be obtained as usual via a Japanese agency as official communication.

6.3.4 Other official communications

For the Russian option, arrangements will be made to comply with any requirements specified in the permit. Iida and Staniland 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

For the original plan all researchers will join the vessel in Japan and the pre-cruise meeting will be held in Shiogama and organised by Takahashi. For the back-up plan there will be an additional pre-cruise meeting in Dutch Harbor organized by Crance.

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 original plan, the post-cruise meeting will be held in Shiogama when the vessel returns to port; it will be organised by Takahashi. For the backup option, a post-cruise meeting will be held in Shiogama and organised by Takahashi, and in Dutch Harbor (organized by Crance if another port call is to be made after completing research cruise in the survey area), depending on the final plan chosen (see Item 5.4).

6.5 Reports

6.5.1 Planning meeting report

This planning meeting report will be uploaded onto the IWC website as a report for SC68D.

6.5.2 Cruise report

As usual, the cruise report will be drafted on the return journey of the cruise following the previous guidelines. The report will be discussed at the next planning meeting and then a final version will be sent to the Secretariat for submission to SC68D in 2022.

6.6 Press releases

The Cruise Leader (or representative) in consultation with the IWC (Kate Wilson and Iain Staniland) 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 to the Steering Group and the Cruise Leader prior to release.

6.7 Security

For the original plan, the Fisheries Agency of Japan, ship agents and the designated Russian representative will investigate the situation and ensure that adequate security measures are in place. When in port or needed the IWC banner will be readily visible, this is already on stored on the vessel.

The same procedures adopted in previous visits to Dutch Harbor will be followed if the backup plan is used.

7. OTHER

7.1 Data validation and analysis

Work on data validation continues at the Secretariat. Where difficulties arise, these are dealt with in cooperation with the Cruise Leader.

7.2 IWC website

The Secretariat will ensure that the IWC website is updated as appropriate.

7.3 Other

There was no particular discussion.

8. WORKPLAN

8.1 Plan for a workshop before SC68D

It was agreed that an in-person meeting of the Technical Advisory Group was needed to discuss the complex issues around the development of the medium-term plans for the IWC-POWER programme. It is preferable to hold this before SC68D but it could be delayed until later in the calendar year if this is not possible. It would not be possible to do this between 11 April and the start of SC68D because of other commitments. All agreed that planning could begin well before the meeting including drafting an agenda and the compilation of documents and a list of key people.

8.2 Timeline to develop medium-term planning

There will be at least two more cruises (depending on the Russian Permit situation) required to complete the initial programme. However, it is essential to begin the planning for the next (medium-term) phase as soon as possible (see Item 8.1) with a view to completing the planning by 2024.

8.3 Suggestion from Russia for the future survey

Bizikov suggested time was needed to consider any future surveys and efforts should concentrate on the application for the 2022 cruise. The Committee has already agreed the need to complete coverage of the Bering Sea by covering the waters of the Russian Federation there. The planning meeting confirmed that this was still a high priority area.

8.4 Other

The need to expedite the finalisation of the report was emphasised and a deadline for completion by 20 December 2021 was agreed.

9. CONCLUDING REMARKS AND ADOPTION OF REPORT

Bizikov informed the group that Dr. Zharikov who had worked in the POWER programme for many years had retired for his illness. Bizikov agreed to pass on the regards and gratitude of the planning meeting to Dr. Zharikov for all his work over the years.

Moronuki confirmed that the Japan's position had not changed since the withdrawal from the IWC and it continued to work with international organisations to support science and international management of cetaceans. The IWC POWER programme was an important part of this and would continue to be supported as before. Staniland thanked Moronuki for his encouraging words noting the IWC and its Scientific Committee looked forward to working with Japan and the international researchers on this important programme.

Matsuoka thanked the participants for their hard work over the two days. The participants in turn thanked Matsuoka for his excellent chairing of the meeting. The meeting adopted the report (subject to final editorial work) and concluded its business at 22:00hrs (UTC) on 20 December 2021.

REFERENCES

International Whaling Commission. 2012a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 13:1-74.

International Whaling Commission. 2012b. Report of the Scientific Committee. Annex G. Report of the Sub-Committee on In-Depth Assessments. Appendix 4. Report of the Small Group planning for the 2012 IWC Pacific Ocean Whales and Research (POWER). *J. Cetacean Res. Manage. (Suppl.)* 13:189-90.

International Whaling Commission. 2021. Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG), 18-19 January 2020, Tokyo, Japan. *J. Cetacean Res. Manage. (Suppl.)* 22:231-58.

International Whaling Commission. 2022a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 23:1-171.

International Whaling Commission. 2022b. Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG) and 2021 Planning Meeting, virtual meeting, 9-10 November 2020. *J. Cetacean Res. Manage. (Suppl.)* 23:25pp.

Matsuoka, K., Crance, J., Gilpatrick, J.W., Yoshimura, I. and Ohkoshi, C. 2020. Cruise report of the 2019 IWC-Pacific Ocean Whale and Ecosystem Research (IWC-POWER). Paper SC/68B/ASI/20 presented to the IWC Scientific Committee, May 2020, Virtual Meetings (unpublished). 58pp. [Paper available from the Office of this Journal].

Annex A

List of Participants

Robert Brownell, Southwest Fisheries Science Center, USA
Jessica Crance, Alaska Fisheries Science Center, USA
Greg Donovan, Emeritus Head of Science, IWC
Pavel Gushcherov, Russian Federal Research Institute of Fisheries and Oceanography (TINRO), Russia
Takashi Hakamada, Institute of Cetacean Research, Japan
Takeru Iida, Fisheries Agency of Japan
Masaki Kadota, Fisheries Agency of Japan
Hidehiro Kato, Institute of Cetacean Research, Japan
Taiki Katsumata, Institute of Cetacean Research, Japan
Natalie Kelly, Australian Antarctic Division, Australia
Sidorov Lev. Konstantinovich, Russian Federal Research Institute of Fisheries and Oceanography (VNIRO), Russia
Koji Matsuoka, Institute of Cetacean Research, Japan
Hideki Moronuki, Fisheries Agency of Japan
Hiroto Murase, Tokyo University of Marine Science and Technology, Japan
Debra Palka, Northeast Fisheries Science Center, USA
Yurie Sawasaki, Fisheries Agency of Japan
Iain Staniland, Head of Science, Conservation and Management, IWC
Megumi Takahashi, Institute of Cetacean Research, Japan
Mioko Taguchi, Institute of Cetacean Research, Japan
Bizkov V. Alexandrovich, Russian Federal Research Institute of Fisheries and Oceanography (VNIRO), Russia
Isamu Yoshimura, Kyodo Senpaku Co. Ltd
Midori Ohta, Interpreter, Japan
Saemi Baba, Interpreter, Japan

Annex B

Agenda

1. Introductory items
   - 1.1 Opening remarks and welcoming address including notes from the IT support team
   - 1.2 Election of the Chair
   - 1.3 Adoption of the Agenda
   - 1.4 Appointment of rapporteurs
   - 1.5 Review of documents
2. Review of cruise discussions at IWC 68C and the TAG meeting (SC/68C/Rep01)
   - 2.1 Review of Scientific Committee recommendations
   - 2.2 Objectives and priorities
     - 2.2.1 Long-term
     - 2.2.2 Short-term
     - 2.2.3 Medium-term
   - 2.3 Progress since last planning meeting
   - 2.4 Other
3. Results of the 2021 cruise
   - 3.1 Sightings
   - 3.2 Biopsy sampling
   - 3.3 Photo-identification
   - 3.4 Other
   - 3.5 Recommendations from cruise team
4. 2022 cruise: 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
   - 4.4 Research permit for US waters
5. 2022 survey - priorities and cruise plan
   - 5.1 Research priorities (original and back-up plan)
   - 5.2 Research area(s) (original and back-up plan)
   - 5.3 Research vessel and days available (general itinerary)
   - 5.4 Cruise track design (original and back-up plan)
   - 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

- 5.7.1 Priority species
- 5.7.2 Equipment
- 5.7.3 Analysis and archiving

5.9 Other studies
- 5.9.1 Marine debris
- 5.9.2 Oceanographic studies
- 5.9.3 Satellite tagging studies

6. 2022 cruise logistical issues (original and 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
- 6.5.6 Other

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

7.3 Other

8. Workplan

8.1 Plan for a workshop before SC68D

8.2 Timeline to develop medium-term planning

8.3 Suggestion from Russia for the future survey

8.4 Other

9. Concluding remarks and adoption of report

Annex C

List of Documents

01. Timetable (Ver20211129).
02. Excerpt from 2021 Scientific Committee Report (SC/68C SC Report).
03. Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG) and 2021 Planning Meeting: November 2020 (SC/68C/Rep01).
04. Report of the Steering Group of the IWC-POWER (North Pacific Ocean Whale and Ecosystem Research Programme) Programme to SC68C (SC/68C/ASI/17).
05. Cruise report of the 2021 IWC-POWER (Murase *et al.*).
06. Proposal for original plan (east off Kamchatka, Russian EEZ) of 2022 survey (Revised SC/68C/Rep01).
07. Proposal for backup plan (south of Aleutian Islands, US-EEZ) of 2022 survey (Takahashi and Hakamada).
08. Task list for the 2022 cruise.
09. Request for marine scientific research.

Annex D

Recommendations from the Researchers of the 2021 POWER Cruise

1. STRATIFICATION OF THE RESEARCH AREA

The 2021 IWC-POWER was conducted from the middle of August to the middle of September which was assumed to be the end of the northbound migration season. It covered three different waters: subarctic and subtropical waters, and the transition zone between them (subarctic-subtropical transition zone). It appeared that distributions of four baleen whale species were related to these waters: blue and fin whales in the subarctic water, sei whales in the transition zone and Bryde's whales in the subtropical water. Allocation of the planned tracklines in each water zone was apparently limited in this cruise given the size of the survey area. It is recommended that the survey designers reconsider the survey timing and stratification of the research areas when formulating a medium-term plan, taking into account the objectives, target species, season, oceanography and the past results of the IWC-POWER cruises. In 68C IWC/SC, it was pointed out that the research area of the 2021 IWC-POWER might be too large to obtain a good estimate given the number of days available (IWC, 2021b).

2. SCHEDULE OF THE SURVEY

Initially, there was an option that *YS2* called to Kodiak, US for refuelling and joining/leaving researchers (IWC, 2021a). However, it was decided that the 2021 IWC-POWER would be conducted for 60 days without refuelling considering the COVID-19 pandemic situation at the time of departure from Japan. This decision limited the total research days to 30 days. Furthermore, *YS2* reduced the ship's research speed to 10.5 knots to conserve fuel although it was in the range of accepted speed for the sighting survey. Reducing the ship's speed affected the total searching distance. It was recommended that port calls outside of Japan should made in the future survey to maximize survey effort in the research area if the situations allow. This consideration is especially important when the research area is considerably distant from Japan.

3. PHOTOGRAPHIC DATABASE PROCESSING IN LIGHTROOM (LR)

As in the case of 2021 cruise, images collected during the cruise were uploaded to LR and preliminarily coded. By processing images directly in LR, post-cruise processing time is greatly reduced. Furthermore, it allows for real-time photo-analysis summaries and expedites image access/sharing. It is recommended that researchers on future cruises continue LR processing. However, processing images would overwhelm researchers if a large number of images are taken in a high-speed consecutive shot mode. It is recommended that photographers try to take only 'high-quality images' as much as possible to minimize number of images for LR processing. It is recommended that guidance documents specific for photo-processing during the cruise and the IWC LR Photographic Database Manual are kept up-to-date and that hard and electronic copies are made available on future cruises. It is recommended that newest version of LR at the beginning the survey is installed on the IWC-POWER laptop with an up-to-date catalogue prior to future IWC-POWER cruises. It is recommended that the IWC secretariat holds a workshop of LR for researchers in advance of each cruise so that database manager and researchers can have mutual understanding on management of images in LR.

4. CAMERA EQUIPMENT

A Canon EOS 5D Mark II camera with 100-400mm lens (courtesy of SWFSC) was used as one of the primary cameras for photo-identification during the 2021 IWC-POWER survey. However, because it was identified that the SWFSC's lens was not functioning properly, the ICR's lens was used in conjunction with the SWFSC's camera. It is recommended that in accord with usual practice, all cameras be carefully checked well before the survey.

5. ASSESSMENT OF FEASIBILITY OF PHOTO IDENTIFICATION FOR FIN, SEI AND BRYDE'S WHALES

Target species for photo-ID are North Pacific right, blue, gray and humpback whales although photos of all other species were obtained opportunistically. Generally, it is believed that photo identifications of fin, sei and Bryde's whales are extremely difficult one because they do not have unique features for the identifications and the other because matching is difficult considering their abundance. Their photos have taken since the beginning of this programme without assessment of the feasibility. It is recommended that the feasibility of their photo identifications be assessed before continuing this practice in the future cruises. This is also important consideration on workload of researchers.

REFERENCES

International Whaling Commission. 2021a. Report of the Meeting of the IWC-POWER Technical Advisory Group (TAG) and 2021 Planning Meeting, virtual meeting, 9-10 November 2020. Paper SC/68C/REP/01rev01 presented to the IWC Scientific Committee, Virtual Meetings, April-May 2021 (unpublished). 25pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2021b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 22:1-122.

Photographic credits

Front cover image is a Vaquita
With thanks to Paula Olson of NOAA

Produced by the IWC Secretariat

The International Whaling Commission (IWC)

The Red House,
135 Station Road,
Impington,
Cambridge, CB24 9NP
United Kingdom

www.iwc.int