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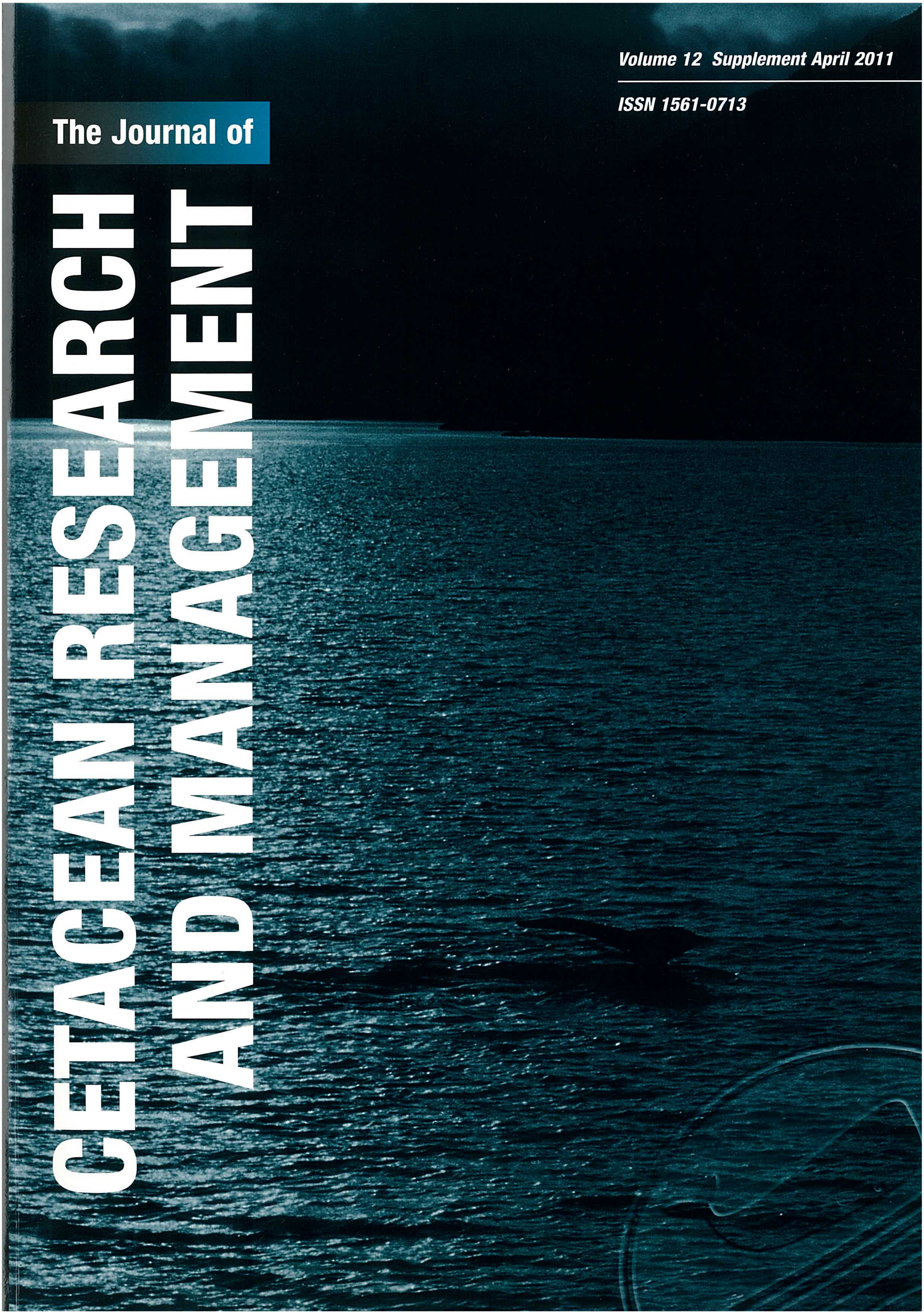


Introduction

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

This supplement to the Journal contains the Report of the Scientific Committee from its Annual Meeting held from 30 May-11 June 2010 in Agadir, Morocco. The meeting was attended by over 160 participants (including some 55 invited participants); 25 member nations were represented. It also contains the reports of five intersessional meetings:

(1) the Southern Right Whale Die-Off Workshop held in March 2010 in Puerto Madryn, Argentina;
(2) the Third Intersessional Workshop on the Review of MSYR for Baleen Whales held in April 2010 in Seattle, USA;
(3) the Intersessional Meeting on the North Pacific Survey Programme held in September 2009 in Tokyo, Japan;
(4) the IWC POLLUTION 2000+ Phase II Workshop held in February 2010 in Sausalito, CA, USA; and
(5) the Third AWMP Workshop on Greenlandic Hunts held in December 2009 in Roskilde, Denmark.

Several major topics were discussed in Agadir. A brief summary of the work of the Committee in Agadir is given below.

Discussion of the Revised Management Procedure for baleen whales (RMP) centred on completing the *pre-Implementation assessment* for North Pacific common minke whales. This was achieved and the two-year *Implementation* process will now begin. The Committee also reviewed draft research programmes arising out of the completion of the *Implementation* for western North Pacific Bryde's whales in 2007 and North Atlantic fin whales in 2009, and continued its review of MSY rates.

The *Implementation* process takes into account other anthropogenic mortality such as bycatch and the Committee continued its general investigation of these issues, with focus on a Commission Workshop report on entanglements and further work on the issue of ship strikes and the development of a global database on ship strikes.

Work on the development of the aboriginal subsistence whaling procedure is continuing. A Workshop was held to discuss sex-ratio assessment for West Greenland common minke whales, and the major focus at the annual meeting was the *Implementation Review* of eastern North Pacific gray whales. This work will continue next year with a focus on the Pacific Coast feeding group. Advice on catch limits for subsistence hunts was provided.

As in previous years, the Committee continued to work on obtaining agreed abundance estimates for Antarctic minke whales. A work plan has been developed to provide a reasonable chance of resolving the differences and arriving at a final estimate at the 2011 meeting. Work continues on examining the causes for the appreciable decline in the estimates.

Work also continued on the in-depth assessment of Southern Hemisphere humpback whales. There are currently seven recognised breeding stocks of these whales, and this year work centred on BSB (western Africa); the final results will be available next year. The next breeding stocks to be examined will be BSE and BSF. Progress was also made with the in-depth assessment of Southern Hemisphere blue whales. Although the IWC's long programme of cruises in the Southern Ocean (IDCR and SOWER) cruises is now finished, plans are in hand for similar international cruises to be undertaken in the North Pacific. The Committee also reviewed the progress made with the Southern Ocean Research Partnership (SORP). Several draft projects have been put forward for consideration and the Committee is also considering the possibility for a major initiative for a 'Year of the Blue Whale' in 2013/14.

Although a number of whale populations are recovering from previous overexploitation, some remain in a critical state. The Committee again repeated its concerns over the status of populations of the North Atlantic right whale and the Western North Pacific gray whale. The Committee stressed the urgency of reducing anthropogenic mortality to zero in both these cases and approved the extensive draft recovery programme developed in conjunction with IUCN for the latter population. Although several southern right whale populations are increasing, including the South Atlantic population, the Committee reviewed the report of a workshop held to investigate the causes of the high mortality of particularly first year calves around Peninsula Valdes, Argentina. Three leading hypotheses emerged: (1) reduced food availability for adult females; (2) biotoxins; and (3) infectious disease.

In recent years, the Committee has paid increasing attention to the relationship between cetaceans and their environment. Work began on the planning for a new North Pacific survey programme. Progress was also made with regard to the second phase of the POLLUTION 2000+ programme. Other habitat-related discussions continued, with priority being given to the issues of anthropogenic sound and climate change.

A review of the taxonomy, population structure and status of small cetaceans off northwestern Africa and the Eastern Tropical Atlantic was carried out this year. At least 21 different species of small cetacean are known to inhabit this area, and they all face several anthropogenic threats. On reviewing progress on previous recommendations, the Committee reiterated its extreme concern about the vaquita and noted that the species was likely to become extinct if the present rate of bycatch continues. Other populations of small cetaceans continue to give cause for concern including franciscanas off the coast of South America and narwhals and white whales in West Greenland.

Whalewatching off North Africa was also reviewed this year. The Large-scale Whalewatching Experiment (LaWE) was further developed and will continue intersessionally.

The Agadir meeting represented the final meeting to be organised by Dr Nicky Grandy as Secretary to the Commission. The Scientific Committee rose in appreciation of her 10 years of service and thanked her for her hard work, good humour, charm and support over the period. The new Secretary to the Commission is Dr Simon Brockington.

Finally, with respect to the *Journal*, I would like to congratulate Jemma Jones, the assistant Editor on the birth of her first baby, Charlotte Rachel who was born on 7 November 2010, and Clare Addington (née Last) the previous assistant Editor who gave birth to her first baby, Evie, on 26 September 2010. I would also like to thank our new printing company, Cambridge University Press, for an excellent job in producing this large volume.

Greg Donovan
Editor
Cambridge, 17 March 2011

Supplement Contents

This supplement to the Journal contains the Report of the Scientific Committee from its Annual Meeting held from 30 May-11 June 2010 in Agadir, Morocco. It also contains: the Report of the Southern Right Whale Die-Off Workshop held in March 2010 in Puerto Madryn, Argentina; the Report of the Third Intersessional Workshop on the Review of MSYR for Baleen Whales held in April 2010 in Seattle, USA; the Report of the Intersessional Meeting on the North Pacific Survey Programme held in September 2009 in Tokyo, Japan; the Report of the IWC POLLUTION 2000+ Phase II Workshop held in February 2010 in Sausalito, CA, USA; and the Report of the Third AWMP Workshop on Greenlandic Hunts held in December 2009 in Roskilde, Denmark.

*Detailed contents for the Plenary Section (pp.1-75) are given on the next page.

PLENARY SECTION: CONTENTS

Report of the Scientific Committee

The meeting was held at Centre de Congrès, Les Dunes d'Or, Agadir, Morocco from 30 May-11 June 2010 and was chaired by Debra Palka. A list of participants is given as Annex A.

1. INTRODUCTORY ITEMS

1.1 Chair's welcome and opening remarks

Palka welcomed the participants to the meeting. She thanked the Government of Morocco for hosting the meeting and for providing excellent facilities along with fabulous weather. She also expressed thanks for the beautiful artwork exhibited throughout the meeting venue.

With sadness, the Committee noted that Sidney Brown had passed away since the 2009 meeting. Sidney was a long-standing member of the Committee from the early 1960s to the mid 1980s. He was particularly involved in the Discovery Whale Marking Scheme, for which he was responsible for maintaining records of marks fired and recovered, ordering supplies and ensuring their availability for relevant whaling and scientific operations, and writing up the results. His advice on all things cetacean was much sought and greatly respected. His modest English manner belied a shrewd intellect and wide range of interests in maritime history and exploration. A minute of silence was observed in his memory.

1.2 Appointment of rapporteurs

Donovan was appointed rapporteur with assistance from various members of the Committee as appropriate. The Committee gave particular thanks to Butterworth for rapporteuring Item 20. Chairs of sub-committees and Working Groups appointed rapporteurs for their individual meetings.

1.3 Meeting procedures and time schedule

Grandy summarised the meeting arrangements and information for participants. The Committee agreed to follow the work schedule prepared by the Chair.

1.4 Establishment of sub-committees and Working Groups

Two pre-meetings preceded the start of the Scientific Committee. The Working Group on the *pre-Implementation assessment* of Western North Pacific Common Minke Whales (NPM) and the correspondence Working Group on Abundance Analysis Methods for Southern Hemisphere Minke Whales met from 28-29 May, during which agenda items covered were incorporated into their main agendas and reports (Annexes D1 and G respectively).

A number of sub-committees and Working Groups were established. Their reports were either made annexes (see below) or subsumed into this report.

Annex D – Sub-Committee on the Revised Management Procedure (RMP);
Annex D1 – Working Group on the *pre-Implementation assessment* of Western North Pacific common minke whales (NPM);
Annex E – Standing Working Group on an Aboriginal Whaling Management Procedure (AWMP);
Annex F – Sub-Committee on Bowhead, Right and Gray Whales (BRG);
Annex G – Sub-Committee on In-Depth Assessments (IA);
Annex H – Sub-Committee on Other Southern Hemisphere Whale Stocks (SH);
Annex I – Working Group on Stock Definition (SD);
Annex J – Working Group on Estimation of Bycatch and other Human-Induced Mortality (BC);
Annex K – Standing Working Group on Environmental Concerns (E);
Annex K1 – Working Group to Address Multi-species and Ecosystem Modelling Approaches (EM);
Annex L – Standing Sub-Committee on Small Cetaceans (SM);
Annex M – Sub-Committee on Whalewatching (WW); and
Annex N – Working Group on DNA (DNA).

1.5 Computing arrangements

Allison outlined the computing and printing facilities available for delegate use. Requests for Secretariat computing are addressed according to the priority assigned by the Convenors.

2. ADOPTION OF AGENDA

The adopted Agenda is given as Annex B1. Statements on the Agenda are given as Annex U. The Agenda took into account the priority items agreed last year and approved by the Commission (IWC, 2010c). Annex B2 links the Committee's Agenda with that of the Commission.

3. REVIEW OF AVAILABLE DATA, DOCUMENTS AND REPORTS

3.1 Documents submitted

Donovan noted that the pre-registration procedure, coupled with the availability of electronic papers, had again been successful. With such a large number of documents, pre-specifying papers had reduced the amount of photocopying and unnecessary paper dramatically. He was pleased to note that this year, the percentage of people opting to receive their primary papers entirely electronically (27%) was almost triple that of last year (10%) and he hoped that this percentage would continue to grow in future years. The list of documents is given as Annex C.

3.2 National Progress Reports on research

National Progress Reports presented at the 2002-10 meetings are accessible on the IWC website. Reports from previous years will also become available in this format in the future.

The Committee reaffirmed its view of the importance of national Progress Reports and **recommends** that the Commission continues to urge member nations to submit them following the approved guidelines (IWC, 1993). Non-member nations wishing to submit progress reports are welcome to do so. The Secretariat is looking into the possibility of online submission of the data included in national Progress Reports; a simplified progress report template has also been developed (see Annex P).

A summary of the information included in the reports presented this year is given as Annex O; the report template,

Table 1

List of data and programs received by the IWC Secretariat since the 2009 meeting.

Date	From	IWC ref.	Details
Catch data from the previous season:			
03/05/10	Norway: N. Øien	E84 Cat09	Individual minke catch records from the Norwegian 2009 commercial catch. Access restricted (specified 14-11-00).
31/05/10	Iceland: G. Víkingsson	E87 Cat09	Individual catch records from the Icelandic commercial catch 2009.
31/05/10	Japan: H. Okada	E88 Cat09	Individual catch records from the Japanese 2009 North Pacific special permit catch (JARPN II) and 2009/10 Antarctic special permit catch (JARPA II).
31/05/10	Russia: R.G. Borodin	E89 Cat09	Individual catch records from the aboriginal harvest in the Russian Federation in 2009.
03/06/10	St.Vincent: L. Edwards	E90 Cat10	Individual catch records from St. Vincent and The Grenadines for the 2010 humpback harvest.
Sightings data/programs:			
22/02/10	K. Sekiguchi	E86 CD92a-n	2009/10 SOWER cruise photographs and data including sightings, effort, waypoint, ice edge, weather.
00/04/10	L. Burt	CD93	DESS Version 3.63 2010.
30/05/10	Japan: K. Matsuoka	CD94	ICR blue whale photo-id pictures from JARPA 1987/88-2004/05 submitted under IWC data access Procedure B.

is available on the IWC website (*http://www.iwcoffice.org/sci_com/scprogress/htm*). The importance of using the agreed template was **emphasised** by the Committee.

3.3 Data collection, storage and manipulation

3.3.1 Catch data and other statistical material

Table 1 lists data received by the Secretariat since the 2009 meeting.

3.3.2 Progress of data coding projects and computing tasks

Allison reported that work has continued on the entry of catch data into both the IWC individual and summary catch databases, including data received from the 2008 season. Work has focused on updating data for eastern North Pacific gray whales (see Item 9.2) and data from the North Atlantic in the period 1897-1930. Version 5.0 of the catch databases will be available shortly. Entry of data into the bycatch database developed by Simon Northridge has continued with data from the 2004 and 2008 seasons being added. Data from the 2008/09 SOWER sightings cruise have been validated and incorporated into the DESS database and work on encoding and validation of data from the 2009/10 cruise has begun. Burt and Hughes began an audit of the Western North Pacific Bryde's whale survey data intersessionally and this work was completed during the course of the meeting.

Programming work during the past year is discussed later under the relevant agenda items.

4. COOPERATION WITH OTHER ORGANISATIONS

4.1 Convention on the Conservation of Migratory Species (CMS)

4.1.1 Scientific Council

There were no meetings of the Scientific Council during the intersessional period. Perrin will represent the IWC at its next meeting.

4.1.2 Conference of Parties (COP)

There were no meetings of the Conference of Parties during the intersessional period. The Secretariat will represent the IWC at the next COP.

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

The report of the IWC observer at the 6th Meeting of the Parties to ASCOBANS held in Bonn, Germany from 16-18 September 2009 is given as IWC/62/4D. The main topics of relevance to the IWC are summarised as follows:

(1) a new version of the Recovery Plan for Baltic Harbour Porpoises was adopted;
(2) a new Conservation Plan for the Harbour Porpoise in the North Sea was adopted; and
(3) the meeting agreed on guidelines to address the adverse affects of underwater noise on marine mammals during offshore construction activities for renewable energy production.

The 17th meeting of the Advisory Committee to ASCOBANS had been scheduled to take place from 21-23 April 2010 in Cornwall. This was postponed due to flight restrictions caused by volcanic eruptions in Iceland. It has been rescheduled for 4-6 October 2010 in Bonn, Germany.

The Committee thanked Scheidat for her report and **agrees** that she should represent the Committee as an observer at the next ASCOBANS Advisory Committee meeting and Meeting of Parties. Further information can be found at *http://www.ascobans.org*.

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

The ACCOBAMS Scientific Committee met in Casablanca from the 11-13 January 2010, primarily to prepare information for the forthcoming Meeting of Parties that will be held from 9-12 November 2010 in Monaco. It was attended by members of the Scientific Committee, representatives from the Sub-Regional Coordination Units, representatives from International Organisations and observers including partners of ACCOBAMS. The report of the IWC observer is given as IWC/62/4M.

Nine recommendations and a Declaration expressing the Committee's concern about the slow and/or limited level of implementation of the Agreement to effectively address the conservation problems affecting cetaceans in the Agreement area were adopted by the Committee during the meeting:

Recommendation	Topic
6.1	ACCOBAMS Survey Initiative
6.2	Programme of work on population structure
6.3	Conservation of Mediterranean common dolphins
6.4	Ship strikes
6.5	Marine Protected Areas
6.6	Anthropogenic noise
6.7	Monitoring, assessment and reducing cetacean bycatch in the Black Sea
6.8	Climate change
6.9	Minimum funding for the Scientific Committee

The next meeting of the Scientific Committee is planned for early 2011. The full report of the Scientific Committee can be found on the ACCOBAMS website *http://www.accobams.org*. The Committee thanked Donovan for his report and **agrees** that he should represent the IWC at the forthcoming Meeting of the Parties and Scientific Committee meetings.

4.1.5 Memorandum of Understanding (MoU) on the Conservation of the Manatee and Small Cetaceans of Western Africa and Macaronesia

There was no report related to the MoU on the Conservation of the Manatee and Small Cetaceans of Western Africa and Macaronesia. Perrin will represent the Committee at future activities.

4.1.6 Memorandum of Understanding (MoU) for the Conservation of Cetaceans and Their Habitats in the Pacific Islands Region (MoU for Pacific Islands Cetaceans)

The report of the IWC observer at the 2nd meeting of the MoU for Pacific Islands Cetaceans held 28-29 July 2009 in Auckland, New Zealand is given as IWC/62/4E. The meeting was attended by most of the signatories (Australia, Cook Islands, Fiji, French Polynesia, New Caledonia, New Zealand, Niue, Papua New Guinea, Samoa and the Solomon Islands). Federated States of Micronesia was unable to attend, and Tonga attended as an observer. The UK, on behalf of the Pitcairn Islands, signed the MoU at the meeting, bringing the total number of signatories to twelve.

The meeting, *inter alia*, reviewed progress in cetacean conservation in the region, endorsed a proposal to develop an Oceania Humpback Whale Recovery Plan and adopted an Action Plan for the MoU. An offer by the Whale and Dolphin Conservation Society (WDCS) to convene a Pacific Cetaceans MoU Technical Advisory Group was gratefully accepted. The meeting also noted with appreciation the continued support by WDCS for the development of the CMS Pacific MoU website: *http://www.pacificcetaceans.org*. The Committee thanked Donohue for his report and **agrees** that he should represent the Committee at the next meeting of the MoU for Pacific Islands. Further information can be found at *http://www.cms.int/species/pacific_cet/pacific_cet_bkrd.htm*.

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

The report of the IWC observer documenting the 2009 activities of ICES is given as IWC/62/4B. The ICES Working Group on Marine Mammal Ecology (WGMME) met in February 2009. Issues considered included management procedures for estimating bycatch limits for small cetaceans, assessing population and stock structure in small cetaceans, improvements in the procedure for reporting on favourable Conservation Status (FSC) under the EU habitats Directive, and developing a framework for monitoring and surveillance of European marine mammal populations.

A review of the ASCOBANS/HELCOM Working Group (WG) on common dolphin population structure in the Northeast Atlantic was conducted. The WGMME concurred with the recommendation that only one common dolphin population inhabits the Northeast Atlantic, although the distributional range of the population is unknown. A separate Iberian harbour porpoise population has recently been identified using genetic analysis and the WGMME strongly recommended that this population be given a high priority for conservation. The WGMME also strongly recommended immediate action by the Spanish and Portuguese governments in monitoring and conserving the Iberian harbour porpoise population.

New data from the SCANS II and CODA projects were reviewed and the WGMME concurred with the recommendation to use the *Catch Limit Algorithm* approach for estimating bycatch limits for small cetaceans.

The WG noted that the continuation and establishment of national observer bycatch programmes is extremely important in order to obtain current estimates of incidental capture for all marine mammal species. The WG also noted the need for the continuation of surveys such as SCANS II and CODA at least every 5-10 years in order to estimate absolute abundance.

Initial development of a European framework for surveillance and monitoring of marine mammals was undertaken. While it is clear that monitoring of abundance, bycatch and health status may reasonably form the core of surveillance for cetaceans, the importance of other types of information (e.g. life history data) and monitoring of specific threats (e.g. offshore construction) should also be recognised when designing a surveillance strategy. Further, monitoring programme design should take account of new findings on the target stock's structure.

The 2009 ICES Annual Science Conference (ASC) was held in Berlin, Germany, 21-25 September 2009. Some sessions were designed with marine mammals included as an integral part. A number of sessions were of relevance to the Committee, including those describing:

(1) advances in marine ecosystem research;
(2) comparative study of climate impact on coastal and continental shelf ecosystems in the ICES area;
(3) habitat science to support stock assessment;
(4) avoidance of bycatch and discards; and
(5) ecological foodweb and network analysis.

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

4.3 Inter-American Tropical Tuna Commission (IATTC)

No observer for the IWC attended the 2009 meeting of IATTC.

4.4 International Commission for the Conservation of Atlantic Tunas (ICCAT)

The report of the IWC observer to the 21st meeting of ICCAT is given as IWC/62/4J. The critical status of some stocks was highlighted, including the bluefin tuna, and measures adopted to allow the rebuilding of stocks as well as measures to improve the management frameworks and status for swordfish and albacore. The Committee thanked Corrêa for attaneding the meeting on its behalf.

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

The report of the IWC observer at the 28th Meeting of the CCAMLR Scientific Committee (CCAMLR-SC), held in Hobart, Australia from 23-27 October 2009 is given as IWC/61/4A. The main items considered at the CCAMLR meeting of relevance to the IWC included: (1) fishery status and trends of Antarctic fish stocks, krill, squid and stone crabs; (2) incidental mortality of seabirds and marine mammals in fisheries in the CCAMLR Convention Area; (3) harvested species (krill, fish, and stone crabs and their assessment); (4) ecosystem monitoring and management; (5) management under conditions of uncertainty about stock size and sustainable yield; (6) scientific research exemption; (7) CCAMLR Scheme of International Scientific Observation; (8) new and exploratory fisheries; (9) joint CCAMLR-IWC workshop with respect to ecosystem modelling in the Southern Ocean; and (10) the CCAMLR performance review.

Marine Protected Areas were discussed in detail. The area of the southern South Orkney shelf and the Seasonal Pack-ice Zone and part of the Fast Ice Zone south of the Shelf was the first MPA designated by CCAMLR. The following milestones were previously agreed: (1) by 2010, collate relevant data for as many of the 11 priority regions as possible; (2) by 2010, submit proposals on a representative system of MPAs to the CCAMLR Commission; (3) by early 2011, convene a workshop to review progress, share experience and determine a work programme for the identification of MPAs; and (4) by 2011, submit proposals for areas for protection to the CCAMLR-SC.

Two reports of cetacean-fisheries interactions in the Southern Ocean were received by CCAMLR in 2009: (1) a killer whale hooked on a line was dead when brought to the surface; and (2) a sperm whale hauled up dead after being caught in discarded fishing gear on the seabed.

The Committee thanked Kock for attending on its behalf and **agrees** that he should represent the Committee as an observer at the next CCAMLR-SC meeting.

4.6 Southern Ocean GLOBEC (SO-GLOBEC)

The synthesis and analysis process under SO-GLOBEC has continued and has produced a number of papers relating cetacean distribution to prey and other environmental variables. There is no active work with respect to SO-GLOBEC at this time.

4.7 North Atlantic Marine Mammal Commission (NAMMCO)

Scientific Committee

The report of the IWC observer at the 16th meeting of the NAMMCO Scientific Committee held in Reykjavik, Iceland 19-22 April 2009 is given as IWC/62/4L.

The Working Group on Marine Mammals-Fisheries (MMFI WG) considered: (1) new developments in the quantitative description of marine mammal diet by species; (2) new developments in the estimation of energy consumption; and (3) recent developments in multi-species modelling. In light of the report of the WG, the NAMMCO SC agreed that multi-species modelling is a valid approach for understanding ecological relations between species. However, it was noted that ecosystem models have significant data requirements, many of which are currently unavailable. In order to improve the understanding of such modelling, an exercise is planned in which four different modelling approaches are used to describe the same ecosystem.

A successful survey of narwhals was conducted in East Greenland during August 2008. The abundance estimates developed from this are the first for the Scoresby Sound fjord system south to Ammassalik. The abundance estimate for narwhals in Melville Bay, developed from the 2007 survey is the first estimate from this locality. The NAMMCO SC recommended catches be set so that there is at least a 70% probability that management objectives be met for West and East Greenland narwhals, i.e. maximum total removals of 310 and 85 narwhals in West and East Greenland respectively.

At the last NAMMCO SC meeting it was recognised that the preliminary data on abundance of narwhals and white whales show higher estimates and encouraged Greenland to submit fully corrected estimates. These were submitted to and endorsed by the NAMMCO/JCNB Joint Working Group in February 2009.

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

Council

The report of the IWC observer at the 17th Annual Meeting of NAMMCO held in Tromso, Norway in September 2009 is given as IWC/61/4F. The whaling and sealing nations in the North Atlantic confirmed their commitment to ensuring the sustainable utilisation of marine mammals through science-bases management decisions, stressing the vital importance marine mammals have as renewable resources for economies and cultures across the region.

Key conclusions from the meeting relevant to IWC included:

(1) welcoming Greenland's multi-annual catch quotas for white whales and narwhal stocks;
(2) a recommendation from the NAMMCO SC that a quota of 10 humpback whales in West Greenland, including struck and lost animals, would be sustainable;
(3) initiation of an ecosystem modelling programme; and
(4) agreement to convene an expert working group to undertake a review and evaluate the whale killing data submitted to NAMMCO by Japan and to look at data and information on recent and ongoing research on improvements and technical innovations in hunting methods and gears used for the hunting of large whales in NAMMCO countries.

The Committee thanked Goodman for attending on its behalf and **agrees** that he should represent the Committee as an observer at the next NAMMCO Council meeting. Further information on NAMMCO can be found at *http://www.nammco.no*.

4.8 International Union for the Conservation of Nature (IUCN)

Cooke and Larsen, the IWC observers, reported on the considerable cooperation with IUCN that had occurred during the past year and this is given as IWC/62/4K.

Western gray whales (see also Item 10.4)

The IUCN Western Gray Whale Advisory Panel has continued its work (*http://www.iucn.org/wgwap*). The Panel had earlier advised that a seismic survey commissioned by Sakhalin Energy and scheduled for 2009 in the Astokh area be postponed, in view of the anomalous (and possibly disturbance-related) distribution of gray whales off Sakhalin in 2008. Given the apparent return to normal gray whale distribution in the area in 2009, the Panel agreed that carrying out of the survey in 2010 was acceptable, particularly in the light of the jointly developed, improved monitoring and mitigation measures and completion of the survey early in the season before large numbers of whales arrive in the Piltun feeding area.

The Panel was extremely concerned to learn that a further seismic survey is planned for July-September 2010 by the company Rosneft Shelf - Far East, to cover the Lebedenskoie field which underlies the northern part of the prime near-shore feeding ground of western gray whales The IUCN Director General has written to Prime Minister Putin urging the Russian government to order the postponement of the survey at least until 2011 to enable satisfactory mitigation measures to be put in place to minimise the disturbance to whales[1]. A draft Western Gray Whale Conservation Plan has been developed with the help of the IUCN Marine Programme as part of its Range-Wide Conservation Initiative for western Gray Whales (SC/62/BRG24).

Red List updates
Following the comprehensive updating of the Red List entries for cetaceans in 2008, the Cetacean Specialist Group has completed separate assessments of the two species of *Sotalia*, the freshwater tucuxi and the coastal marine and estuarine Guiana dolphin. Draft assessments of a number of Mediterranean subpopulations (fin whale, sperm whale, long-finned pilot whale, Risso's dolphin, striped dolphin, common bottlenose dolphin and Cuvier's beaked whale) are in review.

Asian freshwater cetaceans (see also Item 14.3)
The Cetacean Specialist Group has undertaken several initiatives in Asia over the past year. These have included, most notably a workshop in Samarinda, East Kalimantan, Indonesia in October 2009 on freshwater protected areas for dolphins; a special meeting in Phnom Penh, Cambodia in November 2009 on the conservation of Irrawaddy dolphins in the Mekong River; and a meeting in Patna, India in February 2010 to assist in the development of a national action plan for the conservation of Ganges river dolphins (*Susus*).

The Committee thanked Cooke and Larsen for their report and **agrees** that they should continue to act as observers to IUCN for the IWC. Further information on IUCN can be found at *http://www.iucn.org*.

4.9 Food and Agriculture Organisation (FAO) related meetings – Committee on Fisheries (COFI)
There was no meeting of COFI in 2010. Further information on FAO can be found at *http://www.fao.org*.

4.10 Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)
The report of the IWC observer at the 15th meeting of the CITES Conference of the Parties held 13-25 March 2010 in, Doha, Qatar is given as IWC/62/4H. There were no proposals for changing the listing of whale stocks from Appendix I to Appendix II (downlisting). There were also no proposals for changing the listing of a dolphin or whale species from Appendix II to Appendix I (uplisting).

The CITES Secretariat reviewed all of the Decisions that were in effect after the 14th meeting of the Conference of the Parties, including a recommendation to delete Decision 14.81 relating to great whales. Decision 14.81 states that 'No periodic review of any great whale, including the fin whale, should occur while the moratorium by the International Whaling Commission is in place'. The CITES Secretariat recommendation also noted that if the substance of this Decision should remain in effect, it should be considered in the context of the draft resolution on the periodic review of the Appendices.

A number of Parties opposed its deletion on the basis that the draft resolution on the periodic review had not been accepted. After a vote, the recommendation to delete the Decision was rejected.

The Committee thanked the US Government for attending on its behalf and **agrees** that it should represent the Committee as an observer at the next CITES meeting. Information on CITES can be found at *http://www.cites.org*.

4.11 North Pacific Marine Science Organisation (PICES)
The report of the IWC observer at the 18th annual meeting of PICES held 23 October-1 November 2009 in Jeju, Republic of Korea is given as IWC/62/4G. The Marine Birds and Mammals Advisory Group (AP-MBM), cosponsored by ICES held a theme session on 'integrating marine mammal populations and rates of prey consumption in models and forecasts of climate change-ecosystem change in the North Pacific and North Atlantic Oceans'. A diverse range of topics were covered, including population trends, diet, estimates of prey consumption and models of trophic impact. AP-MBM reviewed aspects of the new PICES science programme (FUTURE), specifically: (1) understanding climate change and anthropogenic impacts on marine ecosystems; (2) forecasting future ecosystem change; and (3) better communication with society. The AP reiterated its primary mission to provide advice to the PICES community about the role of marine birds and mammals in marine ecosystems. Based on its role in FUTURE the AP-MBM defined its focal points as: (1) spatial ecology of predators in marine ecosystems; (2) models of prey consumption of top predators; (3) marine birds and mammals as indicators of ecosystem change; (4) marine mammals as autonomous oceanographic sampling devices; and (5) providing advice to the PICES community.

The Committee thanked Kato for attending on its behalf and **agrees** that he should represent the Committee as an observer at the next PICES meeting. Further information on PICES can be found at *http://www.pices.int*.

4.12 Eastern Caribbean Cetacean Commission (ECCO)
No information on the activities of ECCO was provided.

4.13 Protocol on Specially Protected Areas and Wildlife (SPAW) of the Cartagena Convention for the Wider Caribbean
There were no meetings of SPAW during the intersessional period. Carlson will represent the IWC at its next meeting. Further information on SPAW can be found at *http://www.cep.unep.org/cartagena-convention*.

4.14 Indian Ocean Commission (IOC)
No information on the activities of IOC was provided. Further information on the IOC can be found at *http://www.coi-ioc.org*.

4.15 Permanent Commission for the South Pacific (CPPS)
No information on the activities of CPPS was provided. Further information on CPPS can be found at *http://www.cpps-int.org*.

4.16 International Maritime Organisation (IMO)
The report of the IWC observer at the General Assembly of the IMO held 23 November-4 December 2009 is given as IWC/62/4I. The proposed Agreement of Cooperation between IMO and IWC was approved, which means that the IWC now has definitive IMO observer status. While the impetus for closer co-operation between IMO and IWC was in relation to ship strikes on cetaceans, there are a number of other issues of potential mutual relevance including habitat degradation and noise from shipping. Discussions on

[1]See *http://www.iucn.org/wgwap/wgwap/public_statements/* for the text of this and other letters.

collisions with whales and underwater noise from shipping took place within the Marine Environment Protection Committee (MEPC) at its 59th session held in July 2009 and 60th session held in March 2010.

The MEPC has had 'noise from commercial shipping and its adverse impact on marine life' on its work programme since 2008. A correspondence group was established to identify and address ways to minimise the introduction of incidental noise into the marine environment from commercial shipping to reduce the potential adverse impact on marine life and in particular develop voluntary technical guidelines for ship-quieting technologies as well as potential navigation and operational practices. The IWC Secretariat is a member of this group.

The Committee thanked the IWC Secretariat for its report and **agrees** that it should represent the Committee at the next IMO meeting. Further information on IMO can be found at *http://www.imo.org.*

4.17 Other

An update was received on conservation in the Southeast Pacific under the framework of the Lima Convention and is given as IWC/62/4C. In January 2010 the 16th Meeting to the Parties to the Lima Convention was held in Guayaquil, Ecuador. The five member countries (Chile, Colombia, Ecuador, Panama and Chile) reviewed the activities regarding implementation of a Plan of Action for the Conservation of Marine Mammals in the Southeast Pacific (PAMM). The PAMM was formed to help countries to improve their policies on marine mammals' conservation and to develop activities that require regional cooperation.

In 2009 five pilot projects to mitigate the impacts of fishing activities were conducted: (1) implementation of actions for the conservation of the Chilean dolphin in the zone of Constitucion; (2) study to mitigate impact of the incidental entanglement of coastal cetaceans in the Columbia Pacific; (3) preliminary assessment of the interaction of cetaceans with artisanal fisheries in the Machalilla National Park, Ecuador; (4) reduction of the impact of gillnets on cetaceans in coastal waters within the Gulf of Chiriqui; and (5) study to test the use of pingers to reduce the incidental bycatch of small cetaceans in Peru.

As a result of these projects, a document entitled 'Efforts to mitigate the impact of fishing activities on cetaceans in the Southeast Pacific countries' will be published.

The first phase of a biodiversity and MCPA information system (SIBIMAP-PSE) was finalised. This is an online tool for searching and downloading information crucial for management and conservation of cetaceans, sea turtles and MCPA in the Southeast Pacific. The module on cetaceans is now complete.

A workshop on legal aspects of whalewatching was planned for March 2010, but was postponed until late 2010 due to an earthquake in Chile.

The Committee thanked Felix for his report and **agrees** that he should represent the Committee at future activities related to cetacean conservation in the Southeast Pacific under the framework of the Lima Convention.

5. REVISED MANAGEMENT PROCEDURE (RMP) – GENERAL ISSUES

5.1 Review MSY rates

5.1.1 Report of the intersessional workshop

The Committee has been discussing maximum sustainable yield rates (MSYR) for some time in the context of a general reconsideration of the plausible range to be used in population models used for testing the *Catch Limit Algorithm* (*CLA*) of the RMP (and see Item 5.1.2 below). At present, this range is 1% to 7% when expressed in terms of the mature component of the population. As part of the review process, information on observed population growth rates at low population sizes is being considered because Cooke (2007) noted that in circumstances where variability and/or temporal autocorrelation in the effects of environmental variability on population growth rates is high, simple use of such observed population growth rates could lead to incorrect inferences being drawn concerning the lower end of the range of plausible values for MSYR.

A Third Workshop was held intersessionally to examine whether the observed levels of variation in baleen whale reproduction and annual survival rate parameters were sufficiently large that biases of the nature identified from population models incorporating environmentally-induced variability might be of concern (SC/62/Rep2; Annex D, item 2.1.1).

At the Workshop, an analytical approach was developed and followed to estimate the coefficient of variation (CV) and temporal autocorrelation for the selected time series of calving proportion indices and calving interval data. This information, modified appropriately, provides input for a method developed to relate variability in calving proportion to variability in the annual growth rate of a population using a population dynamics model (see SC/62/Rep2). The model can take into account environmentally-induced variability in population abundance arising from variation in annual survival rate.

The Workshop identified two further steps needed before results from this model can be used to draw inferences about the plausible ranges for the CV and temporal autocorrelation parameters describing the effects of environmental variability on population dynamics in the model of Cooke (2007). The Committee incorporated these into its work plan under this item (see Annex D, item 2.1.2).

The Workshop received a revised approach for a meta-analysis of population growth rates previously discussed (IWC, 2010b) and suggested some additional work to be completed before the 2010 Annual Meeting. Item 5.1.2 and Annex D, item 2.1.1 describe progress made on three other issues listed in the work plan for completion of the MSYR review at last year's meeting.

5.1.2 Issues arising

The Committee received SC/62/RMP3 in response to the Workshop recommendations to: (1) apply the age-structured model of SC/62/Rep2, Annex D to all of the datasets assembled during the Workshop to estimate the resultant CV and temporal auto-correlation in growth rate; and (2) to conduct further tests of the Bayesian meta-analysis approach. More details are given in Annex D, item 2.1.2.

The Committee **agrees** that this Bayesian approach was an acceptable basis to compute a posterior distribution for r_0, once the inputs needed to apply it become available. It also **agrees** that account will need to be taken that the estimates of lower posterior percentiles from this method are positively biased, before making recommendations regarding appropriate values for MSYR for use in trials.

SC/62/RMP2 and SC/62/RMP4 responded to recommendations to use the environmental variability model of Cooke (2007) to provide CVs and temporal autocorrelation estimates for the growth of the population from one year to the next for the standard set of scenarios and to use this model to determine the predicted relationship between the length of series and the estimated level of variability in the population rate of increase. More details are given in Annex D, item 2.1.2. The Committee **agrees** that it now has a basis to link variability in demographic processes with the inputs of the Cooke (2007) model.

Efforts to fit models that account for both process and observation error to the data on calving rates and calving intervals had encountered numerical problems intersessionally The Committee **endorses** a work plan to address this (Annex D, Appendix 2) and looks forward to seeing the results of this work next year.

The Committee discussed how to relate variation in net recruitment rate, which depends on variation in both survival and reproduction, to variation in reproductive rates alone. Details are given in Annex D, item 2.1.2. The Committee considered the question of correlations between survival and reproductive rates to be potentially important for the question of estimating typical levels of variation in net recruitment rate for baleen whales, but **agrees** that more analysis is required before any general inference can be drawn. It **requests** in particular:

(1) a literature review with regard to the question of the circumstances under which correlations between survival and reproductive rates would be negative or positive;
(2) more extensive modelling to cover the full range of parameter values deemed to be plausible for baleen whales in order to determine whether general inferences can be drawn, or at least to identify the circumstances where substantial correlations of a specific sign would be expected;
(3) direct estimation of variability in survival rates to the extent that this is possible.

The Committee **agrees** that if results from this work are available at its next meeting, then they should be taken into account in its deliberations with respect to the level of variability in baleen whale demography. However, that lack of results will not preclude the Committee from completing its review of MSY rates next year.

The Committee considered the extent to which genetic data could place bounds on fluctuations in population size for some examples of trajectories arising for the environmental variation model of Cooke (2007). It recognised the potential of genetic methods to inform its deliberations on the plausible range of MSYR values, but **agrees** that these methods could not be used during the current review. However, it **recommends** that the number of haplotypes in whale populations, along with other population and demographic measures should be assembled since this might inform the current review. The Committee **encourages** completion of a compilation already initiated by Brownell.

The Committee also **agrees** that although the use of time-series of abundance estimates for species other than whales to make inferences regarding the extent of variation and the temporal auto-correlation of the rate of growth remained a good idea, the lack of such time-series at present means that this source of information cannot be pursued during the current review.

In conclusion, although considerable progress was made during the current meeting, the Committee was once again not in position to complete the review. It established a work plan (see Annex D, item 2.5) to address the final issues that need to be examined to complete the review at next year's meeting.

It **agrees** that the review will be completed at next year's meeting on the basis of the data and analyses available. It **accepts** that it is not appropriate to keep extending the time available for the review, particularly given its importance to Item 5.2 below.

5.2 Finalise the approach for evaluating proposed amendments to the *CLA*

The Committee noted that it could not complete discussions on amendments to the *CLA* until the range for MSYR values in the RMP was completed. Regarding the Norwegian proposal for amending the *CLA*, it was noted that all of the relevant trials/results had been presented in Aldrin and Huseby (2007), but that evaluation of this proposal could not occur until the review of MSY rates was complete.

5.3 Version of *CLA* to be used in trials

SC/62/RMP10 examined the sensitivity of catch limits to the level of accuracy when computing posterior distributions using the *CLA*. Four versions of programs used to implement the *CLA* were discussed. More details are given in Annex D, item 2.1.2.

The Committee **endorses** the recommendations in SC/62/RMP10 that: (a) only the Norwegian version of the *CLA* should be used when conducting future trials; (b) the Second Intersessional Workshop in an *Implementation* or *Implementation Review* will need to be carefully scheduled to ensure that all trials can be run before it takes place; (c) if special circumstances arise when it becomes necessary to run additional trials during a meeting (e.g. during the Second Intersessional Workshop), the 'intermediate' version of the Cooke implementation that is more accurate than the 'trials' version (but less accurate than the 'accurate' or Norwegian version) be used for this purpose and the results confirmed using the Norwegian 'CatchLimit' program after the meeting; and (d) a full set of revised results from the trials for North Atlantic fin whales, Western North Pacific Bryde's whales; and North Atlantic minke whales should be run using the Norwegian 'CatchLimit' program and the results placed on the IWC website.

5.4 Updates to RMP specification and annotations

In the context of applying the RMP pursuant to Item 20, the Committee identified some issues where updating and clarification of the specifications of the RMP and the accompanying annotations and guidelines was warranted (see Annex D, item 2.4).

(1) The provision for the adjustment for sources of human-caused mortality other than commercial catches, as recommended by the Scientific Committee in 2000 (IWC, 2001f, p.91), should be included in the RMP with the qualification specified by the Commission (IWC, 2001b) that the provision be limited to mortality due to bycatches, ship strikes, non-IWC whaling, scientific permit catches, and indigenous subsistence whaling. A new annotation should be added to provide the Committee with operational guidelines to implement this provision.
(2) The maximum period of validity of catch limit calculations should be extended from five to six years to be consistent with the six-year cycle of surveying specified in section 3.2.2 of the RMP, as currently implemented for minke whales in the North Atlantic.
(3) The rule for rounding of catch limits to a whole number of whales should be clarified.

(4) The guidelines for conducting surveys under the RMP and those for *Implementing* the RMP (IWC, 2005b; 2005c) should be modified to clarify that changes to the guidelines are not retroactive. That is, results from surveys conducted in accordance with earlier version of the guidelines would not become inadmissible for use in the RMP when the guidelines are changed.

Proposed amendments to the RMP and its annotations to address these issues are given in Annex D, Appendix 5, along with some background information. The Committee **recommends** adoption of these amendments to the RMP specification and annotations. The Committee further **requests** the Secretariat to prepare a proposal to next year's meeting to update the guidelines for conducting surveys and for *Implementations* to accommodate point (4) in Annex D, item 2.4.

Several amendments to the RMP specifications and annotations had been adopted since the most recent published version (IWC, 1999e). These are listed in Annex D, Appendix 5. The Committee **agrees** that the consolidated revised version be published in full in the next supplement to *J. Cetacean Res. Manage.*

6. RMP – *IMPLEMENTATIONS* AND *IMPLEMENTATION REVIEWS*

6.1 Western North Pacific Bryde's whales

6.1.1 Complete Implementation

6.1.1.1 RESEARCH PROPOSAL FOR THE 'VARIANT WITH RESEARCH'

The Committee had agreed in 2007 (IWC, 2008b) that three of the four RMP variants (1, 3 and 4) considered during the *Implementation* for western North Pacific Bryde's whales performed acceptably from a conservation perspective and recommended that those variants could be implemented without a research programme. It also agreed that variant 2 was only 'acceptable with research' because conservation performance was 'unacceptable' on three 'medium' plausibility trials incorporating stock structure hypothesis 4 i.e. two stocks of Bryde's whales in the western North Pacific, one of which consists of two sub-stocks (stock structure hypothesis 4).

In 2008, the Committee reviewed a research proposal (Pastene *et al.*, 2008) that aimed to determine whether or not sub-stocks occur in sub-area 1. Based on this review, the Committee had recommended that the *Implementation Simulation Trials* for the western North Pacific Bryde's whales be used to determine whether differences in age-compositions between sub-areas 1W and 1E could be used to resolve whether there are sub-stocks in these sub-areas and that results from previous (and any new) power analyses that assess the use of genetic methods to evaluate stock structure hypothesis 4 be included in the revised proposal.

This year, the Committee received a revised research plan (Annex D, Appendix 6) and welcomed work done to address several of its earlier recommendations. The results of the *Implementation Simulation Trials* showed that recent age structure data would not be able to distinguish between scenarios in which there is or is not age-structuring in sub-areas 1W and 1E.

The Committee **recommends** that the proposal be revised further and, in particular, that the power analyses focus more clearly on the specific hypotheses for the Western North Pacific Bryde's whales. The Committee was informed that a revised proposal will be presented next year that will focus to a greater extent on the use of genetic data.

6.1.2 Recommendations and work plan

The Committee **agrees** that its work plan for the 2011 Annual Meeting would be to review the revised research proposal for the 'variant with research'.

6.2 North Atlantic fin whales

6.2.1 Complete Implementation

Last year, the Committee had agreed that if the RMP is implemented for this species in this Region, variants 1, 3, 4, 5 and 6 (see Table 4 of IWC, 2010d) can be implemented without an associated research programme but that variant 2 (sub-areas WI+EG are a Small Area) was only acceptable with research.

This year, comparison of results from different versions of the *CLA* (see Item 5.2) revealed that variant 3 (sub-areas WI+WG+EI/F are a *Small Area*) does not have 'acceptable' performance for some of the trials and can no longer be considered to be acceptable without research but is rather only 'acceptable with research'.

Last year, the Committee had confirmed that use of variant 2 for ten years followed by variant 1 (sub-area WI is a *Small Area*) led to performance which was 'acceptable' for all trials and consequently that the requirements for stage 1 of the process for implementing a 'variant with research' had been met. The second stage of the process was for Iceland to demonstrate to the satisfaction of the Committee that a research programme has a good chance (within a 10-year period) of being able to confirm or deny that stock structure hypothesis IV is implausible.

The Committee received a research proposal (SC/62/RMP1) that followed the *pro forma* agreed by the Committee in 2007. Details are given in Annex D, item 3.2.2.

The Committee welcomed the proposal, noting that it was not final and that Iceland was inviting suggestions for how it can be improved. In discussion, it noted that the aim of the proposal should be to assess the probability of hypothesis IV relative to the probabilities for the other stock structure hypotheses. It noted that the *Implementation Simulation Trials* could be used to assess the effect sizes on which the power analyses are based.

In particular, the Committee **recommends** that the lowest rate at which the C sub-stocks mix in sub-areas EC, WG, EG, WI, EI+F, and N and the performance of variant 2 is 'acceptable' for all trials should be calculated and used when conducting power analyses. It further **recommends** that quantitative analyses along the lines of Appendix 3 of SC/62/RMP1 be conducted for each of the stock structure hypotheses.

6.2.2 Recommendations and work plan

The Committee **agrees** that its work plan for the 2011 Annual Meeting would be to review a revised research proposal for the 'variant with research' and to review any abundance estimates for use in the *CLA*.

6.3 North Pacific common minke whales

6.3.1 Initiate pre-Implementation assessment

In 2009, the Commission had agreed that the Scientific Committee should follow the option in its report (IWC, 2010e) that specified completing a full *Implementation Review* as soon as possible, ideally by the 2012 meeting. This timeline will be possible only if the *pre-Implementation assessment* can be completed this year. The Committee was undertaking a *pre-implementation assessment*, rather than immediately commencing an *Implementation Review*, because the 2003 *Implementation* had been conducted before the existing guidelines for *Implementations* had been developed and had focused primarily on 'O' stock.

Committee guidelines for *Implementations* (IWC, 2005b) state that the main focus of a *pre-Implementation assessment* is:

> 'the establishment of plausible stock hypotheses consistent with the data that are inclusive enough that it is deemed unlikely that the collection of new data during the *Implementation* process will suggest a major novel hypothesis (e.g. a different number of stocks) not already specified in the basic *Implementation Simulation Trial* structure.'

Additional foci are examination of available abundance estimates and information on the geographical and temporal nature of 'likely' whaling operations and future levels of anthropogenic removals other than due to commercial whaling.

The importance of creating a document that lists the various datasets and other information available for the *pre-implementation assessment* was recognised (this is normally provided by national scientists in the case of a new request for a *pre-Implementation assessment)*. This will be a living document, at least until the deadline is established for the consideration of no new data for the *Implementation Review* (this occurs at the First Intersessional Workshop although new *analyses* may be presented at the First Annual Meeting). A table containing this information is given in Annex D1, Appendix 2.

6.3.1.1 STOCK STRUCTURE

The goals for the *pre-Implementation assessment* with respect to stock structure were to agree to a set of inclusive plausible hypotheses consistent with the data, and to ensure that the types of information needed for the *Implementation Review* were available. Assessing the relative plausibility of alternative hypotheses regarding stock structure will be considered at the First Annual Meeting of the *Implementation Review*.

The Committee briefly discussed minimum standards for plausibility. It **agrees**, as it has in the past, that the most reasonable approach is to use best professional judgment and common sense, after considering all relevant information.

The Committee first reviewed past discussions on stock structure for western North Pacific minke whales. Details are given in Annex D1, item 5.1.

The Committee then received a number of papers providing new information relevant to stock structure. Details of these and the considerable discussions that ensued are given in Annex D1, item 5.3. The following summary focuses on issues where the Committee made specific statements.

SC/62/NMP22 provided results of a biopsy skin-sampling survey in July-August 2009 in the Okhotsk Sea. Unfortunately, none of the five biopsy samples taken could be removed from Russian waters because of CITES-related restrictions. This is discussed further under Annex D1, item 7.6. In spite of this, the Committee was pleased that that this research had been conducted within the Russian EEZ, and that it had been possible to collect biopsy samples from minke whales on the feeding grounds. The Committee **encourages** future collaborations and **strongly urges** all concerned to find ways to solve these CITES-related issues.

SC/62/NPM10 estimated the mixing proportion of 'O' and 'J' stocks in the Sea of Okhotsk using cookie-cutter shark scars from 22 animals. Based on previous research in sub-area 11 in 1996 and 1999, the maximum likelihood estimate for the proportion of 'J' stock in sub-area 12 was 0. The Committee welcomed this valuable new information, but **agrees** that the method used to estimate mixing proportions needed some refinement.

SC/62/NPM13 reviewed non-genetic biological information relevant to the stock structure of minke whales in the Yellow Sea, Sea of Japan (East Sea), and western Pacific Ocean. The review was structured to examine four key comparisons between: (1) the Yellow Sea and the Korean coast of the Sea of Japan; (2) the Korean and Japanese coasts in the Sea of Japan; (3) the Sea of Japan and Pacific coasts of Japan; and (4) coastal and offshore areas of the Pacific Ocean. The Committee welcomed this attempt to synthesise diverse types of non-genetic information that potentially can inform discussions of stock structure and found the idea of orienting the analyses around four key questions useful. The authors acknowledged that although they had attempted to be exhaustive, they might have missed some relevant biological information, particularly if it was reported outside the IWC context, and requested that any such information be forwarded to them. The Committee in particular supported the collation of information in table 3 in SC/62/NPM13 and **encourages** members to work together to complete this and provide it to the First Intersessional Meeting of the *Implementation Review*.

The Committee reconsidered Hatanaka and Miyashita (1997) that investigated feeding migration based on length data. It was pointed out that these data are consistent with the generic concept of an 'O' stock, and that the length data might be useful for mature/immature determinations to condition different migration patterns for one or more 'O' stocks. The Committee **agrees** to include these data in Annex D1, Appendix 2.

SC/62/NPM11 had two major objectives: (1) to determine the status of whales that could not be identified reliably to 'O' or 'J' stock based on analyses described in Kanda *et al.* (2009); and (2) to examine stock structure of the 'J' stock in the Sea of Japan and Yellow Sea. The Committee **appreciates** the efforts of the authors to respond to some of the suggestions for additional analyses made last year.

Two papers presented new analyses of mtDNA data. SC/62/NPM21 examined genetic variation at the mtDNA control region to evaluate the plausibility of proposed stock structure scenarios for the 'J' and 'O' stocks. SC/62/NPM20 reported on differences in mtDNA sequences and sex ratios in western North Pacific minke whales by combining information from samples collected in Korean market surveys with three Japanese datasets made available through the IWC Data Availability Agreement. SC/62/NPM27 commented on the analyses conducted in SC/62/NPM20. In discussion, it was clarified that although SC/62/NPM20 and SC/62/NPM27 largely considered the same group of samples, there were two important differences: (1) SC/62/NPM20 used market samples for Korean samples, while SC/62/NPM21 used bycatch; and (2) SC/62/NPM21 used mtDNA data that had been error-corrected subsequently whereas due to time constraints and the agreed deadlines for *pre-Implementation assessment*. SC/62/NPM20 used the original data and grouped haplotypes into haplogroups to minimize influence of the sequencing errors.

In further discussion of standards for establishing/rejecting hypotheses, the Committee **agrees** that it is important but challenging to try to find a balance between two potential errors: (1) interpreting minor differences that might be artefacts or not biologically meaningful as evidence for separate stocks; and (2) failing to recognise true stock structure because power to resolve closely related populations is low.

Discussion of these issues highlighted divergent opinions within the Committee regarding how best to deal with the inability to sample populations on their breeding grounds. In one view, the best way to approach this problem is to use results of the program *STRUCTURE* (Pritchard *et al.*, 2000) which is designed to deal with situations in which there are no reliable *a priori* ways of grouping individuals into putative populations. The other view was that this approach has elements of circularity and can result in a false sense of confidence in model results and that *STRUCTURE* has a documented inability to provide reliable results when dealing with mixtures of closely related populations. These issues have arisen previously regarding earlier versions of the genetic data analyses for North Pacific minke whales (IWC, 2010e).

The Committee **agrees** on the potential value of trying to collect samples in areas where a single stock is believed to occur, but recognises the difficulty in identifying the location of these.

Following presentation and discussion of new information, the Committee reviewed and discussed two independent attempts to generate plausible stock-structure hypotheses that synthesised both genetic and non-genetic information. The summaries of these papers and the ensuing discussion are below.

SC/62/NPM12 examined recent progress in the development of stock structure hypotheses for western North Pacific common minke whale ('O' and 'J' stocks), and conducted a preliminary evaluation of these hypotheses in the context of the available scientific information, mainly genetics, presented and discussed by the Committee in recent years. The aim was to identify stock structure scenarios that are consistent with the data. The authors of SC/62/NPM12 considered that the best available scientific evidence is consistent with the hypothesis that there is a single 'J' stock distributed in the Yellow Sea, Sea of Japan and Pacific side of Japan and a single 'O' stock in sub-areas 7, 8 and 9. They considered this hypothesis the most plausible. It is consistent with the pattern of mixing between 'J' and 'O' stocks along the Japanese coast as proposed by Kanda *et al.* (2009), the migration patterns of adult and juvenile 'J' stock whales as suggested by SC/62/NPM1, and the migration of 'O' stock whales as suggested by Hatanaka and Miyashita (1997). SC/62/NPM12 postulated three less plausible hypotheses which modify the most plausible scenario as follows:

(1) a W-stock sporadically intrudes into sub-area 9;
(2) a different stock (Y-stock) resides in the Yellow Sea and overlaps with 'J' stock in the southern part of sub-area 6; and
(3) a W-stock sporadically intrudes into sub-area 9 and a Y-stock resides in the Yellow Sea, and overlaps with 'J' stock in the southern part of sub-area 6.

These four hypotheses are further described and shown graphically in Annex D1, Appendix 3.

SC/62/NPM15 reviewed genetic and non-genetic data regarding stock structure; the authors summarised their conclusions in the context of addressing four key questions, as follows.

(1) Are whales in the Yellow Sea part of a population that migrates into the Sea of Japan?
SC/62/NPM15 summarised that migration north into the Yellow Sea, the presence of mature whales and cow/calf pairs there, and the fact that Yellow Sea whales have only autumn conception dates (n=124), provides evidence that a separate stock exists there. The Korean coast of the Sea of Japan showed some evidence for a mixture of two stocks, and microsatellite DNA showed seasonal differences that might be explained by a Yellow Sea stock moving along the Korean coast only in summer. In summary, the authors consider that the available data suggest that Yellow Sea whales may not be a part of the Sea of Japan stock.

(2) Are whales along the Korean coast part of the same population as whales along the western Japanese coast?
SC/62/NPM15 summarized that there is no obvious hiatus in distribution between the two coasts, and that genetic analyses showed mixed results (haplogroup and *STRUCTURE* found no difference, pair-wise mtDNA and microsatellite DNA found differences). A small sample (n=8) from the Sea of Japan showed a bimodal distribution of conception dates and a larger sample (n=63) showed two different flipper colour patterns, but these data could be explained by a mixture of whales coming into the northeast Sea of Japan from the Sea of Okhotsk. No sex bias or haplogroup-by-sex differences were found for Japanese Sea of Japan bycatch, suggesting a possible year-round presence of a non-migratory coastal stock. In summary, the authors consider that it is plausible there are different stocks on either side of the Sea of Japan, but the data are somewhat contradictory or are lacking in sufficient resolution or spatial extent to make definitive conclusions. Some genetic evidence suggesting a second stock could be most simply explained by whales from a Yellow Sea stock appearing along the coast of Korea in summer.

(3) Are so-called 'J-type' whales on the east coast of Japan the same population as on the west coast of Japan?
The majority of whales bycaught on the southern Pacific coast of Japan (sub-area 2) are assigned to be J-type and so are either part of a Sea of Japan stock or are a coastal stock separate from a Pacific Ocean ('O') stock. Whales caught in the Pacific Ocean, even from sub-area 7 coastal areas, only have winter conception dates (n=68) and a single flipper colour type (n=77); if coastal sub-area 7 had a mixture of stocks there should be autumn conception dates and a mixture of flipper colour types. There are differences in microsatellite DNA and mtDNA between the two coasts of Japan when all samples are used. Additionally, the southern Pacific coast bycatch (sub-area 2) is genetically different from bycatch along the northern Pacific coast of Japan (sub-area 7), suggesting a Pacific coastal stock might be distributed only in the Kuroshio current, and does not occur further north in the Oyashio current. In summary, the authors consider that it is plausible that there are different coastal stocks on either coast of Japan, and/or longitudinally along the Pacific coast.

(4) Is there a coastal population in Subarea 7 (east of Hokkaido and northern Honshu) that is different from offshore minke whales in the Pacific Ocean, even after accounting for Sea of Japan whales that might migrate into this area?
One hypothesis is that there is a 'pure' Sea of Japan stock (J-type whales) and Pacific Ocean stock (O-type whales). Under that hypothesis, genetic differences between Pacific coastal waters (sub-area 7W) and other areas have been interpreted to be a mixture of these two stocks. An alternate hypothesis is that this area contains a distinct stock characterised by intermediate haplotype frequencies, as seen in humpback whales, for example. Again, the lack of evidence of autumn conception dates (n=68) and a mixture of flipper colour types (n=77) in the Pacific Ocean argues

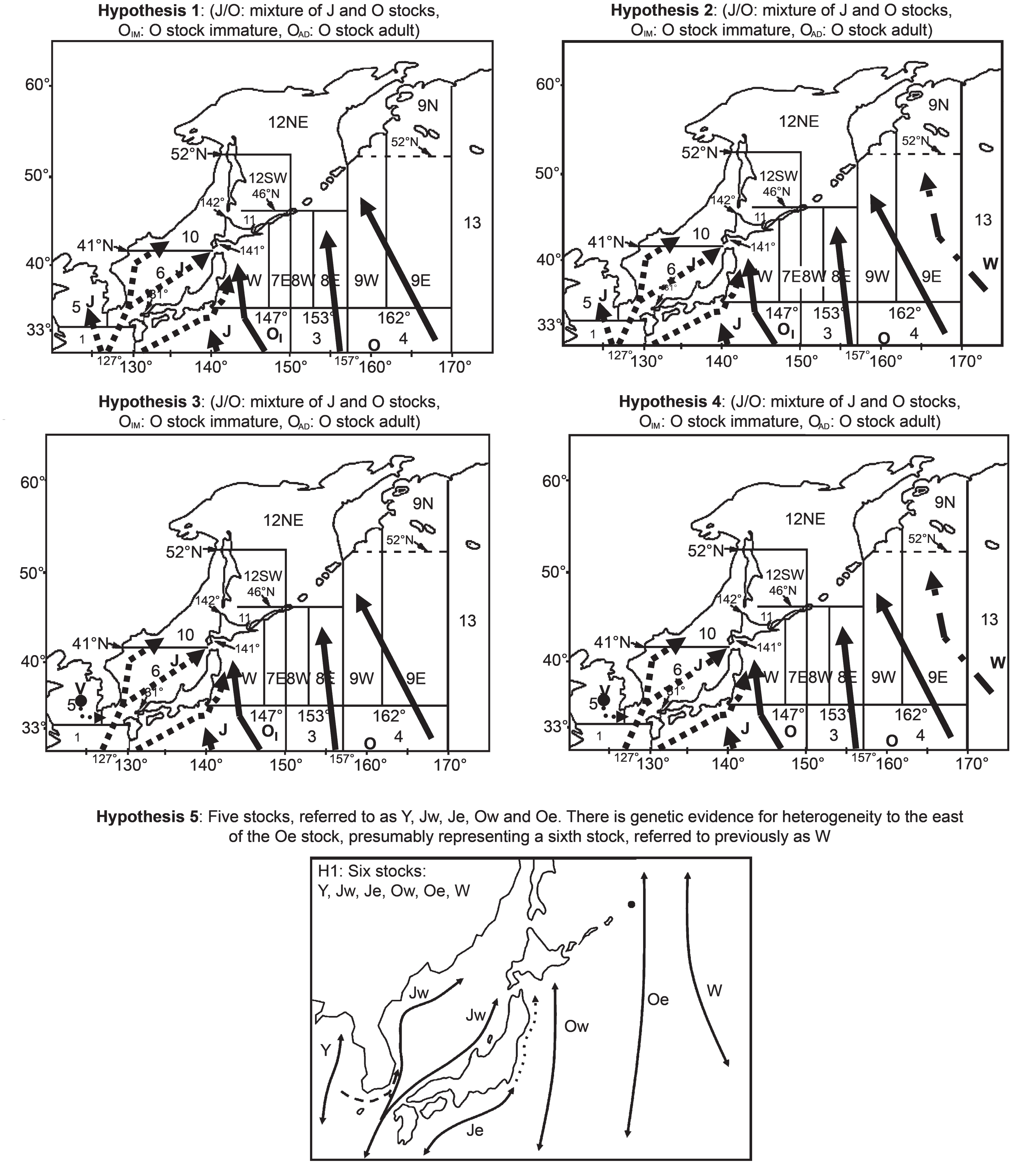


Fig.1. Five plausible stock structure hypotheses for North Pacific minke whales.

against there being a mixture of stocks in coastal Pacific areas. Although it is possible that the haplotype frequencies of sub-area 7W could be explained by a complex seasonal, sex- and age-biased mixing of 2 stocks, e.g. a 'core J' and a 'core O', it is not as parsimonious as the hypothesis of a distinct stock with intermediate haplogroup frequencies. The absence of a strong haplogroup-by-sex interaction in coastal waters is inconsistent with the prediction of a sex-biased mixing of two stocks. SC/62/NPM30 concluded that there was genetic heterogeneity in the Pacific Ocean, with a strong signal in the coastal area east of Hokkaido. In summary, the authors consider that it is plausible that the unique genetic signals seen in coastal waters of the Pacific coast of Japan are due to the existence of a distinct coastal stock or stocks, rather than a mixture of a 'pure J' and a 'pure O' stock.

An additional stock-structure hypothesis based on consideration of the four questions posed above is that there are six stocks (Y, J_W, J_E, O_W, O_E, and W); this is described and shown graphically in Annex D1, Appendix 4.

In discussion, there was general agreement on answers to two of the key questions posed by SC/62/NPM15: (1) a separate J-like stock (denoted Y-stock) occurs in the Yellow

Sea and in at least some years some Y-stock whales are found in the Sea of Japan; and (2) minke whales on the east coast of Korea and on the west coast of Japan are generally part of a single stock.

In contrast, substantial disagreements remained concerning the other two questions. These disagreements centred on how to interpret results of statistical tests showing heterogeneity of allele frequencies. In one view, the results can be explained by overlapping distributions of 'O' and 'J' stock, which leads to different mixing proportions (and hence different allele and haplotypic frequencies) in different geographic areas. Under this hypothesis, it would not be surprising that comparisons of samples from areas having different fractions of the two stocks often produce statistically significant results. An alternative view to an explanation that requires complex mixing patterns is the hypothesis that the statistically significant differences reflect a distinct stock with intermediate gene frequencies.

In conclusion, in spite of the disagreements noted above, the Committee **agrees** that the set of stock-structure hypotheses based on the four proposed in Annex D1, Appendix 3 and the fifth proposed in Annex D1, Appendix 4 were inclusive and sufficiently plausible at least to take forward to the next step in the *Implementation* process (see Fig. 1).

6.3.1.2 CATCHES

The Committee noted that information was available on commercial catches for those countries that have taken the largest catches of western North Pacific minke whales. There are, however, limited data on catches for the People's Republic of China and no catch data for North Korea (if North Korea has taken western North Pacific minke whales).

The Committee reviewed information regarding incidental catches.

SC/62/NPM4 provided information on incidental catches of common minke whales off Japan and Korea. Some suggestions were made on how plausible estimates of future incidental catches can be made, as well as to how past series, now considered erroneous, can be constructed. The Committee noted that it would be useful if estimates were presented to the Preparatory Meeting for the First Intersessional Meeting of the *Implementation Review* (see Item 6.3.2 and Annex D1, item 11.2).

SC/62/NPM19 provided information on bycatch of minke whales in Korean waters from 1996 to 2008. The authors collected bycatch data from the 14 local branch offices of the Korea Coast Guard which investigates the bycatch of cetaceans. A total of 1,156 minke whales were bycaught of which 83.7% were bycaught in the East Sea; 363 animals were entangled or trapped by set nets, 316 and 303 were entangled by fish pots and gillnets, respectively.

SC/62/NPM26 provided information on incidental catches off Korea based on DNA profiling of market products (discussed under Annex J, item 9.4), which suggested that reported bycatch totals may be underestimated. The Committee was informed that the large majority of the incidental catch off Japan was taken in set nets; 119 common minke whales were bycaught in set nets and one animal in a gill net during 2009 (SC/62/ProgRepJapan).

The Committee **recommends** that available data on incidental catches and the associated effort should be analysed to develop CPUE series for possible use during the *Implementation Review*. The Committee **agrees** that sufficient information is available that alternative hypotheses regarding time-series of historical commercial and incidental catches can be developed during the *Implementation Review*. The Committee **agrees** that during the *Implementation Review* there is sufficient information to disaggregate the historical commercial and incidental catches to sub-areas and periods during the year.

The Committee received information on likely future whaling operations for minke whales in the western North Pacific. Japan aims to conduct land-based and pelagic whaling. Land-based whaling will be restricted to close to Japan while pelagic whaling will occur mainly in offshore areas. Temporal and spatial restrictions will be imposed on both types of whaling to try to reduce catching J-type animals. Korea intends to conduct land-based whaling to the east and west of Korea from March to November. These whaling plans will need to be elaborated further during the First Intersessional Workshop of the *Implementation Review*.

The work related to catches that needs to be completed prior to the Preparatory Meeting for the First Intersessional Workshop of the *Implementation Review* is:

(1) construction and GLM standardisation of CPUE series using the incidental catches and the associated fishing effort (see also Annex D1, item 8.3);
(2) development of a format for reporting incidental catches by Japanese and Korean scientists to the Secretariat and the provision of these data in the agreed format to the Secretariat; and
(3) development of alternative hypotheses regarding time-series of past and future commercial and incidental catches.

6.3.1.3 ABUNDANCE ESTIMATES

The Committee reviewed information available on abundance surveys and estimates of abundance.

SC/62/NPM2 provided estimates of abundance for the JARPN II survey area (sub-areas 7, 8 and 9, excluding the Russian EEZ) for the early (May and June) and late (July and August) seasons for 2006 and 2007. SC/62/NPM16 analyzed sightings data from recent surveys conducted by Korea in the Yellow Sea (sub-area 5) and the East Sea (sub-area 6) to estimate the abundance of common minke whales. Details are given in Annex D1, item 7.1.

SC/62/NPM24 reported on a sighting survey for minke whales and other cetaceans in the East Sea from 21 April to 30 May, 2009. An provided oversight on behalf of the Scientific Committee and the survey was undertaken in accordance with IWC guidelines. The plan had been presented to the 2008 Annual Meeting (Choi *et al.*, 2008) and was endorsed by the Committee. Details are given in Annex D1, item 7.1. The Committee expressed its appreciation to the Government of Korea for its continued commitment to surveys for minke whales in Korean waters, and to An for his role of oversight on behalf of the Committee. The Committee **agrees** that data from the 2009 survey off Korea are suitable for use in the RMP.

SC/62/NPM7 summarised the sighting surveys for minke whales in the western North Pacific conducted by Japan and Korea since 2000. The survey period for 'J' stock was April-June, and that for 'O' stock July-September. The areas covered were the Korean EEZ in sub-areas 5 and 6, the Japanese EEZ in sub-areas 6 and 10, the Russian EEZ in sub-area 10, the Sea of Okhotsk (sub-areas 11 and 12) and east of the Kurile archipelago and Kamchatka (sub-areas 8, 9 and 12), including the Russian EEZ. A total of 505 minke whale schools (560 animals) were sighted on 27,045 n.miles on primary search effort in 22 cruises.

SC/62/NPM8 updated the integrated abundance estimates for minke whales in sub-areas 5, 6 and 10 using new information on abundance and $g(0)$. SC/62/NPM14 reviewed the proposed method in SC/62/NPM8 for integrating surveys for use in the *Implementation Simulation Trials*. Details are given in Annex D1, items 7.1 and 7.3.

The Committee **endorses** the method used to combine sightings data over time to estimate the extent of additional variance, but not necessarily the methods proposed for dealing with abundance across spatial areas in this case because of concerns over migration during the survey and extrapolation (see also Annex D1, item 7.3). The Committee did not review the abundance estimates in SC/62/NPM8 *inter alia* because it is unclear whether the sub-areas used for reporting abundance estimates will be used in the *Implementation Simulation Trials* developed during the First Intersessional Meeting. It was noted that although models can be used to interpolate abundance for unsurveyed regions, if a region has never been surveyed, the abundance estimate for that region should be set to zero when calculating catch limits under the RMP.

The Committee discussed possible migration patterns of 'J' stock minke whales in the Sea of Japan, as well as whether some component of the 'J' stock may not migrate to a substantial extent, in relation to how abundance estimates are computed and used in *Implementation Simulation Trials* and when applying the *CLA*. The Committee **agrees** that care needs to be taken to avoid double-counting animals when computing abundance estimates. In relation to animals in the Sea of Japan and the Yellow Sea, the Committee **agrees** that the *Implementation Simulation Trials* will capture hypotheses regarding the migration patterns of western North Pacific minke whales and that the models underlying these trials would be specified accordingly. The abundance estimates used for conditioning will be allocated to the appropriate time periods to avoid double counting.

The Committee **agrees** that there are several abundance estimates available for possible use when conditioning trials. Annex D1, table 1 provides a summary of the sightings surveys for the sub-areas used in the last set of *Implementation Simulation Trials* and those conducted since. The Committee did not discuss the acceptability or otherwise of the use of these surveys for conditioning the *Implementation Simulations Trials*.

The Committee noted that it was not necessary to select the abundance estimates for use in the *CLA* at the present meeting; this will take place during the First Intersessional Meeting of the *Implementation Review*. The selection of abundance estimates for use in *CLA* will need to take account of whether or not the surveys and their analysis followed the Requirements and Guidelines for Conducting Surveys and Analysing Data within the RMP (IWC, 2005c). Some of these surveys (e.g. those from JARPN II) have not been reviewed by the Committee for use in the RMP.

SC/62/NPM9 provided revised estimates of $g(0)$ and abundance for western North Pacific common minke whales. The main changes from the previous analyses were the addition of new data, particularly for the Okhotsk Sea for 2003 and 2005. Details are given in Annex D1, item 7.5. The Committee welcomed this analysis which substantially reduced the previous range for $g(0)$ but there was insufficient time for an in-depth review. The Committee **agrees** to review the method used to estimate $g(0)$ and the resultant estimates further at the First Intersessional Workshop.

The Committee received information on plans for future sighting surveys by Korea and Japan (SC/62/NPM17 and SC/62/NPM4). Japan noted that it was not currently planning to conduct surveys in sub-areas 6 and 10, but may revise that decision in future. It was noted that the results of the *Implementation Simulation Trials* may provide information on which programme of surveys will lead to the best performance of the RMP, and that Japan and Korea may wish to modify their survey plans once the results of initial trials become available.

More specifically, SC/62/NPM25 described plans for a sighting survey in the Yellow Sea in April-May 2011, with the objective to obtain information on the distribution and abundance of minke whales. Details are given in Annex D1, item 7.6. The Committee was pleased to see that distance and angle estimation will be tested and **requests** that the results of analyses of these and previous data be presented to future meetings. It was noted that the survey could be conducted to eliminate the possible implications of migration during the survey. The Committee appointed An to provide oversight on behalf of the Committee.

SC/62/NPM23 described plans for a sighting and biopsy sampling survey for common minke whales in the Okhotsk Sea during summer 2010. The aim of the survey is to collect sightings data for abundance estimation and information on stock identification. To overcome CITES-related issues, genetic analysis using biopsied skin samples will be conducted on the research vessel. The Committee noted the importance of estimating the proportion of 'J' and 'O' stock animals in the survey area. It **recommends** that Japan explore ways that are not constrained by CITES to facilitate extracting relevant information from biopsy samples collected from the EEZ of Russia which could be used to examine stock structure and mixing. Specific suggestions for this are given in Annex D1, item 7.6. The Committee appointed Miyashita to provide oversight on behalf of the Committee.

6.3.1.4 OTHER ISSUES

Regarding information for estimating dispersal rates and mixing proportions, the Committee noted that SC/62/O30 outlined an approach for estimating mixing rates between stocks using microsatellite data.

Values for the biological parameters for use in *Implementation Simulation Trials* for the western North Pacific common minke whales had been assembled for the previous *Implementation* (IWC, 2004).

The previous trials were based on values for MSYR(mat) of 1% and 4%. These values should be used in any new trials unless the current review of MSY rates (Annex D, item 2) leads to a recommendation for a change to this range.

The Committee noted that CPUE data had been assembled and used to compare alternative stock structure hypotheses (Yasunaga *et al.*, 2009, Appendix II). It **recommends** that relevant commercial and incidental catch and effort data, along with the information identified by the 1987 CPUE Workshop (IWC, 1989), should be assembled, GLM standardised where possible, and be available at the First Intersessional Workshop of the *Implementation Review*. Data on flipper colour and conception dates should also be assembled and presented to the Preparatory Meeting of the First Intersessional Workshop of the *Implementation Review*. Initial discussions of future experimental and analytical ways to distinguish among competing hypotheses are given in Annex D1, item 10.

6.3.2 Recommendations

The Committee **agrees** that it has successfully addressed all of the items required for a *pre-Implementation assessment* and therefore **agrees** that the *pre-Implementation assessment* is completed.

The Committee **recognises** that there is a considerable amount of work that needs to be done to complete the *Implementation Review*. Specifically, there is a need: (a) to assemble the data so that they can be used when conditioning the operating models on which the *Implementation Simulation Trials* are based; (b) to specify and code the operating models themselves; and (c) to fit the operating models to the agreed data sets (conditioning).

The Committee **agrees** that it is infeasible to conduct all of the work in a single meeting (the First Intersessional Meeting). Rather, it **agrees** that the probability of completing the work during the first year of the *Implementation Review* will be maximised if two meetings occur. The main objective of the first (the Preparatory Meeting) would be to determine the structure (time-steps, sub-areas and population components) of the operating models so that all relevant data can be assembled at the appropriate spatial and temporal resolutions in time for the First Intersessional Workshop, and to start to specify the operating models and how they will be conditioned. The second step would be to complete work scheduled at the First Intersessional Workshop.

Annex D1, Appendix 9 outlines the work plan in more detail, including tentative dates for deadlines and holding the Preparatory Meeting and the First Intersessional Workshop.

6.4 North Atlantic common minke whales

6.4.1 New information on stock boundaries and abundance estimates

Some of the *Small Areas* boundaries for North Atlantic minke whales were changed during the 2003 *Implementation Review* but not all boundaries were fully specified. The Committee **recommends** that a point at 63°N, 12°W be introduced to fill the 'hole' between the CM and CIP *Small Area*, and that boundaries around the southern tip of Greenland be defined as shown in Annex D, fig. 1. It also **recommends** that the *Small Areas* in Annex D, fig. 1 be adopted for use when the applying the RMP for North Atlantic minke whales.

SC/62/RMP6 presented a method for estimating $g(0)$ from single platform line transect data in which both the forward and perpendicular distances have been recorded. More details are given in Annex D, item 3.3.2. The Committee noted that attempts had been made in the past to estimate $g(0)$ using data from a single platform. It **encourages** efforts to develop methods to achieve this. The Committee **recommends** that the robustness of the method proposed in SC/62/RMP6 to model structure uncertainty, measurement error, and diving pattern be examined.

SC/62/RMP7 summarised a sightings survey conducted in the North Sea area within *Small Area EN* during summer 2009. More details are given in Annex D, item 3.3.2. The Committee **welcomes** this information and noted that these data would be included in a future abundance estimate for the North Atlantic common minke whales.

SC/62/RMP5 presented estimates of abundance for common minke whales in the Central Atlantic from the North Atlantic Sightings Survey conducted by Icelandic and Faroese vessels during June/July 2007. More details are given in Annex D, item 3.3.2.

The Committee **agrees** that the methods in SC/62/RMP5 followed the relevant RMP Guidelines. Annex D, table 1 lists the estimates of abundance in SC/62/RMP5.

The Committee **agrees** to adopt the estimates of abundance for 2007 for the CG and CIP *Small Areas* presented in Annex D, table 1 for use in the RMP.

The Committee **endorses** abundance estimates for the CM *Small Area* and for the Eastern *Medium Area*, by *Small Area*, for use in the RMP given in Annex D, table 2.

6.4.2 Recommendations and work plan

The Committee **recommends** that the boundaries in Annex D, fig. 1 be adopted for use when applying the RMP for North Atlantic minke whales. It also **recommends** that abundance estimates in Annex D, tables 1 and 2 be adopted for use in the RMP. The Committee **agrees** that its work plan for the 2011 Annual Meeting will include the review of any new abundance estimates.

7. ESTIMATION OF BYCATCH AND OTHER HUMAN-INDUCED MORTALITY (BC)

The report of the Working Group on Estimation of Bycatch and Other Human-Induced Mortality is given as Annex J. This subject was introduced onto the Agenda in 2002 (IWC, 2003c) because as part of the Revised Management Procedure, recommended catch limits must take into account estimates of mortality due to *inter alia* bycatch, ship strikes and other human factors in accordance with Commission discussions at the 2000 Annual Meeting (IWC, 2001a), although of course such mortality can be of conservation and management importance to populations of large whales other than those to which the RMP might be applied. Subsequently, the issue of ship strikes has become of interest to the Commission's Conservation Committee (IWC, 2006a).

7.1 Collaboration with FAO on collation of relevant fisheries data

The effort to compile a comprehensive database of entanglement data in the national progress reports, an element of collaboration with FAO, has continued; the IWC Secretariat has now entered data from 2004-09.

7.2 Progress on joining the Fisheries Resource Monitoring System (FIRMS)

The information potentially to be developed in collaboration with FIRMS includes an inventory of fisheries, including gear characteristics and some indicators of fishing effort. The IWC will be eligible to move from observer status to full partnership in FIRMS after completion of the entanglement database (see Item 7.1, above). Details are provided in Annex J.

7.3 Estimation of bycatch mortality of large whales

7.3.1 Mortality in longline fisheries

The Committee received a global review of operational interactions between cetaceans and longline fisheries (SC/62/BC6). It reported deaths of humpback and Bryde's whales. In addition, mortality of southern right whales has been recorded elsewhere (Best *et al.*, 2001). Depredation by some species of cetaceans such as sperm and killer whales (Kock *et al.*, 2008; Kock *et al.*, 2006; Purves *et al.*, 2005) is of economic importance to some fisheries. Research to mitigate depredation and mortality can potentially contribute to estimating both fish and cetacean mortality rates.

7.3.2 Bycatches in Korea and Japan

Genetic analysis of samples of cetacean meat collected in markets in Korea in 2004-05 suggested that 90 common minke whales were represented (SC/62/NPM26). Details of the analyses are given in Annex J. The small number of samples from the same individuals suggests that the whales pass through the market rapidly. The reported bycatch for Korea for 2004 was 61. The detection of a minimum of 90 whales in the market indicates that the true bycatch was greater than reported. The reported bycatch for 2009 is 54. The results of the 2004-05 market survey analyses suggest that this is likely an underestimate.

The Committee welcomed publication of a recent paper describing incidental entanglement of minke whales in the Republic of Korea (Song *et al.*, 2010). This contained information that had been previously been requested of Korea by the Committee.

The Committee noted the need for time series of bycatch for the *Implementation Simulation Trials* for North Pacific common minke whales (see Item 6.3) for Japan and the Republic of Korea. The Committee reviewed the method presented in SC/62/NPM4 to estimate past incidental catches of minke whales in Japan (details are given in Annex J). Concern was raised regarding the multiplicative factor used to adjust reported catch figures for the period 1979-2000. It was noted that there was considerably more variability in the early reported figures, with CVs for the 1980s and 1990s three to six times higher than since 2001. For this reason, some members suggested that a multiplicative adjustment was not appropriate and that the reports of zero bycatch for some years, (which also resulted in zero estimates) were implausible. Other members considered that estimates in SC/62/NPM4 are an improvement compared to the previous assumption of 100 animals each year over a 100-year period. Butterworth commented that point estimates of zero for some years did not necessarily invalidate the method as a basis for estimating cumulative bycatch mortalities over time, which was the primary input required for *Implementation Simulation Trials*; nevertheless he encouraged refinement of the method presented.

In conclusion, the Committee **recommends** that additional analyses to arrive at time-series of bycatches in the region be undertaken for presentation to the preparatory meeting for the first intersessional workshop. In response to a suggestion from some members that bycatch in fisheries other than set nets warrants further examination, including historical information on past fisheries, e.g. the Japanese squid driftnet fishery of 1978-1992 (Yatsu *et al.*, 1994); it was noted that bycatches occur only rarely in types of gear other than set nets in Japanese waters, as reported in the national progress reports of Japan.

7.4 Estimation of risks and rates of entanglement

7.4.1 Report of intersessional workshop

The Committee noted relevant information on entanglement mortality in an advance copy of the report of the Commission's intersessional Workshop on Welfare Issues Associated with the Entanglement of Large Whales (IWC/62/15). The Workshop concluded that:

(1) all species of large whales are at risk of entanglement to varying degree, but common minke, humpback, right (both North Atlantic and southern) and gray whales are the most frequently reported;
(2) all types of stationary or drifting gear (i.e. not actively towed) pose potential risk to entangle, but pound, set and fyke-type nets, along with gill nets and various pot-type gear were most frequently implicated;
(3) entanglements can occur wherever this type of gear and large whales overlap in distribution, and isnot limited to feeding grounds but also includes breeding grounds as well as migratory pathways;
(4) given the cryptic nature of large whale entanglements in combination with the paucity of experienced observers and lack of formal reporting networks, entangled whales are severely underreported globally; and
(5) regional shifts in fisheries and gear types can produce major differences in the character of entanglements and reporting frequency (e.g. coastal versus offshore gear placement).

Based on these conclusions, the Workshop made the following relevant recommendations:

(1) that coastal nations establish adequate programmes for monitoring entanglement of whales; and
(2) that member countries improve reporting to the IWC through National Progress Reports.

The Committee **endorses** these recommendations. In addition it **recommends** that:

(1) all member countries which have coastal fishing operations be encouraged to more accurately report the occurrence and nature of large whale entanglements and establish entanglement response programmes where applicable;
(2) existing and new programmes communicate with each other to standardise the data collected to maximise their usefulness; and
(3) members be encouraged to facilitate thorough examinations of carcasses, at a minimum to record whether fishing gear is present, or fresh scars which might have resulted in mortality are visible, as well as facilitating necropsies on all large whales whenever possible. Such investigations should be conducted irrespective of population status, since this will be required to better estimate entanglement mortality rates including for species and populations that may be subject to whaling.

Additional details reported concerning the entanglement response networks of various nations are given in Annex J.

7.4.2 Entanglement mortality in Oman

An analysis of scars in the peduncle region indicates that 30-40% of whales observed in the isolated and severely depleted population of humpback whales in the western Arabian Sea (known as Breeding Stock X) were likely to have been involved in entanglements (SC/62/SH20). Of 10 stranded baleen whales, three were entangled in gill nets. Fishing effort, including use of drifting and set gillnets and fish traps, is increasing rapidly in the region. The Committee **welcomes** the establishment of a national stranding committee by the Government of Oman, and **recommends** that all member states that do not have national stranding networks to establish these. The importance of indications of fishing effort was also emphasised. The possibility of this population being considered as a candidate for a conservation management plan is discussed under Item 11.2.2.4.

7.5 Progress on including information in National Progress Reports

The data on entanglements and ship strikes reported in this year's National Progress Reports are summarised in Appendix 2 to Annex J. The Committee last year considered a proposal for developing a mechanism for online submission of the information; progress on issues related to online submission of bycatch and other information is discussed further under Item 3.2 and 25 and in Annex P.

7.6 Review of methods to estimate mortality from ship strikes

7.6.1 New data on ship strikes

The Committee received a report on ship strikes affecting southern right whales in Uruguayan waters (SC/62/BC2); between 2003 and 2007, seven whales were observed with large wounds due to collision and five were stranded dead. The Committee **welcomes** this information, noting that this is the type of information requested to be included in the national progress reports; in combination with data on shipping traffic, it may allow comparative analysis of ship-strike rates along the Atlantic coast of South America.

After consideration of a report of a 'near miss' between a humpback whale and a cruise ship in the Antarctic (see Annex J, item 10.1), it was **agreed** that a study of near-miss data (it is known that ferry operators in Hawaii collected such data) may yield additional insight into the dynamics of ship strikes and provide input for modelling risk (see below).

7.6.2 Progress in modelling risk

A report was received on progress in a series of winter and summer surveys of fin whale distribution and abundance in the Mediterranean Sea especially near the Italian coast and in the Pelagos Sanctuary. These surveys are in part intended to improve evaluation of population level effects of human-induced mortality including ship strikes. Details of the results are in Annex J. Plans to collect data on ship traffic were also detailed. The Committee **encourages** continuation of this effort that makes an important contribution towards the modelling of risk and assessing population level effects.

7.7 Progress in developing global database of ship strikes

This effort has been underway since 2007, with associated activities by IMO and ACCOBAMS. Tasks identified at last year's meeting have been completed or are nearly completed. Progress has relied on informal arrangements among the Secretariat, members of the data review group, and an external contractor. In view of the increasing workload and proposed intersessional tasks, detailed in Annex J, Appendix 3, the Committee **recommends** that consideration be given to the appointment of a dedicated coordinator; this is the practice for other similar successful databases of this scale. Funding requested to support intersessional work including data validation, the creation of a handbook and for work on data entry is discussed under Item 24.

The Committee **endorses** the policy on release of information in the database in response to requests from the public detailed in Annex J, Appendix 3. Information from nine fields in the database will be eligible for release on a down-loadable basis. Only data on confirmed ship strikes will be released. Requests for full access will be dealt with on an individual basis.

The Committee noted that IWC and ACCOBAMS will hold a joint workshop in Monaco from 21-24 September 2010 on reducing risk of ship strike and that some agenda items will be relevant to data gathering and estimating numbers of collisions. The IWC also continues to collaborate with IMO on efforts to minimise the risk of ships strikes and to reduce underwater noise from commercial shipping (Annex K, item 9.4).

7.8 Other issues

7.8.1 Methods for assessing mortality from acoustic sources

There was no new information on this topic. However, the Committee noted development of an improved method for handling and analysis of gas embolisms found in stranded cetaceans (Bernaldo de Quiros *et al.*, 2010); such embolisms may be linked with acoustic sources. A workshop entitled 'Diving marine mammals gas kinetics' was held in Woods Hole, MA, USA in April 2010 and the Committee looks forward to receiving the report at next year's meeting.

7.8.2 Methods for assessing mortality from marine debris

Methods used in a study modelling co-occurrence of debris and cetaceans (SC/62/BC5) have potential value for assessing mortality from debris. The Committee **recommends** that full necropsies be conducted on all stranded large whales, irrespective of population status, to detect incidents of mortality associated with ingested debris (and see the earlier recommendation on entanglement).

7.8.3 Other potential sources of human-induced mortality

The Committee noted that while there have been no confirmed reports of whale mortality due to collisions with marine renewable energy developments, the potential exists for such (SC/62/E7 and E8) and see Carter *et al.* (2008).

7.8.4 Actions arising from intersessional requests from the Commission

The Committee was asked to review Annex {DNA} of IWC/62/7rev. This contains a section on market sampling. Although the proposed scheme has the purpose of acting as a deterrent to illegal activity, the Committee noted that it might also potentially provide information for estimating bycatch. A workshop and simulation studies were conducted in the past by the Committee to assess the possibilities for developing a market sampling system to estimate bycatch (details in Annex J).

8. ABORIGINAL SUBSISTENCE WHALING MANAGEMENT PROCEDURE (AWMP)

This item continues to be discussed as a result of Resolution 1994-4 of the Commission (IWC, 1995a). The report of the SWG on the development of an aboriginal whaling management procedure (AWMP) is given as Annex E. The Committee's deliberations, as reported below, are largely a summary of that Annex, and the interested reader is referred to it for a more detailed discussion. The primary issues at this year's meeting comprised: (1) *Implementation Review* of eastern gray whales; (2) various aspects of providing management advice for Greenlandic hunts; and (3) review of management advice for the humpback whale fishery of St. Vincent and The Grenadines. This represented a significant workload. The Chair of the SWG noted that its work this year had been considerably assisted by the progress made at the intersessional Workshop on Greenland fisheries held in Roskilde, Denmark (SC/62/Rep3).

In addition, he recalled that two years ago (IWC, 2009c), the Committee had tested and agreed a safe method to provide interim advice (i.e. catch limits for up to two 5-year blocks) such that the catch limit is 2% of the lower 5th percentile of the most recent estimate of abundance.

8.1 Sex ratio methods for common minke whales off West Greenland

The Committee has been evaluating assessment methods for common minke whales off West Greenland that rely on the relationship between the observed sex ratio of catches and that inferred from population models parameterised in terms of carrying capacity, productivity and how the distribution of males may have changed relative to that of females. This concept was introduced in 2005 (IWC, 2006b; Witting, 2005). The major factor which suggests that sex-ratio data may be informative about population size is that catches have consistently been female-dominated. 'Best' estimates of population size from sex ratio based methods are infinite, in effect indicating that any level of past catches would not have impacted this population of minke whales. However, it is standard Scientific Committee practice, in accordance with a precautionary approach, to base management advice primarily on lower confidence bounds for such estimates. The Committee has therefore focussed attention on developing the novel assessment approach required to calculate these bounds.

Considerable technical work was undertaken by the SWG during the intersessional period with a view to being able to test the approach with an initial set of robustness trials as described in SC/62/Rep3. However, implementation of the new method is proving extremely difficult. The details of this are complex and can be found in Annex E, item 3.1.3 but in short can be said to be due to the continued difficulties the SWG has faced with the likelihood function that underlies the sex-ratio approach.

Several remedies were considered by the SWG. The most promising of these was to re-parameterise the analysis by replacing *K* (carrying capacity) with a suitable transformation. This can be thought of as a high-risk/high-reward option: it could provide an adequate basis for estimation thereby eliminating many of the intricacies that continue to plague the current framework, but it may introduce new difficulties.

The Committee **endorses** the SWG recommendation that this approach receive the highest priority during the next intersessional period. If a transformed analysis could be completed and agreed at the 2011 Scientific Committee meeting, the sex-ratio method could be used as a basis for abundance estimation and submitted to appropriate simulation trials to test performance and robustness. If these trials are passed, the approach could then be used for providing management advice and as a basis for a long-term *SLA* (Item 8.3).

The SWG also considered a number of other options which would not require such a drastic change but which it considered had less chance of being successful, as can be seen in Annex E. An option to try raising the current truncation point was shown not to solve the issue as a result of runs undertaken after the SWG had completed its work.

The SWG had agreed that the continued difficulties in successfully implementing a sex-ratio approach required a re-evaluation of its work plan. The original motivation for this work had been the Committee's inability to provide management advice for this hunt. Thus, reflecting the priorities of the Scientific Committee and the Commission, work on a sex ratio estimation of abundance for West Greenland common minke whales has been the dominant focus of SWG effort for a number of annual meetings and three intersessional workshops.The participants have devoted considerable research effort to this task, the work has been scientifically challenging and methodologically innovative and the potential gain in terms of providing adequate management advice extremely high. However, despite enormous effort, no satisfactory conclusion has been achieved to date. Last year, the Committee had agreed an abundance estimate for common minke whales off West Greenland that, in conjunction with the agreed approach to provide safe interim advice for up to two five-year blocks, meant that the Committee was able to provide satisfactory management advice for the first time.

Therefore, the SWG had concluded that it would no longer prioritise development of the sex ratio approach unless a comprehensive final analysis could be endorsed at the 2011 Scientific Committee meeting. Although it would be regrettable to abandon the sex ratio effort without obtaining an agreed abundance estimate, there are many other urgent issues to which the SWG must turn its focus. The Committee **concurs** with this view.

8.2 Conduct *Implementation Review* of eastern North Pacific gray whales

In 2004, (IWC, 2005d), the Committee presented the Commission with its recommended Gray Whale *Strike Limit Algorithm* (the *Gray Whale SLA*) and this was endorsed by the Commission. The scheduled 2009 *Implementation Review* had been postponed because a number of key analyses would not be ready in time.

The purpose of an *Implementation Review* is to update information on catch history and abundance and to determine whether any other new information that has become available in the intervening (normally) 5-year period indicates that the present situation is outside the region of parameter space tested during *SLA* development. If this is the case, additional trials will need to be developed to test the performance of the *SLA* in this new region. If performance is found to be unacceptable under these new trials, revisions to the *SLA* will be required.

Full details of the parameter space investigated in the development of the *Gray Whale SLA* can be found in IWC (2005d). In practical terms, the most important issues relevant to the present *Implementation Review* relate to the issues of stock structure and updated information on abundance/trends.

8.2.1 The issue of the DAA and the conduct of this Implementation Review

Implementation Reviews are subject to the Committee's Data Availability Agreement incorporating a timetable of events. Although many datasets and analyses were completed within the appropriate timelines, unfortunately, just before adoption of its report, the SWG had realised that the photo-id and genetics data central to its discussions of stock structure and movements had not formally been submitted to the IWC under the DAA (although the papers themselves had met the appropriate deadlines). The same is also true for the telemetry data that, while not central to the conclusions reached, was also discussed under that Agenda Item; in this case the paper also did not meet the appropriate deadline.

The Committee recognised that discussions of these data cannot be considered as part of the *Implementation Review.* Thus although the *Implementation Review* is considered complete with respect to the discussions involving the data properly made available under the DAA, it **recommends** that a new *Implementation Review* takes place at the next Annual Meeting. This is to enable the SWG to take properly into account the important new information received this year that had not met the DAA timeline and that could indicate that the original trial structure was not sufficiently broad (see Item 8.2.7). This issue is referred to, where appropriate, in other parts of this report. A mechanism to ensure that this unfortunate event does not happen again is discussed under Item 8.2.8.

8.2.2 Stock structure

In the development process for the *Gray Whale SLA*, the possibility of a summer feeding aggregation along the Pacific coast between California and southeast Alaska was noted (e.g. IWC, 2001h) but the Committee had agreed that a single stock scenario was the most appropriate (IWC, 2002d).

Considerable new information has been collected since that time on the animals feeding along the Pacific coast and the SWG received three papers of relevance to stock structure at this meeting (unfortunately, as noted above, these did not meet all of the DAA requirements). Although different names have been used in the past by different authors (e.g. the southern feeding group, the Pacific Coast Feeding aggregation), the Committee **agrees** to refer to the animals that spend the spring, summer and autumn feeding in coastal waters of the Pacific coast of North America from California to southeast Alaska as the Pacific Coast Feeding Group or PCFG.

SC/62/AWMP1 presented an analysis of the genetic differentiation between the PCFG (using samples from Vancouver Island) and the larger population (using samples from Baja California). The authors concluded that their results suggest that the matrilines of the southern feeding group are demographically independent from those of the rest of the population, and therefore require separate management consideration.

SC/62/BRG32 reported the results of an 11-year (1998-2008) photo-id study examining the abundance and the population structure of eastern gray whales that spend the spring, summer and autumn feeding in coastal waters of the Pacific Northwest. With respect to stock structure, it concluded that there is one group of whales that return frequently and account for the majority of the sightings in the Pacific northwest during summer and autumn (i.e. the PCFG) and a second group of whales are apparent 'stragglers' encountered in this region after the main migration.

The discussion was also informed by consideration of telemetry data (SC/62/BRG21) and the details can be found in Annex E, item 2.2.

The Committee thanked the authors for these comprehensive papers. There was considerable discussion of them and their implications for stock structure. Despite some differences in interpretation and recognising that further analyses could be carried out, the Committee **endorses** the SWG's conclusion that the hypothesis of a demographically distinct PCFG was plausible and warranted further investigation. The implications of this for the *Implementation Review* are discussed under Item 8.2.7.

Telemetry data may provide the best estimator of residency times for PCFG gray whales in order to evaluate their relative vulnerability with respect to the spatial and temporal characteristics being considered for the Makah hunt. Analogous data from non-PCFG whales may also help determine if there are differences between PCFG and non-PCFG whales with regard to their migrations (distances from shore, water depths or timing) or other behaviours. Therefore, the Committee **recommends** that the satellite tagging work should continue and that these data be analysed with the goal of providing input (e.g. as required in mixing matrices, etc.) for any future trials of the *Gray Whale SLA*.

8.2.3 Catch data

Allison informed the SWG that the catch series had been updated to incorporate new information. The complete series can be found in Annex E, table 1.

8.2.4 Abundance and trends

Two papers relating to calf counts were considered, one from migration and one from the breeding grounds.

SC/62/BRG1 presented calf counts from shore-based surveys of northbound eastern North Pacific gray whales that have been conducted each spring between 1994 and 2009 in central California. Estimates were highly variable between years, with no sign of a positive or negative trend. Calf production indices, ranged between 1.6 - 8.8% with an overall average of 4.2%. The authors hypothesised that a late retreat of seasonal ice may delay access to the feeding areas for pregnant females and reduce the probability that existing pregnancies will be carried to term.

SC/62/BRG36 reported on changes in the abundance of gray whales inferred from boat surveys at Laguna Ojo de Liebre and Laguna San Ignacio between the late 1970s to the present. There was a decrease in the numbers of cow-calf pairs in both lagoons during 2007 to 2009, similar to the results from shore-based surveys at Piedras Blancas during the northbound migration. The counts of cow-calf pairs in both lagoons in 2010 were the lowest over the last 15 years.

In discussion, it was noted that the calf production indices were particularly low (<3%) during two periods (1999-2001 and 2007-09). During the first period, calf counts were low and high numbers of strandings also occurred. However, although the calf counts were low during 2007-09, there is no evidence for higher numbers of strandings during these years. The Committee noted that the calf production indices are being used in its discussion of MSY rates (see Item 5.1). Although the time-series of calf counts is now 16 years long, this is only just long enough to allow estimation of these parameters.

The Committee therefore **recommends** that these data continue to be collected and are reviewed during future *Implementation Reviews*. The series of cow-calf counts in lagoons, which provide a relative index not absolute estimates, are consistent with the calf counts given in SC/62/BRG1.

The Committee noted that the calf count data had been used during the initial development and *Implementation* for eastern gray whales and **agrees** that the new information did not indicate a need to modify the trials structure.

The Committee had two new papers relating to total abundance estimates. The first, SC/62/BRG8 reported a promising new approach that has recently been adopted for the counts of southbound migrating whales at Granite Canyon, California, which form the basis of abundance estimation for the eastern gray whales. The authors recognised the need for new calibration data to evaluate the different biases of new counting methods and new observers before count data can be reliably rescaled to estimate abundance.

The Committee welcomed this report, noting the importance of ensuring comparability among years in any long-term monitoring effort. It **recommends** that data be collected to re-evaluate pod size bias given the change in survey protocol and that variance estimates for future survey estimates of abundance account for the uncertainty associated with calibration of abundance estimates computed using different survey protocols.

The second paper, Laake *et al.* (2009), re-evaluated the data from all 23 seasons of shore-based counts for the Eastern North Pacific stock of gray whales conducted throughout all or most of the southbound migration near Carmel, California using a common estimation procedure and an improved method for treatment of error in pod size and detection probability estimation.

In addition to these papers, the Committee noted that the telemetric information in SC/62/BRG21 provided the first confirmation of day/night migration rates since the original

Table 2
Time-series of agreed abundance estimates of eastern gray whales for use in the *Gray Whale SLA* (taken from Laake *et al.*, 2009).

Year	Estimate	CV	Year	Estimate	CV
1967/68	13,426	0.094	1979/80	19,763	0.083
1968/69	14,548	0.080	1984/85	23,499	0.089
1969/70	14,553	0.083	1985/86	22,921	0.081
1970/71	12,771	0.081	1987/88	26,916	0.058
1971/72	11,079	0.092	1992/93	15,762	0.067
1972/73	17,365	0.079	1993/94	20,103	0.055
1973/74	17,375	0.082	1995/96	20,944	0.061
1974/75	15,290	0.084	1997/98	21,135	0.068
1975/76	17,564	0.086	2000/01	16,369	0.061
1976/77	18,377	0.080	2001/02	16,033	0.069
1977/78	19,538	0.088	2006/07	19,126	0.071
1978/79	15,384	0.080			

radio tag information that has been used when estimating abundance from the southbound census. The Committee thanked the authors for this comprehensive and careful review of this extremely valuable time-series of absolute abundance estimates. It **recommends** that the estimates of abundance given in Table 2 be **adopted** for use in the *Implementation Review* and for use when applying the *Gray Whale SLA*.

SC/62/BRG32 referred to under Item 8.2.2, also used the photo-id data to estimate the abundance of the PCFG. Abundance estimates for whales present in summer and autumn were estimated using both open and closed population models. Methods were proposed to remove the 'stragglers' from both types of analyses, to estimate abundance only of regularly returning whales. Three methods and four geographic scales revealed the abundance of animals that regularly return to the Pacific Northwest to be at most a few hundred individuals.

The Committee **agrees** that these data will be extremely useful during the proposed 2011 *Implementation Review*, along with telemetry data, to determine the probability that animals from the putative feeding aggregation in the Pacific Northwest are at risk of being caught during hunts in that area (see Annex E, item 2.6). The estimates in SC/62/BRG32 will also be useful to condition any trials developed to examine the performance of *SLA* variants for this feeding aggregation.

8.2.5 Assessment

SC/62/AWMP2 fitted an age- and sex-structured population dynamics model to data on the catches and abundance estimates for the ENP stock of gray whales using Bayesian methods. The prior distributions used for these analyses incorporated the revised the estimates of abundance in Laake *et al.* (2009) and SC/62/BRG1, and account explicitly for the drop in abundance caused by the 1999-2000 mortality event. A series of sensitivity analyses were conducted. The baseline analysis estimated the population to be above MSYL and the 2009 population size (posterior mean of 21,911) to be at 85% of its carrying capacity (posterior mean of 25,808); conclusions were consistent across all the model runs. SC/62/AWMP2 only estimated an extra mortality parameter for 1999-2000 based both on calf and strandings data and the analysis of Brandon and Punt (2009a; 2009b) in which annual parameters were estimated for reproduction and survival.

The Committee thanked the authors of SC/62/AWMP2 for the updated assessment. It **agrees** that the results of the assessment are within the bounds considered during the *Implementation*. Although the base operating model used to estimate the *Gray Whale SLA* did not explicitly include the 1999-2000 event, robustness tests involving catastrophic mortality events were conducted and the *Gray Whale SLA* performed adequately for these tests.

8.2.6 Strandings data

SC/62/BRG25 provided a summary of all gray whale strandings in California, Oregon and Washington between 1 January 2010 and 31 May 2010. The Committee welcomes this information, **agrees** that it showed that stranding levels were now similar to 'normal' years, and **recommends** that these data continue to be collected and presented to the Committee.

8.2.7 Consideration of need for new trials (and, if applicable, results of those)

The Committee refers to its earlier comments on the situation with respect to the DAA and the need for an *Implementation Review*.

Although some of the papers/data available could not be considered in terms of the 2010 *Implementation Review*, the Committee **agrees** that the information provided on the PCFG was such that its existence represents a plausible hypothesis, not considered in the original *Implementation*. In accord with Committee guidelines for this process (IWC, 2005b), this is sufficient to trigger a new *Implementation Review* in 2011. The reason that this hypothesis is important from an AWMP perspective relates to the potential harvesting in this region by the Makah Tribe and thus the need for the SWG to provide advice/develop an *SLA* to fulfil both the 'conservation' and 'user' objectives given by the Commission. It noted that the situation for PCFG is not the same as for the Greenlandic feeding aggregation of humpback whales; the latter case involves a feeding aggregation that does not occur (even in the short-term during migration) with animals from other feeding aggregations in the waters where the hunt takes place. In the case of the proposed area for the Makah hunt, both PCFG and migrating whales from the other feeding areas co-occur at least some of the time. In fact the situation is more similar to that of Gulf of Maine humpback whales.

The Committee therefore **agrees** that the information on stock structure and hunting warranted the development of trials to evaluate the performance of *SLA*s for hunting in the Pacific northwest at the 2011 *Implementation Review*. The Committee also noted that the assessment work discussed above (Item 8.2.5) showed that the population as a whole is in a healthy state. It **agrees** that for the purposes of the 2011 *Implementation Review*, the primary focus should be the PCFG.

That being said, it also **agrees** that over the next few years (i.e. in time for an *Implementation Review* in about 2016), further work should be undertaken to investigate the possibility of structure on the northern feeding grounds, especially in the region of the Chukotkan hunts. It **recommends** that relevant information be collected from the Chukotkan region, in particular, where possible, including genetic samples and photographs from the hunt). In addition, the collation of information on the geographical and temporal distribution of the hunt will be valuable.

Annex E, item 2.6 provides some general guidance for the 2011 *Implementation* Review. The Committee **agrees** that any acceptable future *SLA* for the hunt in the Pacific northwest must include a feedback mechanism. It also requests that the Chair of the SWG discuss its requirements for need envelopes with the hunters and members of the

US delegation. The Committee **agrees** that the following would assist, but are not required for beginning, the trial development process:

(1) Collection/analysis of genetic data that would allow more robust comparison of such data from animals in the northern and southern feeding areas;
(2) Collection/analysis of genetic data from Kodiak Island to California to further examine the probable range of the PCFG;
(3) Collection/analysis of genetic data to compare further animals seen in only one year ('stragglers' in SC/62/BRG32) with animals that are frequently seen within the hunting area;
(4) Collection/analysis of additional information (including telemetry data) on the relative temporal 'availability' of PCFG animals within the hunting area (e.g. by month); and
(5) An updated analysis of any additional data to obtain the most recent abundance estimate for the PCFG at the time of the 2011 *Implementation Review.*

8.2.8 Conclusions and recommendations

In light of the DAA difficulties discussed earlier, the Committee **agrees** that it has completed the *Implementation Review* on the basis of the data that had been made available to it in accord with the DAA. However, given the new information available that did not meet the DAA conditions, it **agrees** that a new *Implementation Review* should occur in 2011 to take into account information provided on the PCFG which was presented outside the DAA as noted under Items 8.2.2 and 8.2.7. The Chair of the SWG **agrees** to ensure that all likely contributors to the review are made aware of the DAA requirements as well as the guidelines for genetic analyses and data. The draft guidelines for *Implementation Reviews* referred to under Item 8.4 will also assist this process. The Committee also **agrees** that preparatory discussions for the 2011 *Implementation Review* take place at the proposed intersessional workshop (see Item 21). Management advice for this population can be found under Item 9.2.2.

8.3 Continue work on developing *SLA*s for the Greenlandic fisheries

In 2009, the Committee agreed an approach for providing safe interim advice on catch limits that is valid for up to two five-year blocks. In doing so, this provides time for the SWG to develop long-term *SLA*s for the Greenlandic fisheries. Work on this has progressed in general terms (e.g. see discussion in SC/62/Rep3 and Annex E, items 3.3 and 4.2). However, particularly given the complexity of the multispecies hunt in Greenland, the Committee **agrees** that this must be given high priority for the future work of the SWG, such that suitable *SLA*s can be developed and tested before the interim advice expires.

Simulation evaluation of *SLA*s requires the development and parameterisation of a set of operating models. Unlike the situation for West Greenland common minke whales, the SWG has an assessment for West Greenland fin whales which means that it is in a better position to develop an *SLA* for fin whales. Last year, it was agreed that the set of RMP trials developed to evaluate variants of the RMP for North Atlantic fin whales would be an appropriate starting point for developing such trials and this year the SWG was presented with a summary of the stock structure hypotheses underlying those trials. These will need to be modified to focus more on the uncertainties pertinent to West Greenland if they are to form the basis for evaluation of *SLA*s for fin whales. Unfortunately, the SWG did not have time to consider this further at the present meeting.

With respect to common minke whales off West Greenland, the SWG had previously been awaiting the outcome of the evaluation of a sex ratio method approach before addressing the issue of long-term *SLA*s; the decision potentially to cease work on a sex-ratio abundance estimate in 2011 (see Item 8.1) does not affect the need to begin work on an *SLA* as soon as possible. As noted in SC/62/Rep3, consideration of existing RMP trials for North Atlantic common minke whales may again prove a useful starting point for discussions.

In conclusion, the Committee **re-emphasises** the importance of developing *SLA*s for Greenlandic fisheries as soon as possible. It **agrees** that this should form the primary item for discussion at the intersessional workshop.

8.4 Consider lessons learned from the bowhead whale *Implementation Review*

Two main issues arising from the bowhead *Implementation Review* relating to: (1) stock structure and in particular genetic samples; and (2) data availability. In relation to the first of these two issues, the Committee noted that there are now guidelines for DNA data quality (IWC, 2009h).

In relation to the general question of data availability, a number of issues were raised in the SWG (see Annex E, item 8). One reason for the difficulties encountered was the lack of explicit guidelines for conducting *Implementations* and *Implementation Reviews* for the AWMP process, noting how valuable these had proved for the RMP process. The Committee **agrees** that Donovan should develop a draft of such a document for consideration at next year's meeting.

8.5 Aboriginal Whaling Scheme (AWS)

In 2002, the Committee strongly recommended that the Commission adopt the Aboriginal Subsistence Whaling Scheme (IWC, 2003a, pp.22-23). This covers a number of practical issues such as survey intervals, carryover, and guidelines for surveys. The Committee has stated in the past the AWS provisions constitute an important and necessary component of safe management under AWMP *SLAs* and it **reaffirms** this view. It noted that discussions within the Commission of some aspects such as the 'grace period' are not yet complete.

8.6 Other

8.6.1 Conversion factors for edible products for Greenland fisheries

IWC/62/9 is the report of a Small Working Group (Donovan, Palka, George, Hammond, Levermann and Witting) established by the Chair of the Commission to provide advice on conversion factors for the Greenlandic hunt. The report of the group was presented to the intersessional Commission meeting to consider Greenlandic strike limits. In discussion of the report at that meeting, it was agreed that there was no need for the report to be reviewed in detail by the Scientific Committee but that individual scientists should send comments to the authors so that the report could be revised, if necessary, by the Commission meeting in Agadir. That request and the document itself was circulated to the Scientific Committee with a request for comments by 6 June 2010. However, it had been agreed that this issue would be added to the SWG agenda.

A short summary of the report, which has been available on the IWC website since February 2010, is given in Annex E, item 9.1[2].

[2]The full 52 page report can be found at *http://www.iwcoffice.org/_documents/commission/IWC62docs/62-9.pdf.*

In discussion of IWC/62/9 during the present meeting, one member provided a number of comments on the underlying approach to calculating conversion factors, as well as to the quality of the data used by the authors. Points raised included whether conversion factors should be based only upon what product yield has been achieved in the past, or whether it should consider what could be achieved with significant improvements in processing efficiency. He also commented on the likely inaccuracy and unreliability of the hunter collected data. He suggested that Greenland be asked to come back next year with data of verifiable quality on length and product yield, and/or that the Committee be given details of the new data collection methods, together with information on the process by which the reliability of the product yield data is verified. In response, the authors noted that they had spent considerable time and effort in investigating the original data, recognising that it had not been collected by scientists for the purposes of estimating conversion factors. The large sample size and the consistency with edible product information collected by scientists in the North Pacific, revealed that the data for common minke whales were sufficient to calculate a robust conversion factor (as well as showing the flensing process to be efficient). The limitations of the conversion factors provided for the other species were recognised in the report and considered interim pending the recommended collection of additional data on length correction and edible products. They had offered to assist in appropriate experimental design. They also noted that it would take some time to obtain sufficient sample sizes for some species. They concluded that matters of efficiency were appropriate for discussion by the Commission.

The Committee endorsed the **recommendations** of the report. In particular, it supported the recommendations for further work that data on both 'curved' and 'standard' measurements are obtained during the coming season for common minke whales, fin whales and bowhead whales and that new data on edible products be collected using properly-design protocols, analysed appropriately and reviewed. It also supported the recommendation that the work be undertaken by scientists, hunters and wildlife officers since this would improve the ability of hunters, particularly those in remote areas, to obtain more accurate length and weight measurements. The Committee was informed that Greenland has already begun to implement some of the recommendations of the Small Working Group and they will be implementing all of them in the next season. There is now increased collaboration between hunters, scientists and managers and improved estimates of the three types of edible product should be possible by having each product stored in separate bins and weighed. It was also noted that collaboration between hunters from Alaska and Greenland was underway with the respect to flensing techniques for bowhead whales. Finally, the Committee **requests** Greenland to provide information on its sampling scheme and data validation protocols to next year's meeting.

9. ABORIGINAL SUBSISTENCE WHALING MANAGEMENT ADVICE

9.1 Eastern Canada and West Greenland bowhead whales

9.1.1 Assess stock structure and abundance of Eastern Canada and West Greenland bowhead whales

The Committee has agreed at the previous three Annual Meetings to consider a single stock of bowhead whales in this region as the 'working hypothesis' while acknowledging that there is still some uncertainty about the population structure of bowhead whales in eastern Canada and western Greenland (e.g. IWC, 2009d). Last year, the Committee had expressed some disappointment that the expected genetic analyses had not materialised to take discussions further. It had noted that use of the term 'working' hypothesis implies that alternative hypotheses can still be considered and thus there should be consideration of both one stock and two stock hypotheses. The Committee was therefore pleased to receive this year a number of stock structure papers, some of which include the use of genetic data.

SC/62/BRG26 presented work on genetic differentiation of bowhead whales in Eastern Canada and Western Greenland. The study included sequence data for 346 individuals from Baffin-Bay-Davis-Strait and 197 individuals from Hudson-Bay-Foxe-Basin. There was a slight but significant genetic difference between the two areas in terms of F_{ST} based on haplotype frequencies. However, there was no differentiation between Hudson Bay-Foxe Basin and Cumberland Sound, an area presumed to be within the range of the putative Baffin Bay-Davis-Strait stock. In the context of other biological information available (SC/62/BRG23 and SC/62/ BRG25), the authors consider the observed F_{ST} to be consistent with the one stock hypothesis.

SC/62/BRG25 reported on the re-identification patterns of genetic markers from bowhead whales sampled in Eastern Canada and West Greenland. From the total of 647 identified individuals, 91 were re-identified within the same location and year. Of the remaining 556 individuals (208 males and 348 females), the authors found 16 re-identifications between years. Three of these were between sampling areas and all three had moved from the Hudson Bay-Foxe Basin area to the Baffin Bay-Davis Strait area. In addition, of the 20 new satellite tags put out in 2009 in Disko Bay, four animals had crossed assumed boundaries between putative stocks. The authors concluded that: (i) the low number of re-identifications between years indicates that the population is relatively large; and (ii) the high proportion of re-identifications and movements of satellite tagged animals between areas indicate a high rate of movement between the areas. In the authors' view, these results indicate that there is only one stock of bowhead whales in Eastern Canada and Western Greenland.

SC/62/BRG23 reported on the sexual segregation of bowhead whales sampled in Eastern Canada and West Greenland. Genetic samples (the same as used in the previous two papers) were obtained from one location in West Greenland: Disko Bay (April-June 2000-09) and four locations in Eastern Canada: Pelly Bay (September 2000-02), Cumberland Sound (June-August 1997-2006), Foxe Basin (July-August 1994-2007) and Repulse Bay (September 1995-2005). The sex-ratio was significantly different from 1:1 in Disko Bay (76% females), but this was not the case in the remaining areas. The authors also reviewed available field observations and historical whaling records in the region, which provided further evidence of segregation. They concluded that Baffin Bay is mainly used by adult males and resting/pregnant females, whereas the Prince Regent, Gulf of Boothia, Foxe Basin and northwestern Hudson Bay areas are used by nursing females, calves and sub-adults. The Committee noted that the available information is consistent with some form of structured movement, but that this movement is still not well understood.

There was considerable discussion of these papers and their strengths and weaknesses in their ability to distinguish among stock structure hypotheses as can be seen in Annex F, item 4.2. Some members of the Committee interpreted the seasonal movements and resighting patterns between the two areas to mean that there is a single stock whilst others believed that these movements and the observed shallow population structure between some areas are still consistent with the two-stock hypothesis. The Committee **agrees** that the degree of population structure requires further work with additional molecular markers (nuclear loci) before a final conclusion can be reached and it also **recognises** the importance of the successful satellite tracking study. It **encourages** the continuation of work on structure in order to allow it to conduct a more in-depth analysis next year.

The Committee also received two papers on abundance (Annex F, item 4.2.2). SC/62/BRG28 reported the results of an aerial survey of the late-summer concentration of bowhead whales in Isabella Bay, Nunavut, Canada in September 2009. The resulting abundance of 1,105 (95% CI: 532-2,294) was corrected for whales that were submerged during the passage of the survey plane, but not for whales missed by the observers because >90% of the sightings were detected by both platforms.

SC/62/BRG34 summarised a preliminary evaluation of the potential to use photographs and capture-recapture analyses to estimate the size of the Eastern Canada-West Greenland stock(s) of bowhead whales. The large and often remote summer range of these animals makes it difficult to obtain an aerial survey estimate of abundance. On the other hand, photographic surveys benefit from mixing among the separate sampling areas and have been successfully used to estimate abundance of the B-C-B stock of bowhead whales. The authors proposed that photographic surveys be directed at areas of known summer aggregations. Photography methods and analyses for the proposed surveys would follow methods used for the 2004 B-C-B bowhead population estimate (Koski *et al.*, 2009), which has been accepted by the IWC. The Committee **welcomes** these papers and looks forward to further analyses at next year's meeting.

9.1.2 Review recent catch information

SC/62/BRG27 reported that two female and one male bowhead whales were taken in April-May 2009 and three females in April-May 2010 for subsistence purposes in Disko Bay, West Greenland (no whales were struck in 2008 and no whales were struck and lost in 2009 and 2010). In light of the uncertainties surrounding eastern Arctic bowhead stock structure and abundance, the Committee **requests** the Secretariat to contact Canada to try to obtain data on Canadian catches.

9.1.3 Management advice

In 2007, the Commission agreed to a quota for 2008 to 2012 of two bowhead whales struck annually off West Greenland but the quota for each year shall only become operative when the Commission has received advice from the Committee that the strikes are unlikely to endanger the stock. In 2008, the Committee was pleased to have developed an agreed approach for determining interim management advice (IWC, 2009c), that is valid for two five-year blocks. The Committee again **agrees** that the current catch limit for Greenland will not harm the stock (noting that this applies whichever stock structure hypothesis prevails). It was also aware that catches from the same stock have been taken by a non-member nation, Canada. It **agrees,** as in previous years, that should Canadian catches continue at a similar level as in recent years, this would not change the Committee's advice with respect to the strike limits agreed for West Greenland.

The Committee reviewed the catch limits in Table 4 of the Report of 'Proposed consensus decision to improve the conservation of whales from the Chair and Vice-Chair of the Commission' (IWC/62/7rev). For Eastern Canada/West Greenland bowhead whales, the Greenland strike limit is 2 per year (plus a carryover provision of two unused strikes from the previous year). The Committee **agrees** that the strike limits for Eastern Canada/West Greenland bowhead whales that are listed in table 4 of IWC/62/7rev are in accord with its advice, recognising that the normal regular review is also intended as part of IWC/62/7rev. However, the Committee notes that Canada may allow for regular catches from this stock. If the size of Canadian catches increases then the Committee's advice may change in that the total number of removals may exceed the safe limit determined by the agreed approach. If the Canadian catch increases, then the Committee wishes to draw attention to the fact that the total number taken from the stock may be greater than what is safe. Given the importance of this issue, the Committee **recommends** that the Secretariat should contact Canada requesting information about catch limits for bowhead whales.

9.2 Eastern North Pacific gray whales

9.2.1 Summary of previous season's catch data

A total of 115 gray whales (58 males, 57 females) was harvested in Chukotkan waters in 2009 and 1 was lost. A total of 6 of the 115 individuals were considered as unfit for consumption in 2009 (samples were taken from all 6). Biological sampling was conducted on 61 gray whales.

9.2.2 Management advice

As noted under Item 8.2, the Committee **agrees** that it has completed the *Implementation Review* but that a new *Implementation Review* should take place next year. In this context, the Committee **agrees** that its position with respect to the provision of management advice was unchanged from last year, i.e. the *Gray Whale SLA* remains the appropriate tool to provide management advice for eastern North Pacific gray whales. This remains the case, at least until the 2011 *Implementation Review* is completed.

In line with the values in table 4 of the proposed consensus decision (IWC/62/7rev), the Secretariat ran the *SLA* using the updated information on catches and abundance agreed at this meeting. This confirmed that an annual strike limit of 145 animals will not harm the stock (note that 145 is the maximum catch that can be taken in any one year; the annual average catch is 129 whales). The additional five whales added to the annual maximum in any one year from that previously considered (140) was intended to account for 'stinky' whales (IWC/62/7rev). In providing its advice, the Committee **draws attention** to the need for a new *Implementation Review* next year with a focus on PCFG whales. It was noted that although the table included strike limits for 10 years, the proposed consensus decision envisages the usual periodic reviews of strike limits for indigenous whaling.

Borodin commented that the annual strike limit should include the actual number of struck-and-lost whales and 'stinky' whales (e.g. in 2009 the numbers were 1 and 6, respectively). If hunting is on large whales then the number of struck-and-lost whales will be higher. Within that context, he noted that the annual strike limit should not exceed 150 whales (the number included in the *Gray Whale SLA* trials for the early period of catches during the development process).

9.3 Bering-Chukchi-Beaufort (B-C-B) Seas stock of bowhead whales

9.3.1 Review catch information and new scientific information

The Committee was pleased to receive two papers dealing with broad-scale aerial surveys from the northeastern Chukchi (SC/62/BRG13) and Alaskan Beaufort (SC/62/BRG14) Seas respectively. Details can be found in Annex F, item 4.1.1.

SC/62/BRG13 presented preliminary analyses of broad-scale aerial surveys for large whales in the northeastern Chukchi Sea that were conducted in 2008 and 2009, and compared these with results from similar surveys conducted in that region from 1982-91. The distribution of bowhead whale sightings during the light ice years of the early period (1982, 1986, 1989 and 1990) was similar to the distribution of bowhead sightings during 2008-09. There did not appear to be any major shifts in cetacean distribution between the early and late surveys although there were unexpectedly no gray whale sightings in the offshore shoal areas during 2008-09. In general, it was noted that analysing cetacean distribution in relation to environmental factors like sea-ice was complicated with this data set because the timing of the surveys was not consistent between years.

SC/62/BRG14 presented a similar preliminary study for the Alaskan Beaufort Sea, using data from the Bowhead Whale Aerial Survey Project (BWASP) in 2000-09, with comparisons to historical data. Bowhead distribution was similar in 2000-09 compared with the observed distribution from earlier years with light ice cover.

The Committee **recommends** that these surveys continue on an annual basis in the future in light of their capacity to monitor the effects of climate change and other factors (including anthropogenic activities) on cetacean distributions in the Beaufort Sea.

SC/62/BRG17 provided information about acoustic monitoring during attempts to count migrating bowhead whales near Point Barrow, Alaska in 2009 and to test new acoustic equipment. Results demonstrated the efficacy of a new seafloor array procedure and indicate that it can be used in the future as the method for obtaining acoustic data for the bowhead census and population estimation process. The Committee **welcomes** this report and **encourages** the use of autonomous seafloor acoustic recorders when monitoring migrating bowhead whales.

The Committee also received information on summarised preliminary analyses on identifying yearling bowhead whales in aerial photographs (SC/62/BRG29) and recent efforts to estimate the population size of this stock of bowhead whales (Annex F, item 4.1.1). The Committee welcomed this new information and notes that a full survey effort is being planned again in 2011. In discussion, the importance of monitoring the tails of the distribution of migrating whales was noted in the light of information from this year's migration.

9.3.2 Management advice

SC/62/BRG18 provided information on the 2009 Alaskan hunt. A total of 38 bowhead whales were struck resulting in 31 animals landed). Challenging sea ice conditions and weather contributed to a poor spring hunt. Of the landed whales, 12 were males, 18 were females, while sex was not determined for one animal. Hunters mistakenly harvested two female calves (lengths of 6.2m and 6.6m) in the autumn thinking they were small independent whales. Autumn calves are close in body length to yearlings and it is difficult to determine their status when swimming alone. Other details are given in Annex F, item 4.1.2. It was reported that there were no catches of bowhead whales by Russia this year.

The Committee **reaffirms** its advice from last year that the *Bowhead SLA* remains the most appropriate tool for providing management advice for this harvest. The results from the *SLA* show that the present strike limits are acceptable.

The next *Implementation Review* for B-C-B bowhead whales is scheduled in 2012. The purpose of the *Implementation Review* is to evaluate new information which has become available since the last *Implementation Review* and assess whether the current state is outside the realm of plausibility covered by the *Implementation* trials. If so, it may be necessary to conduct further trials incorporating such information. Therefore, the Committee **encourages** researchers to present relevant papers and new information for consideration during next year's meeting, so that preparations for the next *Implementation Review* can proceed efficiently.

The Committee reviewed the catch limits in table 4 of 'Proposed consensus decision to improve the conservation of whales from the Chair and Vice-Chair of the Commission' (IWC/62/7rev). For B-C-B bowhead whales, the maximum strike limit is 67 per year (plus a carryover provision of 15 unused strikes from the previous year) for total landed of 560 (580 written in footnote 8 is a typo). The Committee **agrees** that the strike limits for B-C-B bowhead whales listed in table 4 are in accord with the management advice provided by the *Bowhead SLA*, noting that the normal regular review is also intended.

9.4 Common minke whale stocks off Greenland (AWMP)

9.4.1 West Greenland

9.4.1.1 SUMMARY OF PREVIOUS SEASON'S CATCH

In the 2009 season, 153 minke whales were landed in West Greenland and 11 were struck and lost. Of the landed whales, there were 105 females, 47 males, and one whale of unreported sex. Genetic samples were collected for 97 of the 153 minke whales landed in 2009.

9.4.1.2 MANAGEMENT ADVICE

In 2007, the Commission agreed that the number of common minke whales struck from this stock shall not exceed 200 in each of the years 2008-12, except that up to 15 strikes can be carried forward. Prior to last year, the Committee has never been able to provide satisfactory management advice for this stock. Last year, the Committee was for the first time able to provide management advice for this stock. It had adopted a new abundance estimate and agreed method for providing interim management advice. Such advice can be used for up to two five-year blocks whilst *SLAs* are being developed (IWC, 2009c). Based on the application of the agreed approach, and the lower 5^{th} percentile for the 2007 estimate of abundance (i.e. 8,918), the Committee **repeats its advice** of last year that an annual strike limit of 178 will not harm the stock.

9.4.2 East Greenland

9.4.2.1 SUMMARY OF PREVIOUS SEASON'S CATCH DATA

Three males and one female common minke whale were struck (and landed) off East Greenland in 2009 (no animals were struck and lost; see SC/62/ProgRepDenmark). Genetic samples were obtained from two of these whales. Catches of minke whales off East Greenland are believed to come from the much larger Central stock of minke whales.

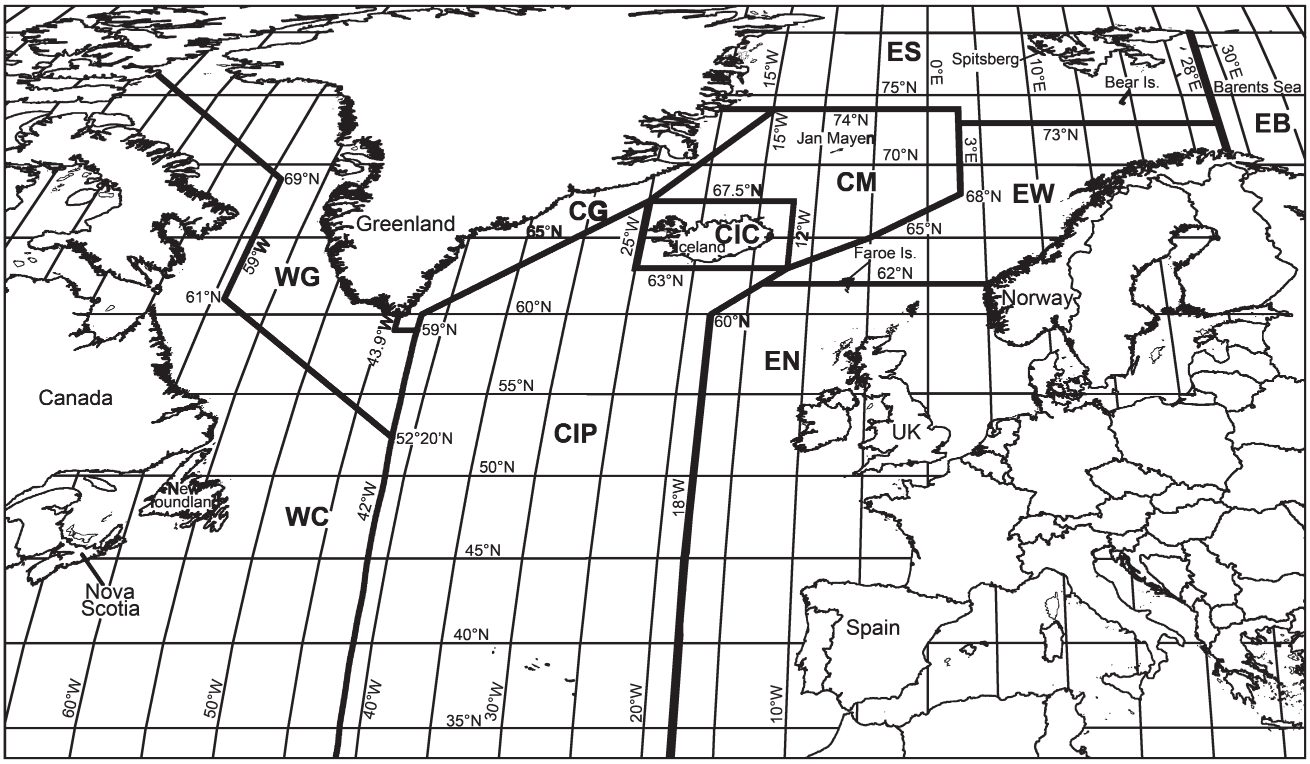


Fig. 2. The specifications for the Small Areas for the North Atlantic minke whales.

Table 3

Most recent abundance estimates for minke whales in the Central North Atlantic.

Small Area(s)	Year(s)	Abundance and CV
CM	2005	26,739 (CV=0.39)
CIC	2007	10,680 (CV=0.29)
CG	2007	1,048 (CV=0.60)
CIP	2007	1,350 (CV=0.38)

9.4.2.2 MANAGEMENT ADVICE

In 2007, the Commission agreed to an annual strike limit of 12 minke whales from the stock off East Greenland for 2008-12, which the Committee stated was acceptable in 2007. The present strike limit represents a very small proportion of the Central Stock (see Fig. 2 and Table 3). The Committee **agrees** that the present strike limit will not harm the stock.

9.5 Fin whales off West Greenland

9.5.1 Summary of previous season's catch data

A total of 8 (1 male; 7 females) fin whales were landed, and 2 struck and lost, in West Greenland during 2009 (SC/62/ProgRepDenmark). Genetic samples were collected for 5 of the 8 fin whales harvested during 2009.

9.5.2 Management advice

In 2007, the Commission agreed to a strike limit (for the years 2008-12) of 19 fin whales struck off West Greenland. The Committee agreed an approach for providing interim management advice in 2008 and this was confirmed by the Commission. It had agreed that such advice could be used for up to two five-year blocks whilst *SLA*s were being developed (IWC, 2009c). Based on the application of the agreed approach in 2008 (IWC, 2009c), the Committee **agrees** that an annual strike limit of 19 whales will not harm the stock.

9.6 Humpback whales off West Greenland

In 2007, the Committee agreed an approach for providing interim management advice and this was confirmed by the Commission. It had agreed that such advice could be used for up to two five year blocks whilst *SLA*s were being developed (IWC, 2009c). Using this approach, as last year, the Committee **agrees** that an annual strike limit of 10 whales will not harm the stock.

9.7 Humpback whales off St Vincent and The Grenadines

9.7.1 Summary of previous season's catch data

The Committee was advised that three females (lengths 34', 34'3" and 43'2") were taken during 2010. Neither genetic samples nor photographs were available for these animals. The Committee has encouraged St Vincent and The Grenadines to submit as much information as possible about any catches to the Committee via an Annual Progress Report.

The Committee **strongly recommends** collection of genetic samples for any harvested animals as well as fluke photographs, and submission of these to appropriate catalogues and collections. In respect of genetic samples, the Committee again **agrees** that the North Atlantic Whale Archive maintained by Per Palsbøll is an appropriate facility.

9.7.2 Management advice

In recent years, the Committee has agreed that the animals found off St Vincent and The Grenadines are part of the large West Indies breeding population. The Commission adopted a total block catch limit of 20 for the period 2008-12. The Committee **agrees** that this block catch limit will not harm the stock.

10. WHALE STOCKS

10.1 Antarctic minke whales (IA)

The Committee is currently continuing an in-depth assessment of the Antarctic minke whale. To complete this assessment, agreed abundance estimates from CPII and CPIII[3] are needed. Two different abundance estimation methods have been developed during the last few years, and although they give quite different point estimates, both are consistent in that they show an appreciable decline from CPII to CPIII. During the JARPA review in 2009, the quality of the Japanese ageing methods was questioned with implications for the catch-at-age analyses. During the present meeting, the priority topics discussed included: the two abundance estimation methods; the reasons for the differences between CPII and CPIII; age reading and the catch-at-age assessment models.

10.1.1 Produce agreed abundance estimates of Antarctic minke whales using IDCR/SOWER data

Skaug reported on work conducted by the Abundance Estimation Intersessional Working Group. Tasks to be considered by the group were directed towards elucidating possible causes for the difference in abundance estimates for Antarctic minke whales from the IDCR/SOWER data from the recent OK (Okamura and Kitakado, 2009) and SPLINTR (Bravington and Hedley, 2009) models. In completing most of these tasks, substantial progress had been made towards this in two regards: (i) development of a reference dataset for model comparisons; and (ii) Bravington had completed a non-spatial version of the SPLINTR model. For (i), a number of internal inconsistencies in the 'standardised' dataset were identified; as noted in IWC (2010f), it is essential that when comparing models, the data are identical. Since the purpose of this dataset is to allow appropriate comparisons between the models, the Committee **agrees** that this dataset is suitable for this purpose.

SC/62/IA14 provided results from applying the IWC 'standard' method (Branch, 2006), and the OK and SPLINTR models to simulated data, focussing on the latter two. In general, both models performed well, although when bias did occur, it tended to be positive for the OK model and negative for SPLINTR. The Committee thanked Palka for co-ordinating this extensive study. The simulated datasets have proved valuable in helping to develop and refine the models and for examining the differences between them. No simulated scenarios show the level of difference between the OK and SPLINTR estimates that the real data analyses reveal. This suggests either that the magnitudes of factors currently in the simulations do not cover the ranges found in the real data (either singly or in combination), or that there are additional factors not currently in the simulations that are important for modelling the real data.

During the pre-meeting and using the reference dataset, the OK and non-spatial SPLINTR outputs were compared. Estimated mean school sizes, effective strip half-widths, and encounter rates were combined using the simple line transect formula for estimating abundance. The resulting examination revealed that: (1) these estimated quantities from each model were being combined correctly to estimate abundance; (2) the effective strip half-widths for OK were about half of those of SPLINTR (i.e. the estimated abundances were approximately doubled, highlighting a need for further investigation); and (3) that the difference between the two models was not due to the data used and was probably not due to differences in mean school size. The Committee questioned whether sufficient progress had been made to determine whether further investigation was likely to determine the reason for the difference between the models. It **agrees** that if the Work Plan, including an intersessional workshop, is accomplished, there is a reasonable chance that this will be the case. It therefore **agrees** to proceed with these investigations until the 2011 Annual Meeting. The Committee also **agrees** a number of technical points related to this intersessional work (Annex G, item 5.1.8).

However, contingency plans (e.g. producing model-averaged estimates of abundance) will also need to be considered if it does not prove possible to resolve the difference in the estimates. Skaug compared estimates from OK, SPLINTR and a model-averaged estimate on the simulated data and found that the model-averaged estimator had smaller bias than either of the two individual models. There was some discussion on the appropriateness of using model-averaged estimates on the real data. However, as noted above, given the progress made this year, it is anticipated that the best outcome would be a resolution of the issue as a result of the intersessional work.

SC/62/IA3 and SC/62/IA12 presented the following 'survey-once' estimates (see Branch and Butterworth, 2001b) of abundance for the CPII and CPIII surveys from the OK and SPLINTR models respectively, as summarised in Table 4.

The Committee thanked both sets of authors for producing estimates and for the substantial amount of intersessional work, much of it collaborative. As last year, the issue is not that either set of diagnostics suggests not accepting the estimates, but rather that the estimates themselves are so different. This leads to the need to consider three – not necessarily unrelated – issues for next year: (1) pursuing the work to explain the differences; (2) the implications, if any, for future surveys; and (3) the procedural question of what the Committee should do if (1) does not succeed. As part of IWC/62/7rev, the Committee is expected to undertake an RMP *Implementation* for Antarctic minke whales in 2015 (and see Item 20). There is thus a pressing need for agreed absolute abundance estimates for the past surveys and an agreed method for analysing data from future surveys.

The Committee **strongly recommends** that the work plan and timeline set out in Annex G, Appendix 3 to finalise estimates be followed and completed. A workshop, to be held by February 2011 at the latest (see Item 21), is an essential component of this.

10.1.2 Conduct an analysis of aging errors that could be used in catch-at-age analyses

Lockyer presented the results of the Antarctic minke whale ageing exercise (SC/62/IA11) which she had carried out intersessionally following the 'blind' experimental design agreed by the Scientific Committee (IWC, 2009e, p.209). The study was assisted by staff from the laboratory at the Tokyo University of Marine Science and Technology, under the supervision of Kitakado. This had involved reading 250 earplugs from 1974/75-2005/06, i.e. including both Antarctic commercial and JARPA samples. The primary aim of the work was to determine whether evidence exists of a drift in reader performance, and, if so, to quantify it. A secondary aim was to quantify age-reading error variability.

The Committee thanks Lockyer and the Japanese graduate students who had assisted her, and for the professional manner in which they conducted the experiment. It also

[3]CPII and CPIII refer to the second and third set of IWC cruises, referring to 1985/86-1990/91 and 1991/92-2003/04, respectively.

Table 4

Comparison of 'survey-once' estimates of abundance, by Management Area, from the OK and SPLINTR models. Estimates shown have been extracted from the papers SC/62/IA3 and SC/62/IA12 and rounded, with CVs incorporating additional variance given in parentheses.

	Area I	Area II	Area III	Area IV	Area V	Area VI	Total
CPII							
OK	209,000	261,000	187,000	104,000	635,000	90,000	1,486,000
	(0.35)	(0.38)	(0.42)	(0.37)	(0.29)	(0.39)	(0.17)
SPLINTR	117,000	141,000	87,000	61,000	282,000	59,000	747,000
	(0.38)	(0.39)	(0.55)	(0.36)	(0.34)	(0.40)	(0.19)
CPIII							
OK	65,000	93,000	126,000	79,000	244,000	105,000	712,000
	(0.34)	(0.37)	(0.33)	(0.45)	(0.33)	(0.34)	(0.17)
SPLINTR	35,000	56,000	59,000	36,000	140,000	57,000	382,000
	(0.33)	(0.35)	(0.31)	(0.33)	(0.31)	(0.33)	(0.17)

endorses the recommendation by Lockyer that a standard reference set of minke earplugs be maintained for age-reading training purposes.

SC/62/IA2 explored the impact of period/reader on age-determination by comparing age-estimates for the above 250 earplugs for the control reader (Lockyer) and three Japanese readers (Masaki, Kato and Zenitani). Overall, the results demonstrated that the Japanese readers and the control reader differed in terms of both expected age given true age and variance in age-estimates. The results also suggested that the expected age and random uncertainty in age-estimates differed among the Japanese readers although the differences were not severe. This work will assist in determining how catch-at-age data are used in the statistical catch-at-age analyses and in future virtual population analyses.

The Committee **welcomes** this study as an important advance. It was noted that: (a) Lockyer tended to report greater ages than the Japanese readers; (b) differences amongst the Japanese readers were slight; and (c) that there was no indication of a trend in bias in Japanese readings over the period examined (i.e. from commercial whaling to special permit whaling). It was also noted that SC/62/IA11 does not provide any information about the accuracy of the age readings in absolute terms, given the absence of known-aged individuals. The absence of known-aged individuals is also the general norm for fish populations although for a number of these there are indications that layers were formed seasonally. Similarly, studies of fin whales, as well as corpora counts and information from animals with known histories, all indicate that the growth layers groups used to estimate whale ages are laid down annually.

In conclusion, the Committee **agrees** that no further experiments or analyses on age reading errors are needed to resolve ageing related problems raised in e.g. the JARPA review.

The Committee also **recommends** that, where they do not already, national or other guidelines for dealing with stranded animals include encouragement to obtain samples which could provide information on the animal's age.

10.1.3 Continue development of the catch-at-age models

SC/62/IA6 examined the impact of allowing for ageing error based on the analyses of the above (Item 10.1.2) age-reading experiment when conducting assessments for Antarctic minke whales in Areas III-E, IV, V and V-W using statistical catch-at-age analysis by means of sensitivity tests. These sensitivity tests explored three scenarios: (a) no ageing error; (b) ageing error is modelled as in previous base-models; and (c) ageing error is based on the results from SC/62/IA2. Time-trajectories of total (1+) population size and recruitment were qualitatively the same, irrespective of how age-reading error was modelled.

In discussion, it was noted that while estimates from recent years of recruitment and abundance for the three different assessments were close, absolute values showed relatively large differences until the 1960s, and estimation variance would be expected to be much higher over this period.

Though the Committee **agrees** that no further experiments or analyses on age reading errors are necessary. This decision did not, however, imply that other issues associated with the data and analyses, such as reasons for the different length distributions at age for younger-aged commercial and JARPA, had been resolved.

Completion of the work on investigation of catch-at-age based assessments requires undertaking the tasks as detailed in Annex G, item 5.2.4. These investigations will require an extension of permission from Japan for use of their Antarctic minke whale catch-at-age data, and would be improved if data from the most recent JARPA cruises could also be made available. The Committee **recommends** that such an approach be made to Japan under Procedure B of the DAA. Kato indicated that corpora count data were available, and that these data would be provided if necessary. An intersessional steering group under Punt was established to co-ordinate this work (see Annex Q).

10.1.4 Continue to examine the difference between abundance estimates from CPII and CPIII

Estimates from the OK, SPLINTR and standard methods (Branch, 2006) were consistent in that they showed a decline from CPII to CPIII. Conclusions reached about the reasons for these changes should integrate information from other sources such as changes in ice coverage during the survey periods concerned. Until recently, there was little quantitative information on the number of Antarctic minke whales that might be present within the pack ice. This year the Committee was pleased to receive several papers reporting on, and analysing data from, surveys of whales within the pack-ice.

SC/62/IA4 investigated trends of sea ice in the period of IWC IDCR/SOWER circumpolar surveys from CPI to CPIII (1978-2004). The sea ice trends are fundamental information to understand the year-to-year sea ice variability. The authors concluded that the difference in abundance estimates between the CPII and CPIII surveys can be partly explained by the change in the amount of open sea areas within the sea ice field. The Committee **agrees** that further region-specific investigation is necessary to examine the extent of the role changes in sea ice may play in examining the change in abundance estimates between CPII and CPIII. In this context the Committee received a progress report from the intersessional working group established to examine this issue (SC/62/IA5). The authors have made progress importing satellite sea ice data from Area II into a GIS database but the work is not expected to be completed until the next Annual Meeting. The Committee **recommends** that every effort be made to complete this important work on time. Although the exact nature of any models relating minke whales densities in open water to those in the ice was not discussed, it is important to continue investigation of the relationships between whale density and ice characteristics.

This requires investigation of at least: (1) the relationship between whale density and days after sea-ice melt; and (2) the relationship between estimates of abundance and sea ice characteristics. The Committee **agrees** the detailed plan for this work given in Annex G, item 5.1.8. Bravington, Murase, Kitakado and Kelly will co-operate in this work.

This year, the Committee was pleased to receive reports (SC/62/IA8 and SC/62/O15) from two aerial survey programmes: the Australian East Antarctic programme (which co-ordinated in 2009/10 with the SOWER survey) using a fixed wing plane; and the German programme surveying the area in the Weddell Sea from a helicopter launched from the ice breaker vessel, the *Polarstern* (which was also used as a Platform of Opportunity for cetacean sightings). These programmes represent some of the first attempts to gather quantitative data to estimate densities of minke whales in the pack ice. Preliminary analyses from each programme can be found in SC/62/IA9 and SC/62/IA13.

The Committee **welcomes** this work and a full discussion can be found in Annex G, item 5.1.6.2. It thanked the governments of Australia, Germany and the Netherlands for supporting this research. It also was **pleased** to see the successful collaboration (both in collection of data, and in regular communications and data exchanges) between the Australian programme and the SOWER survey.

10.2 Southern Hemisphere humpback whales

The report of the Committee on the assessment of Southern Hemisphere humpback whales is given in Annex H. This assessment has been on the agenda of the Scientific Committee since 1992. The Committee currently recognises seven breeding stocks (BS) in the Southern Hemisphere (labelled A to G - IWC, 1998b), which are connected to feeding grounds in the Antarctic (Fig. 3). Preliminary population modelling of these stocks was initiated in 2000 (IWC, 2001g) and in 2006 (IWC, 2007a), the Scientific Committee completed the assessment of BSA (eastern South America), BSD (western Australia) and BSG (western South America). The assessment of BSC was completed in 2009 (IWC, 2010g). Since then, the completion of the assessment of BSB (western Africa) has been considered a priority by the Committee (IWC, 2010g, p.234).

10.2.1 Breeding Stock B

10.2.1.1 DISTRIBUTION

The Committee received several papers addressing the distribution, new records or habitat use of humpback whales along the central and northern Atlantic coast of Africa (Bamy *et al.*, 2010; Carvalho *et al.*, In review; Picanço *et al.*, 2009; Weir, 2010).

10.2.1.2 POPULATION STRUCTURE

It has been hypothesised that there may be two humpback whale sub-stocks in the eastern South Atlantic (IWC, In press). Breeding sub-stock B1 winters along the central West African coast and around the northern islands of the Gulf of Guinea and sub-stock B2 has been observed off the west coast of South Africa (WSA), in an area which appears to serve as a feeding site or possibly a migratory corridor. The breeding site of sub-stock B2 is unknown. A boundary between these two sub-stocks has been tentatively placed in the vicinity of 18°S (IWC, In press), see Fig. 4. At this meeting, the Committee further evaluated the evidence for BSB substructure, in light of new information.

SC/62/SH30 presented three stock structure hypotheses that were used in the assessment models. These hypotheses included: (1) a single, fully-mixed stock; (2) two breeding stocks that mix only on the feeding grounds and (3) two breeding stocks with partial migratory overlap along the west coast of Africa. SC/62/SH8 described temporal population structure in humpback whales on the west coast of Africa using maternally (mitochondrial DNA control region) and bi-parentally (10 microsatellites) inherited markers. Results showed significant genetic differentiation, low gene flow and

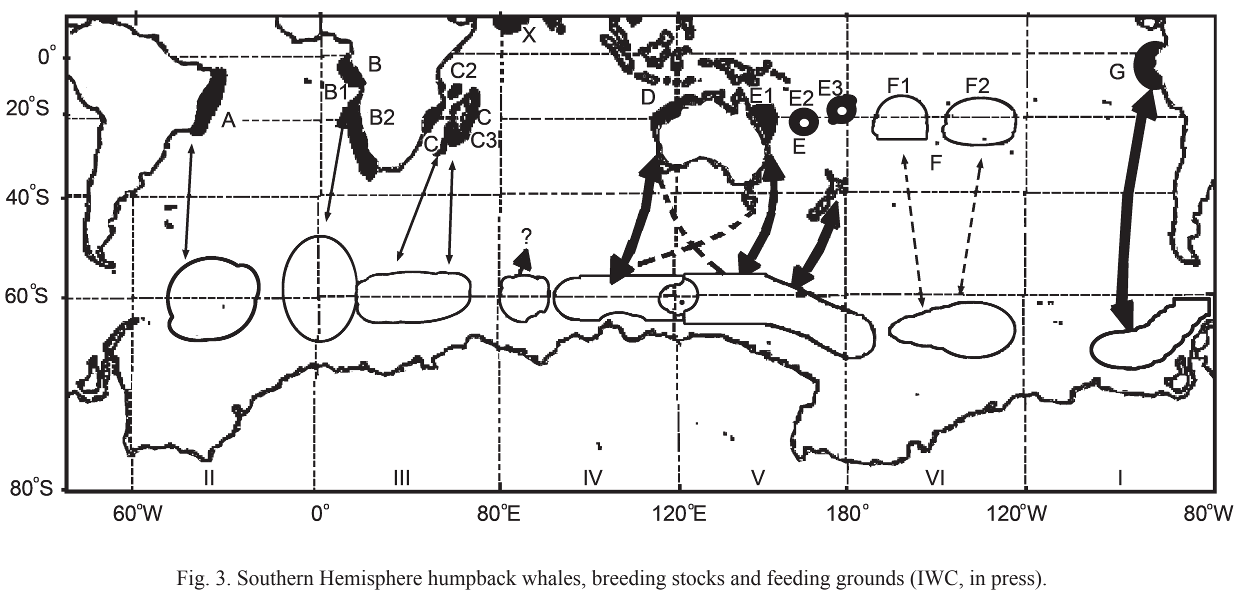


Fig. 3. Southern Hemisphere humpback whales, breeding stocks and feeding grounds (IWC, in press).

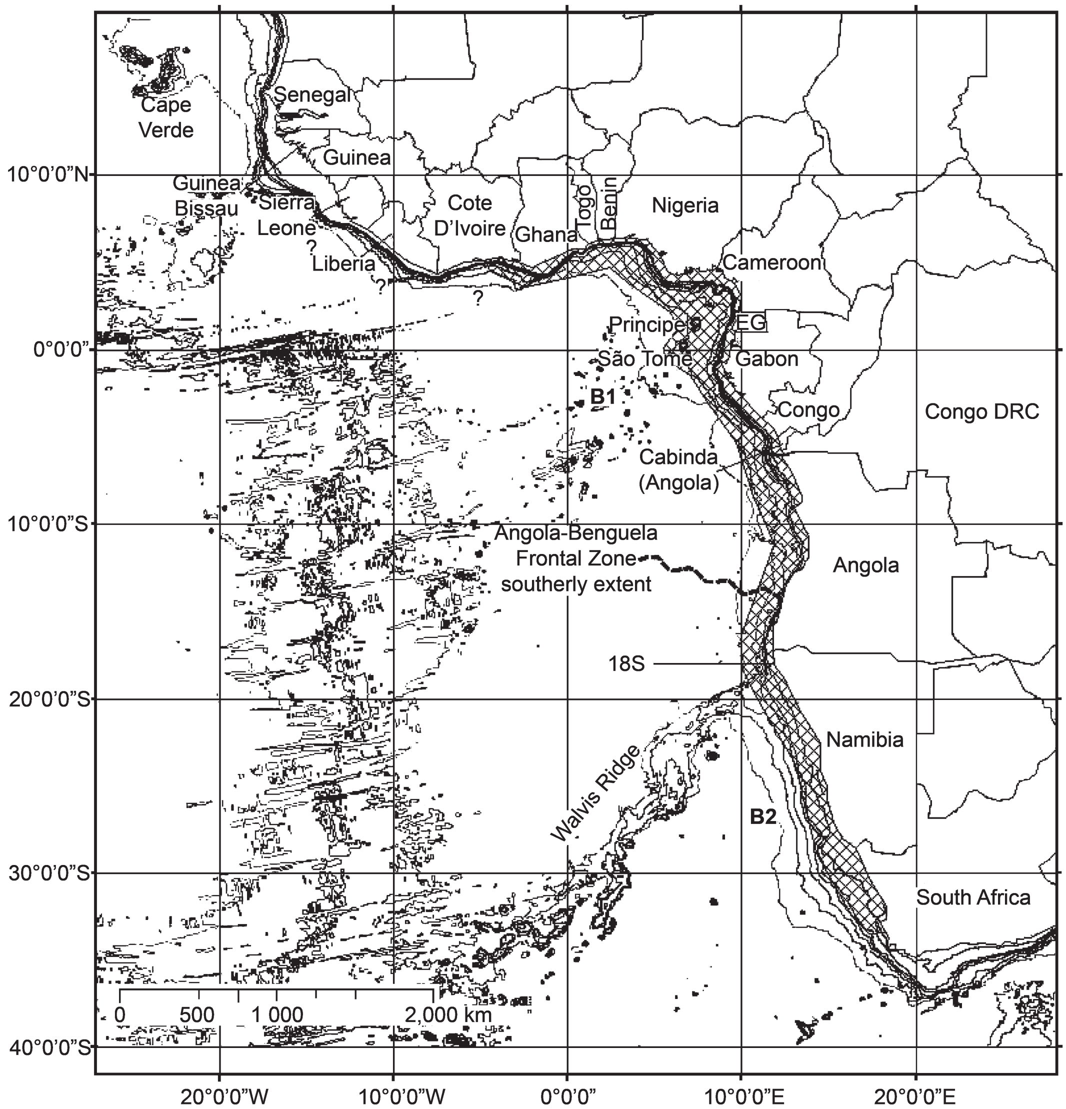


Fig. 4. Distribution of humpback whales in west Africa. The boundary between B1 and B2 has been proposed to be near 18°S (IWC, in press).

seasonal differences between WSA and Gabon. Movements of genetically identified individuals, both males and females, indicate that interchange occurs between these two region, with all movements to date being from north to south.

SC/62/SH15 examined humpback whale genetic structure in the Antarctic and evidence of connectivity to breeding grounds using biopsy samples collected during the 2006/2007 SOWER cruises. An updated analysis of the mitochondrial DNA (mtDNA) data presented in this paper was received during the meeting. Population structure was evaluated for the feeding grounds associated with BSB and BSC, under the catch allocation Hypotheses 1 and 2 developed by the Committee last year (Findlay *et al.*, 2010, fig.1). Under Allocation Hypothesis 1, Gabon was found to be significantly different from the Nucleus feeding areas of both BSB (10°W to 10°E) and BSC (30°E to 60°E). For Allocation Hypothesis 2, samples from Gabon were found to differ significantly from the BSB Nucleus (10°W to 10°E) and BSB/BSC Margin (10°E to 40°E). WSA was significantly different from BSB and BSC Nucleus, as well as the BSB/C margin area. Feeding grounds of BSB and Margin of B/C were found to be significantly different from the Nucleus area associated with BSC under Allocation Hypothesis 1. No significant differentiation was found across feeding areas under Allocation Hypothesis 2.

An analysis of mtDNA on feeding grounds (10°W-10°E) by latitudinal gradient revealed that no significant difference between Gabon and samples collected north of 60°S. WSA differed from samples obtained both north and south of 60°S on the basis of F_{ST} but significance was only found for samples obtained north of 60°S. These results were interpreted as indicative of some type of latitudinal variation in the distribution of whales from BSB in the Antarctic.

The Committee welcomed the genetic studies described above; this research is relevant to the assessments of Southern Hemisphere humpback whale stocks. The Committee **recommends** that a mixed stock analysis be performed to better inform stock structure assumptions and to increase the available data for population dynamics modelling.

The Committee also considered new photo-id matching results relevant to the stock structure of BSB. SC/62/SH10 presented preliminary results of photographic matching between Gabon, WSA and Antarctic Areas II and III. A total of three matches were found between Gabon and WSA. SC/62/

SH31 reported no matches resulted from the comparison of a photo-id catalogue from WSA and another from the south coast of east South Africa and southern Mozambique (BSC1). It was noted that a substantial number of images held by Oceans and Coast (the South African governmental agency from BSC1) have not been compared to WSA. In this regards, the Committee **recommends** comparisons of the WSA fluke photographs to the Oceans and Coast catalogue and **requests** that the relevant photographs and associated information be made available.

Barendse *et al.* (2010) described the results of shore-based observations on humpback whales off Saldanha Bay, WSA. This area was presumed to be a migration corridor for whales from the postulated BSB2 breeding sub-stock. The authors concluded that the area off WSA is not strictly a migration corridor, but also a primary or supplementary feeding ground. Discussion of this paper is given in Annex H, item 2.1.2.

SC/62/SH5 reviewed the catch history, seasonal and temporal trends in availability and the migrations of humpback whales along the west coast of southern Africa. After the initial decline in availability in all areas pre World War I, the catch history in Gabon differed markedly from those in the three southern grounds, especially off South Africa. This suggests some degree of stock sub-structure within BSB. A hypothesis of a single breeding ground (in the Gulf of Guinea) but separate, maternally-directed migratory routes to and from different feeding grounds was proposed.

The Committee concluded that the following points were relevant to the development of stock structure hypotheses based on its extensive review of information:

(1) there is probably more than one genetically distinct humpback whale population in the eastern South Atlantic;
(2) Gabon is a breeding ground and WSA exhibits characteristics of both a feeding ground and a migratory corridor;
(3) at least some of the animals sampled at Gabon migrate to the Antarctic to feed and that migration may follow an inshore route (via WSA), an offshore route or both (if the latter individual migrants maintain fidelity to a particular route or maintain alternate routes);
(4) some of the whales that breed at Gabon may maintain maternal feeding site fidelity to west South Africa, such that they do not migrate to the Antarctic; and
(5) individuals observed at WSA may migrate to an unidentified breeding site that is distinct from Gabon (if so, some fraction of those individuals may pass by Gabon, *en route* to that breeding site) or the breeding ground of these individuals may lie between Gabon and WSA.

In light of the new information presented above, the Committee indentified new stock structure hypotheses and progressed with exploratory population dynamics model runs. Results of these analyses are presented under Item 10.2.1.4 below. A minority statement in relation to item (5) above is found in Annex H, item 2.1.2.

10.2.1.3 ABUNDANCE ESTIMATES

The Committee received two papers with abundance estimates based on capture-recapture data. SC/62/SH2 reported on within-region photo identification and genotypic matching for WSA. Resightings between six different time-periods and five different datasets (three from photo-id data, one from microsatellite data and one combined) resulted in estimates of abundance ranging from 223 (CV=0.35) to 939 (CV=0.38) individuals. SC/62/SH11 presented estimates of abundance for humpback whales in Gabon for the period 2001-06 using photographic and genotypic data. While the estimates themselves provided in this paper were not discussed, the capture-recapture data were used in preliminary assessment models presented at the meeting (SC/62/SH30). Details of these papers and the data therein are presented under item 2.1.3 in Annex H.

10.2.1.4 POPULATION ASSESSMENT

After initial discussion of the assessment models in SC/62/SH30, the Committee developed additional stock structure hypotheses on the basis of the new information presented in Item 10.2.1.2. Additional model runs were then undertaken to inform the Committee about possible implications of various stock structure hypotheses and input data selection for population model outputs. Preliminary results suggested that the assessment model parameter estimates were relatively robust across the proposed stock structure hypotheses and input data for sub-stock B1 (Gabon). However, the population trajectories varied widely for sub-stock B2 (WSA). Based on these results, the Committee concludes that additional modelling was required and **agrees** upon a suite of stock structure hypothesis that would probably be used in the assessment of BSB (Annex H, item 2.1.4). The Committee selected three priority hypotheses that it **recommends** should be used in further population assessment (Fig. 5).

The Committee also discussed model input data and possible sensitivity analysis when evaluating the results of the stock assessment models (details in Annex H, item 2.1.4). Input data included allocation of breeding and feeding ground catches, values for minimum past population sizes (N_{min}), type of capture-recapture data (photo-id, genotype), proportions of whales migrating to breeding and feeding grounds, and rate of struck and lost whales. The Committee **agrees** to a selection of input data to be used as the reference cases and sensitivity scenarios in the population dynamic models, as presented in Table 5.

The Committee **agrees** that considerable progress was made during the meeting. However, there was insufficient time to complete the assessment of BSB. In this regard, the Committee notes that last year it had agreed to complete the assessment of BSB as a single stock if an assessment at the sub-stock level was not possible. However, in light of the new information brought forward this year, the Committee **agrees** that a considerably more robust assessment could be finalised if additional work was conducted intersessionally. The Committee **agrees** that the completion of the assessment of BSB by 2011 is a matter of the highest priority for the sub-committee on other Southern Hemisphere humpback whales. It **strongly recommends** that the strict work plan outlined in Table 6 be followed to facilitate completion at next year's meeting. Regular progress on these tasks will be monitored and reported by Zerbini to an intersessional group (Annex Q). The Committee **recommends** a pre-meeting to the Annual Meeting to ensure the timely completion of this work.

The modelling required to complete the assessment has financial implications for the Committee and this is discussed under Item 24.

The Committee **agrees** that it will conclude the assessment of BSB humpback whales at next year's meeting. Therefore, the Committee **recommends** that assessments of BSE and BSF humpback whales should be initiated and a progress report be presented at SC/63. An intersessional e-mail group was established under Jackson to assemble all the relevant

Table 5

Input data reference cases and sensitivities selected for use in population modelling for the assessment of BSB.

Data category	Population	Reference case	Sensitivity analysis
Capture-recapture	Gabon	Microsatellites, males-only* (see note below)	Flukes; microsatellites (both sexes)
Capture-recapture	WSA	Microsatellites* (see note below)	Right dorsal fin; flukes
Minimum past population	Gabon	$N_{min} = 68$	None
Minimum past population	WSA	$N_{min} = 24$	None
Catch allocation (north of 40°S)	Gabon	Congo and 50% Angola	Congo and Angola; Congo only
Catch allocation (north of 40°S)	WSA	50% Angola, Namibia and WSA	Namibia and WSA; Angola, Namibia and WSA
Catch allocation (south of 40°S)	Gabon	Allocation Hypothesis 1 developed last year	None
Catch allocation (south of 40°S)	WSA	Allocation Hypothesis 1 developed last year	None
Migration to unknown breeding ground	Gabon	25%	None
Migration to Antarctic	WSA	50%	100%; 0% (does not migrate)
Struck and loss rate	Both	0.15 (as presented in SC/62/O2)	0

*Microsatellite data will only be used as a reference case for capture-recapture data if genotyping errors can be incorporated into assessment models. Otherwise flukes will be used.

Table 6

Intersessional tasks to finalise the assessment of BSB humpback whales.

Task	Responsible persons	Final deadlines: Circulation to group for consideration	Final deadlines: Decision regarding use in model
Work on data inputs to model and possible refinements to stock hypotheses			
Inspection of mark-recapture data within and between Gabon and WSA for consideration in stock structure hypothesis refinement.	Barendse and Collins	15/12/10	31/01/11
Investigate and update estimates of potential and realized error in genetic and photo-identification data.	Carvalho, Collins, Rosenbaum, Cerchio	15/12/10	31/01/11
Re-analyse mark-recapture data from WSA using multi-year Program MARK (or equivalent) models to examine the effects of heterogeneity (for fluke data), tag loss (for dorsal fin data) and genotype error on abundance estimates, and assess the most appropriate data on interchange.	Barendse, Cerchio, Best	15/12/10	31/01/11
Conduct feeding-breeding ground mixed-stock analysis in order to estimate stock mixing proportions between Gabon and WSA and the Antarctic in order to further refine stock structure hypotheses for assessments.	Rosenbaum, Carvalho, Loo	15/12/10	31/01/11
Examine catch data for incorporation in population models, which should be sex-disaggregated, if possible.	Best and Butterworth	15/12/10	31/01/11
Comparison of WSA catalogue to South African government Oceans and Coast Catalogue (advantageous but not critical).	Barendse, Findlay and Meyeo	01/12/10	31/01/11
Modelling work			
Development of assessment models consistent with stock structure hypotheses selected by the Committee. Highest priority is for the models in Annex H, table 2. To the extent time permits variants of these models will be considered as sensitivities (Annex H, table 3). The assessment models should use the input data identified as the reference cases and sensitivities in table 2 above. Data output should include the posterior median and the 90% probability interval for the year for which the abundance prior corresponds. Present results for at least highest priority hypotheses.	Butterworth, Muller, Johnston	Some initial runs for highest priority stock hypotheses 15/01/10	Final runs for at least highest priority stock hypotheses One week before pre-meeting

data needed for these assessments. The assessment of BSD humpback whales (western Australia) had been completed at the SC meeting in 2005 (IWC, In press), but because of extensive mixing in the feeding grounds with other stocks (e.g. BSE) this stock might needed to be re-assessed along with BSE and BSF. The intersessional group will also consider the inclusion of BSD humpback whales in the assessments of the two other stocks.

The Committee **agrees** that a new item will be added to its agenda to consider new information on the Arabian Sea humpback whale population.

10.2.2 Review new information on other breeding stocks

10.2.2.1 BREEDING STOCK A

The Committee welcomed two papers with new information relevant to BSA. SC/62/SH27 reported a photographic match of a female humpback whale between Abrolhos Bank, Brazil (BSA) and the east coast of Madagascar (BSC3), which represents a new mammalian distance record. SC/62/SH28 presented a new line-transect abundance estimate of 9,330 whales (95% CI=7,185-13,214; %CV=16.13) for the coast of Brazil in 2008. This stock appears to be undergoing a steady growth, but further studies are necessary to reduce uncertainties associated with $g(0)$ estimation and other potential sources of bias. Further details are described in Annex H, item 2.2.1.

10.2.2.2 BREEDING STOCK D

Two papers provided information relevant to Breeding Stock D. These are summarised below, with additional details provided in Annex H, item 2.2.2. SC/62/SH21 reported on the deployment of 23 satellite tags on southward migrating whales off Kimberley coast, northwestern Australia. In total, 263 days of location data tracked whales over a total distance of nearly 20,000km. This work has provided the most detailed movement data off northwestern Australia to date and revealed an unexpected 1,200km movement from the coast into the Indian Ocean.

SC/62/SH24 described an unusual peak in recorded mortalities (n=47) of humpback whales in Western Australia

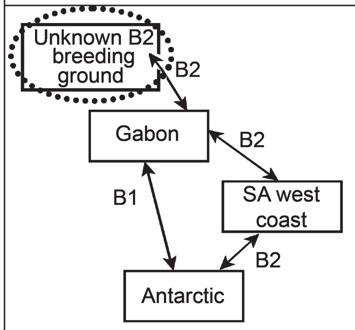
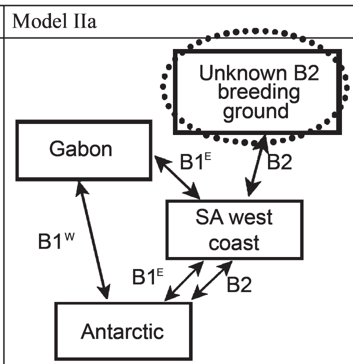
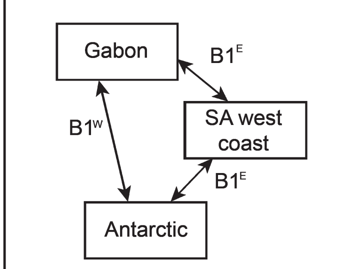
Model Ia	Model IIa	Model III
		
Model description: model assumes two independent breeding sub-stocks which can mix on Antarctic feeding grounds. Whales from breeding sub-stock B1 feed in the Antarctic and migrate to Gabon for breeding. Whales from breeding sub-stock B2 feed off WSA and migrate along the West African coast through Gabon to a separate unidentified breeding ground. Additionally, some portion of B2 animals migrate to Antarctic feeding grounds. Variants on this model were not considered priority for the assessment of BSB.	*Model description:* model assumes two breeding sub-stocks, B1 and B2. B1 has two migratory components, B1E and B1W. Whales from B1W migrate from Antarctic feeding grounds directly to Gabon while whales from B1E migrate through waters off west South Africa before continuing on to the Gabon breeding grounds. Whales from sub-stock B2 feed primarily off WSA, do not migrate past Gabon and migrate to a separate unidentified breeding area. In addition, some portion of animals from sub-stock B2 migrates to Antarctic feeding grounds. Variants on this model were not considered priority for the assessment of BSB.	*Model description:* model assumes a single breeding stock, B1, with two migratory components B1W and B1E. B1W migrates directly to Gabon from Antarctic feeding grounds while B1E migrates through waters off west South Africa before continuing on to the Gabon breeding grounds. The proportion of animals using each migratory route may change over time.

Fig. 5. Stock structure hypotheses selected as priority for use in the BSB assessment.

in 2009. Only a few mortalities have been reported per year in previous decades. The authors hypothesised that this event could represent:

(1) an artefact of searching effort and coastal oceanography;
(2) a temporary increase in mortality rates; or
(3) the start of an increasing trend in mortality.

They considered the latter two hypotheses to be the most plausible, but noted that additional research would be required to discriminate between them. The Committee noted the importance of continued stranding monitoring to clarify the cause of such unusual events.

10.2.2.3 BREEDING STOCKS E AND F

The Committee welcomed papers on Breeding Stocks E and F and noted these will be relevant for the forthcoming assessment of these stocks. Two papers provided new information on the distribution and habitat use of humpback whales along the east coast of Australia (BSE1).

SC/62/SH21 described results from 13 satellite tags from northward migrating humpback whales off Evans Head, eastern Australia. In total, 371 days of location data tracked whales for nearly 21,000km. The results represent the first detailed movement data of this species in their proposed calving area around the southern Great Barrier Reef.

SC/62/SH25 described the first on-water photo-id study of humpback whales in the Great Barrier Reef Marine Park Cairns/Cooktown Management Area. Thirty percent of the 28 groups observed contained young calves, indicating that this may be an important nursery area for BSE1. Seven individuals were matched to sightings in other areas of east Australia in previous years. Group size, composition, distribution and behaviour were also discussed. Further work is planned and data are available for collaborative research.

Three papers provided new information on the population structure and dynamics of BSE and BSF. SC/61/SH14 presented annual realised growth rates and survival of post-yearling BSE1 humpback whales off New South Wales, Australia (1994-2009). Several caveats were noted and suggestions for further analysis of these data are described in Annex H, item 2.2.2.

SC/62/SH7 reported on a large collaborative comparison of microsatellite genotypes from the migratory corridor along eastern Australia (n=734), the South Pacific Islands (n=1,086) and Antarctic feeding Areas I-VI (n=175). Breeding ground interchange was detected between Eastern Australia-New Caledonia (n=11) and Eastern Australia-Tonga (n=1). The only matches made to feeding grounds were between Eastern Australia and Antarctic Area V (n=3), despite larger sample sizes from Areas IV and VI. The authors concluded that breeding sub-stocks may be mixing on both their breeding and feeding grounds.

They also highlighted the feasibility of this type of collaborative research for studying migratory interchange on a large-scale. SC/62/SH18 reported photographic and genotypic mark-recapture estimates of abundance for humpback whales breeding at the South Pacific Islands (BSE2, BSE3 and BSF) for the period 1999-2003 and concluded that total combined abundance for these breeding stocks likely lies between 2,361 and 3,520 whales. No significant trend in abundance for this population was detected.

Additional details on the discussion of papers on BSE and BSF can be found in Annex H, item 2.2.3.

10.2.2.4 BREEDING STOCK X (ARABIAN SEA POPULATION)
The Committee received two papers with new information on the status of breeding stock (BSX). It had been given this name at a 2006 workshop on Southern Hemisphere humpback whales (IWC, In press). The population is believed to be resident to the Arabian Sea, is currently estimated at 82 individuals (95% CI=60-111) (Minton *et al.*, In press) and recently listed by the IUCN as endangered (Minton *et al.*, 2008). The Committee **agrees** to henceforth call this the Arabian Sea population.

SC/62/SH6 reported on the genetic distinctiveness and current population status of the Arabian Sea population. Genetic analyses based on 11 microsatellite markers and mtDNA sequences revealed significant differentiation between whales sampled off the coast of Oman (n=67), relative to the North Pacific and four Southern Hemisphere regions. Estimated levels of differentiation are among the highest recorded for humpback whale populations worldwide.

It is very unlikely that there is currently any exchange between the Arabian Sea and the Southern Indian Ocean stocks. Tests of population expansion suggest that the population has not yet started recovering and may still be in decline. SC/62/SH20 discussed the anthropogenic threats facing this population and challenges faced in monitoring this endangered population. Baleen whales in this region are potentially vulnerable to impacts from fishing, coastal development, shipping and noise and impacts. At least one live humpback whale entanglement in a gillnet is known to have occurred during the period 2007 and 2009. Research effort has been severely limited in recent years.

The Committee thanked the authors for this new information, noting its **great concern** over the status of this population. The Committee **strongly recommends** the continuation of research on humpback whales in the Arabian Sea in light of the small population size and escalating threats (see also Annex J, item 9.3). It further recognised the difficulty of undertaking such studies for small populations in remote areas.

The Committee also makes the following **recommendations** (in order of priority) for this population:

(1) studies that enable identification and quantification of threats to the Arabian Sea population should be initiated, including an in-depth investigation into the impact of bycatch;
(2) studies and surveys in Oman should be continued and expanded in scope to include more detailed genetic, acoustic and behavioural studies, as well as satellite telemetry studies;
(3) surveys should be encouraged in additional locations in confirmed range countries (Kuwait, India, Iran, Iraq, Oman, Pakistan, Sri Lanka, United Arab Emirates, Yemen), with particular focus on those countries with large coastal regions, such as Pakistan and India - in this regard, abundance surveys should be repeated on a regular basis in order to enable determination of population abundance and trend;
(4) further investigation into humpback whale occurrence in suspected/potential range countries (Bahrain, Maldives, Qatar, Saudi Arabia) should also be conducted; and
(5) studies and surveys to determine the population identity of whales in the Seychelles Exclusive Economic Zone should be performed.

The Committee further noted that given that this is a small population with known anthropogenic threats, it may well benefit from the development of a conservation management plan, following the model for western gray whales described under Item 10.4 and based upon Donovan *et al.* (2008). The Committee **agrees** that this should be explored further, perhaps within the context of conservation management plans being discussed by the IWC Conservation Committee

Further discussion of the Arabian Sea population is found in Annex H, item 2.2.4

10.2.2.5 FEEDING GROUNDS
SC/62/SH3 described a pilot study of cetacean distribution off Adélie Land that was launched by the French Polar Institute (IPEV) as part of the Southern Ocean Research Partnership (SORP). One photo-id match supported a migratory link between BSE and Area V. The Committee **recommends** the continuation of this programme, noting its relevance and utility for the forthcoming assessments of BSE and BSF.

SC/62/O12 presented a preliminary report of a joint Australian-New Zealand Antarctic Whale Expedition. Thirty humpback whales were satellite tagged on the Southern Ocean feeding grounds, and over 60 biopsy skin samples and approximately 60 individual fluke photographs were also collected. The Committee welcomed this research, which will make an important contribution to forthcoming assessments, and **recommends** its continuation. It also **recommends** that photo-id, biopsy sampling and satellite tagging research be conducted in other poorly surveyed areas of the Southern Hemisphere. The Committee **appreciates** the data sharing that has occurred post-expedition; this has been very productive with respect to matches identified with the East Australian breeding region and it **recommends** the continuation of such open collaborations. Finally, the Committee further **recommends** that long-term studies of humpback whales be undertaken and continued in the Southern Hemisphere.

SC/62/SH19 reported molecular genetic species identification of 281 whale bones collected between 2006 and 2007 in South Georgia. The prominence of humpback, fin and blue whale bones correspond to the early catch record in this area. Historical and contemporary humpback whale mtDNA haplotype diversity will be compared to measure the extent of the 'exploitation bottleneck' of stocks around South Georgia. The Committee **welcomes** this work and strongly **encourages** the continuation of bone collection for 'historical' DNA analysis. It further noted that this research will be important for the comparison of historic and current population abundance and diversity.

10.2.2.6 PRELIMINARY MULTI-STOCK ASSESSMENT
SC/62/SH33 reported preliminary results from the development of a population model that aimed to include all seven Southern Hemisphere humpback whale breeding stocks in a single joint assessment, with the purpose of allowing high-latitude historic catches to be allocated to breeding stocks in proportion to abundance, rather than on set ratios. The Committee **encourages** the further development of this model and the presentation of results in future meetings.

10.2.3 Antarctic Humpback Whale Catalogue
SC/62/SH17 described the progress of the Antarctic Humpback Whale Catalogue (AHWC). A total of 899 photographs of 721 individuals were catalogued from Antarctic and Southern Hemisphere waters for the interim

period. Images were submitted by 21 individuals and research organisations. These submissions bring the total number of catalogued whales identified by fluke, right dorsal fin/flank and left dorsal fin/flank photographs to 3,665, 413 and 407, respectively. New inter-area matches were as follows: BSG-Antarctic Peninsula (19), BSG-Chile (3), BSA and BSC3 (1; see SC/62/SH27) and BSE-Antarctic Peninsula (2; see Robbins *et al.*, 2008). Re-sightings were also made at the Antarctic Peninsula (3) and within BSG (11). Progress continues to encourage contributions from researchers and eco-tourism. A new on-line catalogue using Flickr is in development and can be viewed at *http://www.flickr.com/ahwc*. The Committee noted the importance of this IWC-supported work and **recommends** its continuation.

10.3 Southern Hemisphere blue whales

In 2002, the Committee recommended that the assessment of blue whales be started in 2005, after the completion of the IDCR/SOWER review (IWC, 2003a, p.41). In 2008, the Scientific Committee completed a circumpolar assessment of Antarctic blue whales (IWC, 2009f) and recommended that area-specific analysis be examined to evaluate whether separate assessments can be done for each IWC Management Area (IWC, 2009f). The Committee also recommended gathering data relevant for the assessment of non-Antarctic (pygmy-type) blue whales. Detailed discussions from this year can be found in Annex H, item 3.

10.3.1 New information

The Committee welcomed new abundance estimates of blue whales off Chile. A new analysis of line transect data collected as part of the 1997/98 SOWER cruise off Chile (Williams *et al.*, 2009b) resulted in an estimate of 303 individuals (95% CI=217-455). Aerial line transect surveys conducted off Isla Chiloé in 2007, 2009 and 2010 resulted in estimates of 97 (CV=0.51), 154 (CV=0.32) and 163 (CV=0.39) individuals, respectively. Further details of these surveys are presented in Annex H, item 3.1.

At last year's meeting, the Committee noted that available line transect estimates probably do not represent the total size of the population(s) present and recommended other approaches be used to estimate blue whale abundance. Progress was reported on the Alfaguara Project's field season off Isla de Chiloe (southern Chile), and particularly its continuing blue whale photo-id research. A preliminary mark-recapture abundance estimate was also presented for pygmy blue whales at the Perth Canyon, Western Australia. Further description of that on-going work is provided in Annex H.

The Committee **recommends** that new or revised estimates of abundance be provided to next year's meeting; specifically from Chile (Galletti and Hucke-Gaete). For Western Australia (Perth Canyon) the level of research necessary to improve the mark recapture data (which is currently very sparse in recaptures) for updated abundance estimates is unlikely to be affordable in the coming year. The Committee also **recommends** that the intersessional e-mail group under Bannister continues to work toward providing new estimates of mark-recapture abundance of blue whales and to report new information at next year's meeting.

The Committee was informed of progress on the development of a cooperative Southern Hemisphere blue whale photo-identification catalogue (SHBWC). Nine groups have joined the SHBWC, including researchers in Chile, the Eastern Tropical Pacific, Australia, Sri Lanka, and Antarctica. Photo-id data from the Japanese Institute for Cetacean Research (ICR) Whale Research Program under special permit in the Antarctic (JARPA 1987/88-2004/05 seasons) has also been submitted to the IWC Secretariat and will be added to the SHBWC through the appropriate data availability channels. The Committee **welcomes** the update on the work of the SHBWC and **recommends** its continuation. It **recommends** that the photographs from the ICR catalogue should be compared to those already held at the Southwest Fisheries Science Center.

SC/62/SH29 reported on archiving and matching of blue whale photographs collected by the IDCR/SOWER cruises between 1987/88 and 2008/09. Over 23,000 photographs were obtained from all six IWC Management Areas, with 219 individual whales identified. Results suggest some degree of residency within a summer feeding season.

The Committee **recommends** that work on the Southern Hemisphere Blue Whale Catalogue (SHBWC) be continued. Over the next two years this will require completion of the matching from the three regions. Budget implications are given under Item 24.

SC/62/SH21 reported on satellite tagging of pygmy blue whales off southwestern Australia. Three tags were deployed (two males, one female) and the whales were tracked for over 8,000km. The tag with greatest longevity (137 days) provided definitive evidence of a link between whales that feed offshore of the Perth Canyon and those that occur around eastern Indonesia, such as the Banda Sea where reports of blue whales appear to be increasing.

The Committee welcomed a number of studies on blue whale acoustics. SC/62/SH26 described the migratory patterns and estimated population sizes of pygmy blue whales traversing the Western Australian coast. An analysis of passive acoustic data estimated that 662-1,559 pygmy blue whales passed the sampling instrument during the 2004 southbound migration. The Committee noted that the acoustic approach to estimating population size reported here represents an important theoretical development, but noted that a number of assumptions of this method needed to be explored in more detail before it could be considered to produce robust estimates of abundance. The Committee also encouraged the continuation of this work.

Gedamke and Robinson (2010) reported the results of an acoustic survey for whales and seals in eastern Antarctic waters (30-80°E) between January and February 2006. Blue whales were the most commonly recorded species identified. They were detected in large concentrations where relatively extensive sea ice remained off the continental shelf and the more eastern waters off the Prydz Bay region. Two detections of pygmy blue whales represent the most southerly recordings of these species.

SC/62/SH13 described results from passive acoustic monitoring for the presence of baleen whales off the coast of Northern Angola, off the Congo River outflow. A series of pygmy blue whale calls were detected by two marine autonomous recording units deployed between March and December 2008, 15km and 24km offshore. This represents the first confirmed modern documentation of this sub-species in Southeast Atlantic waters north of 60°S since the cessation of commercial whaling for blue whales in the region. The calls were of the type attributed to the Sri Lanka population of pygmy blue whales, and not previously recorded outside of the Indian Ocean. Antarctic blue whale calls were not detected. The recording of Sri Lanka pygmy blue whale calls in the Atlantic Ocean was considered to be of great interest.

Progress was reported on a genetic study of Antarctic blue whales, which has been carried out with access to 218 IDCR/SOWER biopsy samples provided by the IWC. More than half of the haplotypes detected thus far have not previously been described. Analysis of the samples is ongoing and the results will be used to estimate the minimum historical population abundance of the Antarctic blue whale. The Committee welcomed this work and **recommends** its continuation. It was observed that this study expands on the haplotype data originally reported by LeDuc *et al.* (2007); the additional haplotypes reported here likely originated from IWC Management Areas II and III (Donovan, 1991), which were under-sampled in the previous study.

The Committee welcomed information on an upcoming study of the global taxonomy of blue whales using mitogenomic and nuclear sequence data. This work aims to conduct a comprehensive genetic assessment of blue whale taxonomy using next-generation sequencing methods to sequence whole mitogenomes and a large number of nuclear regions, for phylogenetic analysis. The project will particularly focus on determining the sub-specific status of blue whales in the North Pacific. The Committee **strongly encourages** continued collaborative efforts to acquire blue whale samples globally, and welcomed further updates on the results of the study

Four blue whale genetic projects are currently in progress: (1) genetics of blue whales in Geographe Bay, Western Australia, as part of a southern Australian study (11 samples collected, 11 analysed and archived, Möller, see SC/62/ProgRepAustralia); (2) a genetic population structure study of blue whales in the southeast and Eastern Tropical Pacific regions (Flores-Torres); (3) a global taxonomy study of blue whales (Lang); and (4) a genetic analysis of the diversity of IDCR/SOWER Antarctic blue whale biopsy samples and South Georgia whalebones (Sremba). The Committee **encourages** continuation of this research and **recommends** that results from these studies be reported when they become available.

10.4 Western North Pacific gray whales (BRG)

10.4.1 New scientific information

Considerable information was presented, and this is discussed in Annex F, item 6.1. Only a brief summary of that work is given here.

In SC/62/BRG11, data generated using a panel of 13 microsatellite loci were combined with updated information from mtDNA control region sequences to further assess the population structure of gray whales in the North Pacific. The results are consistent with the possibility that there may be some dispersal between two populations but that observed genetic differentiation is supportive of two populations.

SC/62/BRG10 presented the results of a paternity analysis conducted on the western gray whale population. The results suggest that some males that contribute to reproduction in this population may not regularly use the primary Sakhalin feeding ground. This highlights the need to collect genetic samples from animals recorded in other areas of the western gray whale's range. The results also provide evidence of interbreeding among animals that show fidelity to the Sakhalin feeding ground.

SC/62/BRG5 presents the first analysis of genetic (mtDNA) data obtained from the gray whales migrating along the Japanese coast (n=6) and incorporated comparison of these with a sample of animals from the Chukotkan hunt in 2008 (n=7). In summary, while recognising the small sample size: (a) all of the mtDNA haplotypes found had been previously reported; (b) the level of genetic diversity within samples was surprisingly high; (c) no genetic heterogeneity in haplotype frequencies was detected between the two samples; and (d) phylogenetic analysis of the haplotypes detected no distinct cluster for the Japanese whales.

The Committee **welcomes** these analyses. It **encourages** the collection of more samples from areas outside Sakhalin feeding ground when they are available and **recommends** a more detailed analysis of samples currently available and a number of suggestions are given in Annex F, item 6.1.

The Committee also received a number of papers on distribution and abundance. A number of points of interest were raised by these papers including:

(1) the potential for western gray whales to reoccupy parts of their former range if the currently small population expands (SC/62/BRG3);
(2) significant annual variation in whale densities among years within the Piltun and offshore feeding areas (SC/62/BRG4);
(3) updated information on an industry-sponsored monitoring programme using photo-id included the movement of animals between Sakhalin and Kamchatka and mother-calf pairs in Olga Bay, Kamchatka (SC/62/BRG9);
(4) updated information from the 2009 collaborative Russia-U.S. research programme (SC/62/BRG6);
(5) comparison of age at sexual maturity in western and eastern gray whales suggesting that the range 6-12 yrs is appropriate for both populations although further data would be welcome (SC/62/BRG2); and
(6) updated information on research and conservation in Japan including information on skeletal studies and an educational programme for fishermen (SC/62/O7).

The Committee **welcomes** all of the new information on this critically endangered population. It **encourages** further work and as in previous years, re-emphasises the importance of continued long-term monitoring. The Committee **recommends** that, if the observed density of gray whales in the Piltun feeding area continues to decline or remains lower than in previous years, future studies should investigate whether this reflects natural variation (e.g. in prey availability), industrial disturbance or some other factors.

Donovan reported on progress with the telemetry programme on western gray whales that has been recommended by the Committee (e.g. see IWC, 2010c). He reported that the programme is progressing and that all involved are grateful to Ilyashenko and his colleagues at IPEE for their work to try to ensure that this project goes ahead, particularly at this stage with respect to the permit issue. An overall administrative and scientific structure has been agreed between the participating institutions and companies, the IWC and IUCN. The scientific steering group is continuing to work on finalising the protocols that will ensure that the IWC Scientific Committee safeguards and guidelines are met as it has been tasked by the Committee; the final protocols will be drawn up in co-operation with IPEE and OSU. IWC, IUCN and the funding companies are also working hard on difficult budgetary issues. It is hoped that it will be possible for the programme to take place this summer.

10.4.2 Conservation advice

The Committee again **recognises** that the problem of net entrapment of western gray whales is a range-wide issue. It **welcomes** the efforts of Japan to reduce mortality, including the educational programme, and notes that net entrapments could occur in other range states. Brownell summarised plans for seismic surveys off Sakhalin Island in 2010. There is concern that anthropogenic sound, especially from seismic surveys, will negatively affect western gray whales in their primary feeding area. Previously, the Commission expressed concern and passed resolutions on this topic. Two seismic surveys in or near the feeding area are planned for 2010. It was noted at the recent meeting of the IUCN Western Gray Whale Advisory Panel that the company (Rosneft) planning the later survey has not followed the same procedures in regard to monitoring and mitigation as the company planning the first survey (by Sakhalin Energy). As currently planned, the Rosneft survey will occur while the highest number of feeding gray whales, including cow and calves, are present. The Committee is **extremely concerned** about the potential impact on western gray whales and **strongly recommends** that Rosneft postpone their survey until at least June 2011 The Committee also **recommends** that Rosneft use monitoring and mitigation measures similar to those used by Sakhalin Energy (see Annex F, Appendix 4), which have been independently reviewed by experts, and that all energy companies operating in the feeding areas of western gray whales should use comprehensive monitoring and mitigation measures to protect western gray whales.

As in previous years, the Committee **acknowledges** the important work of the IUCN Western Gray Whale Advisory Panel (WGWAP). This year's update on the panel's activities is given in Appendix 4 of Annex F. Noting that the WGWAP's present contractual five year life span ends after December 2011, the Committee **re-emphasises** its view that its work is important and should be **continued** if at all possible, and the Committee **requests** the Secretariat to send a letter to IUCN in this regard.

In 2009, the Committee welcomed the report of the IUCN range wide workshop (IUCN, 2009). An important conclusion of that workshop was the need for the development of a conservation plan for western gray whales and this recommendation was endorsed by the Scientific Committee.

This year, the Committee was extremely pleased to receive the first draft of this important Plan (SC/62/BRG24). It **commends** the authors, who include scientists from range states as well as elsewhere, for this important document. The Plan follows the guidelines developed for such plans by Donovan *et al.* (2008) that were endorsed by the Committee (IWC, 2009a). Much of it is based on the report and recommendations of the IUCN rangewide workshop that have also been endorsed by this Committee. The Committee emphasised that the Plan should be supported and endorsed by many stakeholders, including national and local governments, industry, and non-governmental organisations, as well as international organisations such as IWC and IUCN. The overarching goal of the Plan is to reduce mortality related to anthropogenic activities to zero as quickly as possible. The Plan includes 11 focussed actions (related to co-ordination, public awareness, conservation research, monitoring and mitigation) of high importance for the conservation of this critically endangered population. The most immediate, in terms of ensuring the success of the Plan is the appointment of a Steering Committee and of finding funds for and appointing a full-time Co-ordinator. This is also critical to the need, identified by the authors, to engage broad stakeholder participation in the Plan as soon as possible.

The Committee **strongly endorses** this Plan and **commends** it to the Commission and range states. It also **recommends** that it is broadly distributed, including being posted on the IWC and IUCN websites. Consideration is being given to it being published by the *JCRM*. The Committee **recommends** the Plan as a model for the development of other conservation plans for cetacean populations.

10.5 Southern Hemisphere right whales

10.5.1 Australian and New Zealand areas

The Committee received a number of papers on southern right whales from these areas. Details can be found in Annex F, item 5.3. A number of points of interest from these are given below:

(1) genetic comparison of animals around the subantarctic Auckland Islands and the main islands of New Zealand provided documented evidence for the first time of the movement between the two regions and, along with other available data, is most consistent with either the one stock or the extirpation/recolonisation hypotheses (SC/62/BRG16);
(2) results from satellite telemetry provided data on migratory movements of three whales tagged at the Auckland Islands revealed that animals from this nursery area/breeding ground can move north to their feeding ground - the reverse of the generally accepted migratory pattern for southern right whales (SC/62/BRG19);
(3) information on acoustic contact calls from southern right whales near the Auckland Islands (SC/62/E13); and
(4) updated information on long-term aerial survey monitoring programme along the southern Australian coast results in an annual increase rate for cow/calf pairs of around 7.5% (95%CI 3.2, 12.0) for the period 1993-2009 and a minimum population size of 2,530, with a total Australian population of about 3,000.

Difficulties or complications experienced in obtaining permits for biopsy sampling of right whale calves were discussed. Although there were legitimate concerns over possible disturbance to mother-calf pairs, no adverse effect had been shown on subsequent calving interval in a study of the effects of biopsying over 100 cow-calf pairs off South Africa, although the statistical power was low (Best *et al.*, 2005). Given the potential value of such sampling, particularly in establishing issues of paternity the Committee **recommends** that permitting authorities should view requests for biopsy sampling of cow-calf pairs on their scientific merit and apply appropriate safeguards to limit the degree of disturbance where necessary.

10.5.2 South America area

The primary item discussed under this item was the report of a workshop (convened by Brownell) held at the Centro Nacional Patagónico (CENPAT) in Puerto Madryn, Argentina from 15-18 March 2010. The goal of the workshop was to investigate the causes of the high mortality of southern right whales around Península Valdés, Argentina. Participants included experts on the ecology and marine environment of the Península Valdés region, scientists studying right whales in the South Atlantic and international experts on whale strandings and mortality.

Small numbers of strandings have been recorded in the region since 1971. However, since 2003, when the Southern Right Whale Health Monitoring Program (SRWHMP) was established, a total of 366 right whale deaths have been recorded, with peaks in 2003 (31), 2005 (47), 2007 (83), 2008 (95) and 2009 (79). Over 90% of the deaths have been of first-year calves. After investigating thoroughly a range of possible causes for these first year deaths, the workshop agreed three leading hypotheses (it was not possible to determine which was most likely and some combination of factors may have occurred, at least in some years): (1) reduced food availability for adult females; (2) biotoxins; and (3) infectious disease.

The workshop recommended a number of steps to build a better understanding of the cause or causes as listed in Annex F, item 5.3.2.

Of these, continuation of the long-term aerial photo-id programme, other complementary monitoring effort and the SRWHMP are highest priority. The workshop agreed that cooperation and collaboration among research groups is essential for addressing complex questions concerning the die-offs. A western South Atlantic right whale consortium (the North Atlantic right whale consortium) could be used to establish and maintain links among researchers and to share information (this should also include researchers in different parts of the range). Efforts to improve such cooperation and collaboration should be a high priority for local and national governments, NGOs and INGOs.

It was also agreed that the absence of conclusive information regarding the cause(s) of exceptional right whale mortality should not preclude authorities from proceeding with some management measures, particularly in relation to kelp gulls, where gull lesions are clearly harmful to the whales, especially the calves.

The workshop also recognised: (1) the considerable efforts of the researchers in Argentina (and abroad) to investigate the die-offs in the face of fiscal and logistical constraints; and (2) the importance of governmental commitment to the long-term conservation of right whales in Argentina.

The Committee thanked Brownell for his presentation and **endorses** the workshop report. The Committee **welcomes** the announced intention of the Argentine authorities to introduce this year a pilot plan for the control of nuisance gulls.

As in previous years, the Committee **recognises** the value of the long-term photo-id programme of right whales at Península Valdés that had now lasted 40 years, particularly in being able to describe the significance of the recent die-off events and test certain causation hypotheses. It **strongly recommends** its continuation. It also noted that this year emergency funding had been provided by the US Marine Mammal Commission to enable the necropsy programme to take place and strongly **recommends** the continuation of this programme to investigate the reason(s) for the die-off.

The Committee also considered SC/62/BRG15, a preliminary assessment of the genetic structure of the southern right whales from Península Valdés, Argentina. A number of comments to assist in future analyses were raised in discussion (Annex F, item 5.3.2) and the Committee looks forward to an updated analysis next year.

The Committee was pleased to receive information on the 2009 flights of an aerial survey programme off Brazil and it **recommends** the continuation of the surveys.

10.5.3 South Africa area

The Committee was pleased to receive updated information on demographic parameters obtained from the long-term monitoring programme of South Africa (SC/62/BRG30). The results are discussed in Annex F, item 5.3.3 but key features include an annual growth rate of about 7% (95% CI 6.5%, 7.5%); a mean calving interval of about 3.2 years; and a population size in 2006 as about 4,100 animals. SC/62/BRG31 examined the possibility of changes in some demographic parameters for right whales off South Africa through the analysis of re-sighting data for females with calves over the 1979-2006 period. No statistically significant change in adult survival rate or population growth rate was found but a reduction in mean calving interval from 3.2 to 3.1 years was detected.

SC/62/BRG33 reported on the recent announcement of the intention to drill exploratory boreholes for natural gas in eight districts of the coastal region of the southwest coast of South Africa, three of which included nearshore waters that were home to the largest concentration of cow-calf pairs on the African coastline. About 75% of cow-calf pairs on the southern African coast occur in this region in spring, some of which are resident for up to three months, while the westward coastal movement seasonally means that an even larger proportion of the population almost certainly uses the region.

The Committee viewed this potential development with concern, noting the current lack of information available on the proposed activities. It **recommends** to the South African government that all permits issued for exploratory activities should contain mandatory mitigation measures to avoid disturbance to right whales, including confining all marine drilling activity to the season when right whales are absent (January to May). It also **recommends** that if gas production is ultimately planned for the region, the use of closed areas or the development of further mitigation measures such as directional drilling should be considered.

The Committee **endorses** a proposal for the establishment of a Southern Ocean Right Whale Photo-identification Catalogue (the Antarctic Humpback Whale Fluke catalogue). The intention is to provide a resource that could be consulted when researchers holding images taken in coastal waters wished to establish linkages with feeding grounds in pelagic waters (see Appendix 2 of Annex F for detail). It was confirmed in discussion that this would be supplementary to such coastal catalogues. The Committee looks forward to receiving a progress report at its next meeting. Funding is dealt with under Item 24.

10.5.4 Plans to review southern right whales

Brownell reported on progress in preparing for the Southern Right Whale Assessment Meeting, planned to be held at Puerto Madryn, Argentina, in September 2011. Given that this meeting would be held very shortly after next year's IWC meeting a budget would have to be prepared at this meeting (and reserved until 2011). A small group was set up to draw up the budget and draft the Terms of Reference for the meeting (see Annex F, Appendix 3). The Committee **agrees** that this should be funded next year.

10.5.5 Other

The Committee recognises the importance of long-term studies, to provide biological information from photo-id and information on trend and population size from sighting and mark-recapture analyses. It **strongly recommends** the continuation of such long-term studies in relevant areas.

10.6 Other stocks of right whales and small stock of bowhead whales

10.6.1 North Atlantic right whales

An update was provided on North Atlantic right whales for the period May-October 2009, as an addendum to information presented in Pettis (2009). The summary reflects the work of the North Atlantic Right Whale Consortium (NARWC). A shared photographic catalogue was used to produce a 'best' estimate of population size of 438 for 2008. This total did not explicitly account for unphotographed whales in the population and may change slightly as additional data are incorporated into the catalogue. One right whale death was documented during the report period, but the cause was not determined. Additionally, there were three new entanglement cases and eight previous entanglement cases that had not yet been resolved.

The Committee **agrees** that the documented growth in the catalogue plus successive years of improved calf production gave grounds for cautious optimism over the future status of this population. However, while welcoming the management measures that have been taken to date, the Committee **repeats its previous recommendations** on this population that it is **a matter of absolute urgency** that every effort be made to reduce anthropogenic mortality to zero.

10.6.2 North Pacific right whales

SC/62/BRG3 reviewed past sightings of North Pacific right whales off western Kamchatka from spring to autumn. A number of sightings of these whales were made during Japanese-led surveys from 1989 to 2003; these were mostly restricted to the southern portion of study area. However, there were also a few sightings in earlier years by Soviet scientists, including in the northern part of the area. These sightings also highlight the need for directed research and monitoring of right off western Kamchatka in areas overlapping with fishery and oil and gas development activities.

SC/62/NMP22 provided results of observations of North Pacific right whales during the common minke whale sighting and biopsy survey conducted in the Okhotsk Sea in summer 2009. The research area was set north of 46°N, south of 57°N and west of 152°E in the Okhotsk Sea including the Russian EEZ. 17 schools (29 animals) of North Pacific right whales were found, mainly in the offshore waters deeper than 200m. Of these, 16 schools were targeted for photo-id research and 22 animals in 15 schools were individually identified (there are no re-sightings among them).

The Committee welcomes the sighting and photo-id information from these cruises and **encourages** continuing these studies in the area.

Wade *et al.* (2010) used photographic and genotype data to calculate the first mark-recapture estimates of abundance for right whales in the Bering Sea and Aleutian Islands. The estimated abundance data reveal this to be an extremely small population of perhaps around 30 animals. The results will be updated using more samples and images from another survey planned in the eastern North Pacific this year and the Committee looks forward to receiving this information.

Noting the extremely small size of this population, and also the potential for disturbance and ship-strike mortality from greatly increased ship traffic resulting from the likely opening of the northeast or northwest Passages due to sea ice retreat, the Committee considers it **a matter of absolute urgency** that further research be conducted on eastern North Pacific right whales, and **recommends** that this research focus on assessing status and identifying any current sources of anthropogenic mortality.

10.6.3 Small stocks of bowhead whales

SC/62/BRG3 summarised sightings of bowhead whales off western Kamchatka from existing published literature and other available sources. Okhotsk Sea bowhead whales were recorded only a few times in the study area during the spring-autumn period, with one sighting during winter; however it is known from historical whaling data that this species was abundant in the area, particularly in the northern regions during periods of open water.

SC/62/BRG20 reported the results of a survey for bowhead whales conducted in the Fram Strait during 29 March-14 April 2010. Two observations were made, but it was determined based on identifiable scars that both encounters were of the same individual.

Witting reported that 12 sighting of bowhead whales were made in the Northeast Water Polynia off Northeast Greenland during an aerial survey for walrus during August 2009. He also reported that a female with a calf was seen off Norske Island, Northeast Greenland in July 2009. In discussion, it was noted that two passive acoustic recorders were deployed in the Fram Straight during 2008-09 and that these instruments detected numerous bowhead sounds including songs.

The Committee welcomes the above information and **encourages** future updates and research.

10.7 Antarctic cruises

10.7.1 General review of 2009/10 cruise

The planning meeting for the 2009/10 IWC/SOWER cruise was held in Tokyo, Japan in September 2009 (SC/62/Rep6). The cruise took place in Area IV and had two main objectives: (1) to undertake a sightings survey in collaboration with an Australian Antarctic Division aerial survey; and (2) to continue research on the priority species (southern right, blue, fin, and humpback whales). The total number of minke whales sighted in the research area was 83 groups, comprising 152 animals; humpback whales were the most frequently sighted species (174 groups comprising 322 animals). Biopsy samples and individual identification photographs were taken from 21 and 45 humpback whales and 22 and 26 southern right whales, respectively. A total of 28 groups of southern right whales (38 animals) were sighted (SC/62/IA1).

The Committee thanks the Government of Japan for generously providing the vessel and crew for this survey, and also thanks the Cruise Leader for her efforts. Noting that this was the last IDCR/SOWER cruise, the Committee also extended its appreciation to all member nations and researchers who had contributed to this extensive programme, and particularly to the governments of Japan and the former Soviet Union, for providing the survey vessels. The data collected during the programme provide an unparalleled source of information on Antarctic cetaceans. The experience gained from these surveys will continue to be of use in planning future studies, in the Southern Ocean and elsewhere. The Committee **agrees** that a Special Issue of the *JCRM* on the IDCR/SOWER surveys is warranted and re-establishes the working group to progress this idea (see Annex Q).

10.7.2 Plans for cetacean sighting surveys in the Antarctic in the 2010/11 season

SC/62/O17 described a dedicated, systematic cetacean sighting survey which was being planned to take place from December 2010 to February 2011 in order to obtain estimates of abundance for use in the RMP. The research area will be south of 60ºS in Area V and the western part of Area VI (130ºE-145ºW), including the Ross Sea. This survey will be conducted in relation with the Japanese Whale Research Programme under special permit in the Antarctic (JARPA II). Two dedicated, sighting survey vessels, *Shonan-Maru No.2* and *Yushin-maru No.3*, will be used and the survey procedures will be based on the standard

SOWER search modes; closing (NSC) mode and passing with the independent observer (IO) mode.

In order to minimise difficulties associated with survey design, an intersessional Working Group was established under Matsuoka (Annex Q). The Committee **agrees** that Matsuoka is responsible for IWC oversight.

10.8 North Pacific cruises

10.8.1 Recommendations for 2010 cruise and short term objectives

During the last year's Scientific Committee meeting, Japan presented a proposal for a medium- to long-term research programme involving sighting surveys to provide information for cetacean stock management in the North Pacific. The Scientific Committee welcomed the initiative and agreed the value of a large-scale, medium-long term integrated research programme in the North Pacific and encouraged this in the context of international collaboration under IWC auspices.

A meeting to discuss the North Pacific survey programme was held in Japan in September, 2009 (SC/62/Rep3). The meeting agreed four terms of reference:

(1) review the Scientific Committee's issues in the North Pacific;
(2) review the past and ongoing survey activities and available data in range states;
(3) consider possible line transect survey plans and additional data collection (e.g. photo-id and biopsy) for the 2010 season; and
(4) prepare a proposal for an intersessional workshop (to be held between SC/62 and SC/63) on future surveys beyond 2011.

SC/62/IA15 was provided in response to the first term of reference from the meeting and provided a summary of the Scientific Committee issues relating to North Pacific sei, common minke, Bryde's, right and blue whales. The distributions of these whale species were described and requirements for further surveys, in order to estimate abundance and investigate stock structure, were considered.

SC/62/IA10 presented the research plan for an IWC/Japan whale sighting survey taking place in summer 2010. The plan had been drawn up following guidelines agreed at the North Pacific programme intersessional meeting. The research area (170°E-170°W) had been chosen because for some species it spans proposed stock boundaries and has been poorly covered by previous surveys, representing an important information gap for several large whale species. The cruise will collect line transect data to estimate abundance, and biopsy/photo-id data contributing to the work of the Scientific Committee on the management and conservation of populations of large whales in the North Pacific. It will provide:

(1) information for the proposed future in-depth assessment of sei whales in terms of both abundance and stock structure;
(2) information relevant to *Implementation Reviews* (e.g. common minke whales) in terms of both abundance and stock structure;
(3) baseline information on distribution and abundance for a poorly known area for several large whale species/populations, including those that were known to have been depleted in the past but whose status is unclear; and
(4) biopsy samples and photo-id photos to contribute to discussions of stock structure for several large whale species/populations, including those that were known to have been depleted in the past but whose status is unclear.

The cruise will last about 60 days (including transit time) between July and August. In order to adequately cover the longitudinal range, the latitudinal range is restricted between a southern boundary at 40°N and a northern boundary at the Aleutian Islands chain. Four researchers can be accommodated on this cruise; US and Korean scientists will participate. The cruise will follow the requirements for reports and documentation developed for cruises that could provide data for use under the RMP and will be the responsibility of the Japanese scientists.

The Committee thanked the Government of Japan for its generous offer of a vessel for this survey. Matsuoka was assigned responsibility for IWC oversight.

Brownell reported that a scientist from SWFSC had now been identified for the cruise, but major problems regarding CITES permits remain; these issues are similar to those described in SC/62/NPM22 that were encountered between Japan and Russia for the collection of minke whale biopsy samples in the Russian EEZ. There are CITES issues for both inside and outside the US EEZ, because samples collected outside the US EEZ have to enter US waters and then all samples must be exported to Japan. A possible solution (institutional permits) has been proposed to Japan and it is being considered. If these problems are not worked out, it will not be possible to collect any biopsy samples (inside or outside the US EEZ) during this cruise. This would be a major scientific loss to advancing our understanding of the stock structure of baleen whales in the North Pacific, specifically sei whales. The Committee **recognises** the importance of the CITES issue and agreed that it should be resolved among parties concerned expeditiously. The Committee **endorses** the working group's report, and **recommends** that the investigations regarding the use of Institutional permits to exchange biopsy samples proceed as soon as possible, with the results of the investigations being reported to the Planning Meeting scheduled for October 2010.

SC/62/O16 described two sighting surveys for cetaceans, taking place in the North Pacific in 2010, to examine the distribution of sei, Bryde's and minke whales and to estimate abundance for use in the RMP. Both surveys are in the middle part of the Western North Pacific. The main target species are sei and minke whales for the first survey and Bryde's whale for the second survey. The Committee assigned responsibility to Matsuoka for IWC oversight.

10.8.2 Mid- to long-term plans for the North Pacific Survey Programme

In addition to plans for a 2011 cruise, the Committee **recommends** that a coherent multi-year plan be developed for the survey programme in accordance with the discussion given in SC/62/Rep3. A Steering Group to oversee the IWC North Pacific surveys was established under Kato (Annex Q). It was proposed that a meeting of the Steering Group should be scheduled immediately prior to the Planning Meeting for the 2011 cruise, in order to develop the programme of research to be undertaken over the next few years.

10.9 Other

The precise taxonomic relationships and species delineations within the Bryde's/Eden's whale complex are currently uncertain. In South Africa, 'inshore' and 'offshore' forms of Bryde's whale have been described (Best, 1977), and there has been some uncertainty as to whether they should be referred to as *B. edeni* and *B. brydei* respectively. The Committee received a proposal for opportunistic collection of biopsy samples of Bryde's whales during a forthcoming research cruise between the Strait of Gibraltar and Cape Town, South Africa. These samples would be used to facilitate more in-depth genetic analysis of the relationship between the 'offshore' form and other more well sampled Bryde's whale species. The Committee **recommends** this proposal, assuming that relevant permits will be acquired. The Committee also **recommends** that biopsy samples from other whales be obtained, where legally permitted to do so.

11. STOCK DEFINITION (SD)

This Agenda Item was established in 2000, and has been handled since then by a Working Group; see IWC (1999d, p.83) for the original Terms of Reference. The term 'stock' has been used with different meanings in different contexts at different times, both within IWC and in other management and conservation contexts. These multiple meanings have sometimes hindered the Committee's ability to provide management advice. The Working Group was set up to clarify the issue of 'stocks' in a management context (see Item 11.3), to create a bridge between IWC and the expertise of the wider population genetics community (see Items 11.2 and 11.3), to develop software that evaluates the management utility of various population genetic analyses (see Item 11.2), and to develop guidelines for preparation and analysis of genetic data within an IWC context (see Item 11.1). These issues are of fundamental importance to the Committee's discussions on assessments and to the development of management advice. The Report of the Working Group is given as Annex I.

11.1 Statistical and genetic issues related to stock definition

11.1.1 Guidelines on DNA data quality

The Committee has previously endorsed a general set of guidelines for ensuring sufficient quality in genetic data used for management advice (IWC, 2009g; *http://www.iwcoffice.org/sci_com/handbook*). These guidelines constitute a 'living document' that will be updated as necessary. Since the issues involved are complex, the guidelines currently lack any numerical reference points, and the Committee again **encourages** suggestions accordingly. The intersessional e-mail group established in 2008 (Annex Q) was unable to report back this year, but will be continued in the coming year. The item remains on the agenda for the 2011 Annual Meeting.

11.1.2 Guidelines on genetic and statistical analysis

In parallel with the development of data quality guidelines, the Committee is developing guidelines for some of the more common types of statistical analyses of genetic data that are employed in IWC management contexts. These guidelines, which are being developed through another intersessional working group, are at an earlier stage of development than the DNA data quality guidelines. The proposed structure of the document, including a motivating example, was shown last year (IWC, 2009h).

This year, the Committee reviewed a preliminary version of the guidelines (SC/62/SD1), with drafts of several of the sections. Some further work is required, but after one further iteration, the guidelines should be able to appear on the IWC website. Following review of the text so far, a number of suggestions were made for the next iteration, including an 'FAQ' and the possible use of simulated datasets from TOSSM (see Item 11.2) as worked examples. The full list may be found in Annex I. This document will entail a great deal of effort, but should be of lasting importance. It deserves to be published, both online via IWC and in peer-reviewed literature.

11.1.3 Other approaches to stock identification

The Committee has previously considered the utility of acoustic data in questions of stock definition (IWC, 2005e, pp.248-49). Acoustics may be an efficient tool for proposing stock distinctions and boundaries, but interpretation can be difficult unless *inter alia* the stability of individual acoustic behaviour over time is known. This year, paper SC/62/SD2 presented results from acoustic monitoring of fin whales in different seasons and regions of the Mediterranean. The Strait of Gibraltar and Alborán Sea areas experience an influx, during the breeding season only, of fin whales that are acoustically consistent with Icelandic or Norwegian animals, but distinct from other Mediterranean fin whales. The results suggest a possible explanation for the low levels of gene flow that have been found between Mediterranean and North Atlantic fin whale populations. The Committee noted the value of these new data in suggesting rather precise areas where stock mixing and/or separation may occur, and consequently in assisting development of economical sampling design. It **encourages** plans to follow up this study with biopsy sampling.

11.2 TOSSM (Testing of Spatial Structure Models)

The aim of the TOSSM project is to facilitate comparative performance testing of population structure methods intended for use in conservation and management planning. From an IWC perspective, the TOSSM software package allows evaluation of methods for detection of genetic structure, in terms of how well the methods can be used to set spatial boundaries for management. As noted last year, the framework is now complete and the software is available for all to use; simulated datasets exist for three of the five stock-structure archetypes previously proposed by the Committee (IWC, 2009a, p.51). To date, ten methods have been tested on datasets from the two simplest Archetypes (single-stock panmixia, and two populations with limited migration sampled and harvested on the breeding grounds). No new results were received this year. Just as last year, though, the Committee noted the relevance of Archetype IV to North Pacific common minke whale discussions, where program STRUCTURE (Pritchard *et al.*, 2000) is receiving extensive use. It may well be possible to use TOSSM datasets to investigate the likely performance of STRUCTURE in a North Pacific minke whale-like setting, not merely in terms of overall 'boundary setting' but also in terms of specifics such as ability to assign individuals to specific stocks.

Mark-recapture data are another powerful tool for investigating stock issues. These have not yet been considered in TOSSM; next year, the Committee will consider the feasibility of incorporating mark-recapture data into TOSSM datasets. Another potentially powerful tool is the suite of coalescent-based methods but no coalescent-based approaches to boundary-setting have yet been considered in TOSSM. The Committee hopes to consider results of a TOSSM on the coalescent-based software MDIV next year.

There has been much discussion of how to interpret results from the program STRUCTURE, specifically in assigning individuals either to a smaller number of stocks which mix to a different extent in different places, or to a larger number of 'new' stocks that are less mixed. The Committee **encourages** the submission of papers investigating the performance of STRUCTURE for this question, and noted that datasets from TOSSM (existing ones, or new ones if necessary) might be a good starting point for such investigations.

11.3 Unit-to-conserve

'Unit-to-conserve' is a standing item on the SD Working Group agenda. It provides for discussion of potential 'definitions of stock' in a management context, including their operational implications for measurement and management. No new proposals were considered this year.

12. ENVIRONMENTAL CONCERNS (E)

The Commission and the Scientific Committee have increasingly taken an interest in the possible environmental threats to cetaceans. In 1993, the Commission adopted Resolutions on research on the environment and whale stocks and on the preservation of the marine environment (IWC, 1994a; 1994b). A number of resolutions on this topic have been passed subsequently (IWC, 1996a; 1997; 1998a; 1999b; 1999c; 2001c). As a result, the Scientific Committee formalised its work on environmental threats in 1997 by establishing a Standing Working Group that has met every year since then. Its report this year is given as Annex K.

12.1 State of the Cetacean Environment Report (SOCER)

The SOCER aims to provide Commissioners and Scientific Committee members with a non-technical summary of events, developments and conditions in the marine environment relevant to cetaceans. The report is compiled annually, in response to IWC (2001c), with a focus on one pre-selected region each year plus a global section.

The 2010 SOCER was focused on the Arctic and based on peer-reviewed papers published between 2008 and 2010. The overwhelming issue for the Arctic was climate change – e.g. rate of ice loss and ecosystem shifts – but many of the papers in the review period had already been summarized in previous Committee reports because of their global significance. There were few pollutant studies specifically on cetaceans in 2008-10, but the Arctic Monitoring and Assessment Programme (AMAP) 2009 Assessment of Arctic Pollution Status (*http://www.amap.no/*) provides a comprehensive review of pollutant levels in the Arctic. Globally, the environmental issue that received the most attention over the past year was underwater noise, especially disturbance from boat traffic, impacts of sonar on beaked whales and the acoustic impacts of wind farms. Of note, a bibliometric analysis showed that there has been a shift in focus in the cetacean research literature from basic biology topics, which were prevalent in the literature in the 1970s, to conservation topics in recent years. Next year the SOCER will focus on the Southern Ocean.

12.2 Review progress in planning for POLLUTION 2000+, Phase II

The IWC-Pollution 2000+ programme was initiated to investigate pollutant cause-effect relationships in cetaceans, and arose from a Workshop on chemical pollution and cetaceans held in Bergen, Norway in 1995 (Reijnders *et al.,* 1999). Following the Bergen workshop, a planning meeting was held in 1997 (Aguilar *et al.,* 1999a) and a workshop was held in 1999 (Aguilar *et al.*, 1999b), where Phase I of the POLLUTION 2000+ programme was launched. Phase I had two objectives: (1) to select and examine biomarkers for exposure to and/or effects of PCBs; and (2) to validate/calibrate sampling and analytical techniques. The results of Phase I were reviewed and a general framework for POLLUTION 2000+ Phase II was outlined (IWC, 2008a). Discussion for Phase II studies since that time has determined the need to: (1) produce a framework for modelling the effect of pollutants on cetacean populations; (2) identify cetacean populations to be studied under Phase II; and (3) develop a protocol for validating biopsy samples and applying this protocol to any large whale species selected.

Last year, the Committee had proposed the following modified goals for the Phase II programme:

(1) develop an integrated modelling and risk assessment framework to assess cause-effect relationships between pollutants and cetaceans at the population level, building on the progress made during Phase I and on recent research, using modification of a tiered risk assessment paradigm;
(2) extend the work to new species and contaminants as appropriate; and
(3) validate further biopsy sampling techniques for use in addressing issues related to pollution, including legacy contaminants and new contaminants of concern and associated indicators of exposure or effects.

In February 2010, an expert workshop (with expertise in chemical contaminants, toxicology, cetacean biology, veterinary medicine and biomarkers) was held to further develop proposals for Phase II of the programme (SC/62/Rep4). Presentations were made on risk assessment frameworks, chemicals of emerging concern, contaminant exposure, modelling approaches and case studies. Biomarkers of chemical exposure and effects were also discussed, with the workshop purposefully selecting those that have been validated in cetaceans. An international prioritisation survey for chemical contaminants was developed and will be distributed to subject matter experts, with a final report on survey results to be presented at the 2011 IWC Scientific Meeting.

The Committee **endorses** four **recommendations** made at the Workshop:

(1) to improve existing concentration-response (CR) function for PCB-related reproductive effects;
(2) to derive additional CR functions to address other endpoints (i.e., survival) in relation to PCB exposure;
(3) to integrate improved CR components into a population risk model (e.g., individual-based model) for one or more case study species (e.g. bottlenose dolphin and/or humpback whale); and
(4) to develop new biomarkers and improve the linkages between lower and higher levels of organisation (molecular - individual - population). The highest priority for biomarker development should include those with direct relevance to population-level endpoints such as reproduction and survival.

A plan to make progress on Phase II can be found in Annex K. The Committee noted data gaps and research needs identified at the Workshop, specifically noting that progress on this topic will require initiating new studies or additional support of existing efforts

The ICES Working Group on Marine Mammal Ecology (WGMME) met in April 2010 in part to 'Review the current contaminant loads reported in marine mammals in the ICES area, the cause-effect relationships between contaminants and health status, and the population-level effects of environmental impacts.' The SWG had reviewed recommendations made by the WGMME with regard to pollutants in marine mammals (*http://www.ices.dk/reports/ACOM/2010/WGMME/wgmme_final_2010.pdf*). and the Committee **endorses** these recommendations.

The Committee received new information (SC/62/E9) on the development of a suite of sensitive biomarkers from non-lethal sampling to evaluate the toxicological status of Bryde's whale in the Gulf of California. A 'multi-trial-biomarker-tool' was developed, combining protein biomarkers with concentrations of organochlorines and polycyclic aromatic hydrocarbons. A second biomarker study (SC/62/E10) examined a multi-response *in vitro* method to detect toxicological effects of contaminant mixtures on skin samples from cetaceans in the Mediterranean Sea. Preliminary findings indicate that the combination of protein biomarkers, gene expression levels and tissue contaminant levels may be a useful tool in determining 'multiple toxicological stress' in free-ranging cetaceans. The Committee **welcomes** these studies but **emphasises** the importance of standardisation of contaminant concentration reporting.

The Committee received an overview of the oil spill that followed the explosion on board and subsequent loss of the drilling structure 'Deepwater Horizon' on 20 April 2010, approximately 50 miles southeast of Louisiana in the Gulf of Mexico. The incident claimed the lives of 11 workers. Immediately after the spill, response networks for marine mammals, sea turtles, and birds were established, including four facilities for de-oiling of manatees, dolphins, and sea turtles.

As of 4 June, 31 dead dolphins and 277 dead sea turtles had been documented, with numerous accounts of large and small cetaceans seen swimming in oil-contaminated waters. The Committee **commends** all groups that are responding to impacted marine mammals and turtles in the region.

It also **agrees** that it is extremely important to learn as much information as possible from this tragedy in order to accurately assess impacts and be better prepared for potential future oil spills. In this regard, the Committee **strongly recommends** that the government of the USA, range states of the Gulf of Mexico and the responsible parties:

(1) search for and examine as many cetacean carcasses as possible that may have been impacted by the spill through detailed necropsies and thorough tissue sampling;
(2) analyse tissues for contaminants specifically related to spilled oil (i.e. polycyclic aromatic hydrocarbons, dispersants and mixtures of the two);
(3) provide detailed chemical composition of the dispersants that have been used in the Gulf of Mexico;
(4) develop and examine a suite of biomarkers that will be useful for understanding impacts from the spilled oil and use of dispersants in the Gulf of Mexico; and
(5) conduct biomarker studies of cetacean populations in the Gulf of Mexico, especially bottlenose dolphins, sperm whales and Brydes whales.

The situation in the Gulf of Mexico also emphasises the need for adequate environmental baseline data *before* oil and gas exploration, development, or production occurs in any region and for these data to inform mitigation and management decisions. Therefore, for member governments with on-going or planned offshore oil and gas activities within their territories the Committee **strongly recommends** the collection of baseline data to include:

- contaminant levels in cetaceans, their prey, and in sediments, especially polycyclic aromatic hydrocarbons (PAHs) and other contaminants that may interact with PAHs;
- biomarker levels in cetaceans and their prey;
- abundance and distribution of cetaceans and their prey; and
- condition of cetacean habitats (i.e. water quality, sediment quality, etc.).

Finally, the Committee **strongly recommends** contingency planning and training for oil spill responses in areas of oil and gas development. It looks forward to receiving an update on the studies into the effects of this spill at future meetings.

12.3 Review progress of CERD Working Group

The CERD working group was established in response to the report of a workshop on infectious and non-infectious diseases of marine mammals and impact on cetaceans that was held in 2007 (IWC, 2008d). The Committee received an update on its intersessional accomplishments and plans (Annex K, item 8), which are summarised in five categories: (1) skin disease; (2) diagnostic laboratories and veterinary experts; (3) prioritization of pathogens; (4) emergency response; and (5) enhancement of capacity and communications among stranding networks. With regard to the last category, capacity building workshops were held in four regions: West Africa, Caribbean, Brazil and India. Drawing information from the ICES working group and the IWC Ship Strike Working Group, a global inventory of stranding networks has been developed and the CERD working group is developing recommendations to maintain and provide access to the inventory.

The Committee also noted a prioritisation of cetacean pathogens developed on behalf of the US Working Group on Marine Mammal Unusual Mortality Events, from a survey that evaluated 76 pathogens based upon five factors. Of the pathogens included in the survey, most were potentially zoonotic, while others were associated with emerging/re-emerging human diseases in the United States. The ten highest priority pathogens among small cetaceans were morbillivirus, parapoxvirus, *Brucella* spp. anisakis, calicivirus, herpesvirus, nasitrema, *Clostridium* spp., and toxigenic *Escherichia coli*. Although the CERD WG is not tasked to compare cetacean-borne pathogens to those in terrestrial species, the Committee expressed interest in this broader approach, which is consistent with the global *One Health* approach to medicine (*http://onehealthinitiative.com/index.php*). Specifically, *One Health* highlights the importance of integration of surveillance systems in wildlife, domestic animals, public health and environmental health. The Committee **commends** projects that integrate a *One Health* approach to build capacity in countries that are responding to diseases that are shared by people and wildlife. Further, it **recommends** that marine species be considered by all organisation that are implementing the *One Health* approach. Finally, the Committee **commends** the many and varied accomplishments of the CERD WG and **endorses** the work plan for 2011 (Annex K, Appendix 3).

12.4 Review new information on anthropogenic sound: focus on 'masking sound'

The Committee's SWG on environmental concerns has included an item on underwater sound on its agenda each year since 2004 (IWC, 2005f, p.268). In 2009, a presentation on low-frequency 'masking sound' precipitated adopting it as a focal-topic. Low-frequency (LF) ocean noise has increased substantially in recent decades, concomitant with a three-fold increase in commercial shipping and other offshore industrial activities. The Committee reviewed a mechanistic model that dramatically demonstrates the reduction in the 'communication space' of baleen whales that now occurs, especially near shipping lanes and busy ports (Annex K, item 9). It then reviewed a variety of evidence with regard to the masking sound and its possible effects on whales, including: (1) altered calling patterns and frequency in the presence of LF sound from shipping and seismic airguns shown by fin whales in the western Mediterranean Sea and humpback whales off the coast of Northern Angola; (2) chronic exposure of the small population of humpback whales in the Arabian Sea to LF sound from construction, shipping and seismic surveys; and (3) the elevation of LF sound levels at distances from 450 to 2,800km from a seismic survey area south of Tasmania in the Southern Ocean. Based on the aggregate information presented to the SWG with regard to masking sound from anthropogenic sources, the Committee **recommends** that:

(1) seismic surveys be regulated in the same legal frame, whether for scientific or commercial purposes;
(2) baseline data be collected, satisfactorily analysed and modelled using appropriate techniques, regarding the seasonal and spatial distribution of whales in areas of interest to the geophysical community (scientific and commercial) before survey operations;
(3) the masking potential of anthropogenic sources be quantified and acoustic measurements be standardized to ensure that datasets among researchers are comparable; and
(4) in studies examining potential changes in whale acoustic behaviour, the ability to detect whale calls during periods of exposure and non-exposure to anthropogenic LF sound be quantified.

Further, the Committee **strongly recommends** that further research be conducted on the Arabian Sea humpback population (and see Item 10.2.2.4), including studies directed at quantifying the impacts of acoustic disturbance and masking to support conservation planning and protection for this small population.

The SWG had reviewed available information on plans for seismic surveys in support of oil and gas development planned for the Russian Far East, including the Sea of Okhotsk, Anadyr Gulf, the East Siberian and Chukchi Seas (Annex K, item 9.1). The scale of these activities is 'matched' by plans for broad-scale seismic surveys in the US Chukchi and across the US-Canadian Beaufort sea region. At least six endangered whale species (e.g. North Pacific right whales and Okhotsk Sea bowhead whales) occur in low numbers in waters offshore western Kamchatka, where seismic surveys are anticipated during summer 2010.

In light of this, the Committee **recommends** that additional surveys to provide baseline information on cetaceans be conducted in waters off western Kamchatka, and that seismic surveys and other potentially disturbing industrial activities should be conducted during times of lower cetacean abundance in all ocean regions whenever possible (e.g. see the mitigation and monitoring plan for a seismic survey in the Sakhalin region developed under the auspices of IUCN's Western Gray Whale Advisory Panel, and information regarding other seismic survey issues specific to western gray whales under Item 10.4 above). When informed that industry has initiated research into alternative (quieter) technology (vibroseis), the Committee **strongly encourages** this research and **recommends** continued development of such methods.

The conclusions from the workshop on 'Cumulative Impacts of Underwater Noise with Other Anthropogenic Stressors on Marine Mammals' were reviewed (Annex K, item 9.3). That workshop had agreed that cumulative impact assessments (CIAs) are needed to account for sub-lethal effects of human disturbance. The Committee **recommends** that member governments work to develop a quantitative approach for assessing cumulative impacts, including ways that anthropogenic sounds might impact cetaceans and their prey.

In regard to reducing LF sounds from shipping, the SWG (Annex K, item 9.4) had noted rapid progress, especially in the past three years, towards addressing this issue, including both the formation of a Correspondence Group within the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) and the granting of IMO 'observer status' to the IWC (IWC/62/4). With reference to the IWC's awareness of the critical nature of acoustic communication to whales and that interference, or masking, of this communication is to some extent preventable, the Committee **strongly recommends** that:

(1) the goal of noise reduction from shipping advanced in 2008 (i.e., 3dB in 10 years; 10dB in 30 years in the 10-300Hz band) be actively pursued;
(2) new and retro-fit designs to reduce noise from ship propulsion be advanced within the goals of the IMO, when and wherever practicable; and
(3) the IWC and IMO continue to work collaboratively to advance the goal of worldwide reduction of noise from commercial shipping when and wherever practicable including reporting progress on noise measurements and implementing noise reduction measures.

12.5 Review progress on work from the 2nd Climate Change Workshop

The 2nd Climate Change Workshop (IWC, 2010j) resulted in a series of recommendations summarised under three headings corresponding to working groups established at the workshop: Arctic; Southern Ocean; and Small Cetaceans (and see Annex K, item 10). With regard to the Arctic, three study themes were established: (a) Single Species-Regional Contrast; (b) Trophic Comparison; and (c) Distribution Shift. With reference to theme (a), planning discussions have been completed for a comparison of physical indicators of climate change and available data on population dynamics and behavioural ecology of the Bering-Chukchi-Beaufort Seas and Hudson Bay-Davis Strait populations of bowhead whales. In the Southern Ocean, the SWG was provided an update on the responses of the southern right whale population of Península Valdés, Argentina to climate driven changes on their feeding grounds off South Georgia. As was reported in the Southern Right Whale Die-Off Workshop (SC/62/Rep1 and see Item 10.5 above), one of three possible hypotheses to explain recent peaks in calf mortalities is a decline in food availability for adult females on their feeding ground during the year or two prior to calving. This hypothesis will be explored by updating an analysis on the relationship between changes in sea surface temperature and calving success. The Committee reviewed a draft agenda for a Small Cetaceans and Climate Change Workshop planned for November 2010, where the main focus will be: (1) restricted habitats – estuaries, reefs, environmental discontinuities, rivers and shallow waters; and (2) range changes – i.e. evidence of changes in distributions, reasons and consequences; and (3) with a review planned for small cetaceans in the Arctic Region and suggested that the definition of restricted habitat be broadened (Annex K, item 10). Noting that last year the Committee had recommended that countries should pay more attention to tertiary concerns arising from climate change, the Committee noted that Alter *et al.* (2010) provide arguments suggesting that tropical, coastal and riverine cetaceans are particularly vulnerable to those aspects of climate change that are mediated by changes in human behaviour.

12.6 Other habitat related issues

There has been a rapid expansion of marine renewable energy devices (MREDs) in European seas as governments strive to meet renewable energy commitments. Today there are some 89 such sites in various stages of development (most of these are wind farms), representing a five-fold increase in numbers since 2000, with a concomitant major increase in the size of planned developments. The SWG reviewed concerns associated with the construction, operation, maintenance and (ultimately) decommissioning of wind, tidal and wave renewable energy technologies (Annex K, item 11.1) and the Committee **strongly recommends** that countries co-operate to limit impacts on marine wildlife from these sources. The SWG subsequently discussed the ICES WGMME recommendations with regard to the effects of wind farm construction and operation on marine mammals (Annex K, item 11.1) and the Committee **endorses** those recommendations.

The French Agency for Marine Protected Areas (AAMP) has initiated the REMMOA project, a series of surveys across the French EEZ to identify hotspots of abundance and diversity. Extensive surveys have been conducted across the EEZ of Martinique and Guadeloupe, off Guiana and in the southwest Indian Ocean region. The South Pacific regions will be surveyed during 2010-11 (French Polynesia) and 2011-12 (southwest Pacific Ocean around New Caledonia and Wallis and Futuna) and the Atlantic survey is planned for 2012-13. The Committee also received information on systematic monitoring of density and abundance of the most common cetacean species of the Pelagos Sanctuary and in the seas surrounding Italy. The aim of this work, funded by the Italian Government, is to inform conservation measures throughout the Mediterranean Basin. It also responds to priority actions in a number of other international bodies (e.g. the Sanctuary Management Plan, ACCOBAMS, the Specially Protected Areas and Biodiversity Protocol under the Barcelona Convention, the EU Habitat Directive and the Convention on Biological Diversity). The Committee **commends** both of these studies and encourages their continuation. It noted the impressive advancements of current methods giving the authors the ability to correlate cetaceans with specific habitat features as well as other megafauna.

Finally, there has been limited progress since the update on the Madagascar Mass Stranding Event (MMSE) given in 2008 (IWC, 2009a, p.71). Two potential scenarios to move forward with an Independent Scientific Review Panel (ISRP) were identified: (1) a National Office of the Environment (ONE) to request and oversee an ISRP; or (2) the Environmental Governance Commission to serve as an intermediary body between the Government and/or ONE to promote the need for an ISRP to assess the results of the MMSE. The Committee welcomed this update and thanked The Wildlife Conservation Society and its partners' continuing efforts to bring the results of the MMSE to an appropriate conclusion through an ISRP process, as well as keeping the SWG updated on the current challenges and progress.

13. ECOSYSTEM MODELLING

The Ecosystem Modelling Working Group was first convened in 2007 (IWC, 2008c). It is tasked with informing the Committee on relevant aspects of the nature and extent of the ecological relationships between whales and the ecosystems in which they live. This advice is important to other responsibilities of the Committee: it can be used to simulate an ecosystem framework in which to evaluate management strategies; it can provide a bio-physical context within which to try to understand spatial or temporal (e.g. interannual, interdecadal, or long-term climate-driven) variability in cetacean population dynamics, distribution, behaviour, and health; it can provide insight into interactions between whales and fisheries; and it may inform the prioritisation and design of future IWC research projects by identifying critical information gaps and offering recommendations of when, where and how field efforts should be conducted to successfully collect new data that are necessary for providing insight into key questions. The Commission has stated their interest in such work in a number of resolutions (IWC, 1999a; 2001c; 2002a). Each year the Working Group reviews the progress in developing ecosystem models relevant to the work of the IWC, which is a broad task encompassing the evaluation of model inputs, assumptions, structure and outputs. In addition, the Working Group has placed a priority on discussions and collaborations with institutions outside of the IWC to facilitate the exchange of information on the state of the science of ecosystem modelling and, where applicable, to collaborate to achieve a common goal. No primary ecosystem modelling papers were received this year, so the Working Group dedicated its time to three general tasks: (1) reviewing ecosystem models and modelling approaches that were developed outside of the IWC; (2) learning about the Climate Impacts on Oceanic Top Predators (CLIOTOP) project; and (3) discussing and planning the future role of this Working Group within the Scientific Committee. The report of the Working Group is given as Annex K1.

13.1 Review ecosystem models relevant to the Committee's work

This year, Lehodey introduced the CLIOTOP project and in particular the ecosystem model that he and his colleagues developed to analyse and predict the spatio-temporal dynamics of tuna populations under the influence of environmental and fishing pressures (Lehodey *et al.*, 2008). The model has been applied to skipjack, bigeye, yellowfin and albacore tuna in the Pacific Ocean (Lehodey and Senina, 2009) and also been used to investigate potential influences of climate change on tuna population dynamics (Lehodey *et al.*, 2010).

CLIOTOP is a global project implemented under two International Geosphere-Biosphere Programme (IGBP) international research programmes: Global Ocean Ecosystem Dynamics (GLOBEC) and Integrated Marine Biogeochemistry and Ecosystem Research (IMBER). Its general objective is to enhance the understanding of oceanic top predators in their ecosystems in the context of both climate change and fishing, and to develop new tools leading to the evaluation of management strategies. CLIOTOP and the IWC share many common scientific interests, including: studying the behaviour, movement patterns and habitat of large predators; developing and applying technology for animal tracking; estimating food consumption rates; understanding and modeling predation by, and competition among, large predators; modelling and acoustic monitoring of prey fields; investigating various approaches to ecosystem modelling; and addressing issues of bycatch. The Committee **encourages** the establishment of collaborations between the IWC and CLIOTOP.

As part of its remit to preview general developments in ecosystem modelling to identify new modelling approaches and develop an evaluation framework that may be of benefit to the Committee's work, four recently published papers were reviewed (A'Mar *et al.*, 2009; Allen and Fulton, 2010; Buckley and Buckley, 2010; Hannah *et al.*, 2010). These covered issues of model structure, assumptions, complexity and validation. In discussion, it was noted that some existing research suggests that management strategies relying on empirical data through fisheries statistics performed better than those that incorporated ecological information; however, ecological data are valuable for constructing and constraining the range of ecosystem models that could be used to evaluate management strategies within the Scientific Committee.

13.2 Recommendations on the role of this Working Group within the Committee

SC/62/EM1 motivated discussions about the future of the Ecosystem Modelling Working Group. It provided background into the initial objectives and the history of the Working Group; reiterated the distinction between 'tactical' models (those used to set catch limits or to make other management advice) and 'strategic' models (those used to simulate an environment in which to test simpler models); listed some of the ecological and analytical issues that have been recurrent in Committee discussions to date; and introduced several recommendations to help the Committee evaluate ecosystem models, given the numerous uncertainties inherent in the modelling process. As did the Working Group, the Committee **agrees** to the following recommendations, based on those in SC/62/EM1:

(1) standardised templates should be developed for documenting metadata and analytical techniques;
(2) performance criteria should be established, including testing model fit to historic or present data and assessing its ability to generate ecologically reasonable predictions into the future;
(3) sensitivity analyses should be conducted to quantify and provide insight into the importance of model inputs (which can guide data collection priorities) and assumptions on model outputs;
(4) Scientific Committee members should be given access to relevant background information (such as the full mathematical specification) used in any presented ecosystem models that may inform management decisions (via the Secretariat);
(5) the Scientific Committee should explore various ecosystem modelling approaches for a system in order to compare performance across models;
(6) intersessional meetings should be used, when necessary, to allow in-depth examination of competing models; and
(7) the EM Working Group should continue to convene every year at the annual meetings to address issues relevant to the Scientific Committee and to remain informed about new developments in the ecosystem modelling field.

The Committee **emphasises** that the Working Group is an important forum for evaluating ecosystem model inputs, structure, assumptions and predictions related to its work. *Inter alia*, it is also the appropriate sub-group within the Committee for reviewing the ecosystem aspects of ongoing special permit whaling programmes.

The Committee **recognises** the need to involve outside experts in the Working Group. Work is underway to establish an avenue for exchanging information about new developments in ecosystem modelling and its feedback into management, and to solicit feedback on how ecosystem models could inform IWC management decisions.

The Committee **agrees** that the activities of the Working Group should be structured around the timetable of RMP assessments and *Implementations*, enabling ecosystem models relevant to a specific stock being assessed to be reviewed prior to the assessment; the North Pacific is the appropriate region for 2011. The Working Group will take efforts during the intersessional period to engage researchers involved in the North Pacific Marine Science Organization (PICES) and the North Pacific Research Board (NPRB) to collaborate on primary papers for next year's meeting on how North Pacific ecosystem models can be used to inform the RMP process. Two additional issues were highlighted for discussion next year, if primary papers can be prepared in advance. One is a review of functional responses, and the second is a review of methods for evaluating ecosystem models. It is expected that the latter will result in a framework that the Committee will use to guide future ecosystem model evaluations, providing model developers specific details regarding the information required to determine whether the input data and parameters, the model and the resulting predictions should be considered acceptable to inform the work of the Committee.

13.3 Work plan

The work plan is detailed under Item 24. The Working Group requests no funds for the upcoming year.

14. SMALL CETACEANS (SM)

The Committee has been discussing issues related to small cetaceans since the mid-1970s (IWC, 1976). Despite the differences of views over competency (IWC, 1993), the Commission has agreed that the Committee should continue to consider this item (IWC, 1995c). The report of the sub-committee on small cetaceans is given as Annex L.

14.1 Review taxonomy, population structure and status of small cetaceans of northwestern Africa and the Eastern Tropical Atlantic (ETA)

The priority topic this year was the review of the status of small cetaceans of northwestern African and eastern tropical Atlantic waters (Fig. 6), a region with a variety of ecosystems and coastal habitats. The review was greatly assisted by the availability of published review papers and documents prepared for this meeting by scientists working in Canary Islands (Spain), Mauritania, Cape Verde, Guinea, Ghana, Togo, Benin, Nigeria, São Tomé and Príncipe, Cameroon, Gabon, Congo and Angola.

The following sections represent a short summary of the extensive review. Details can be found in Annex L.

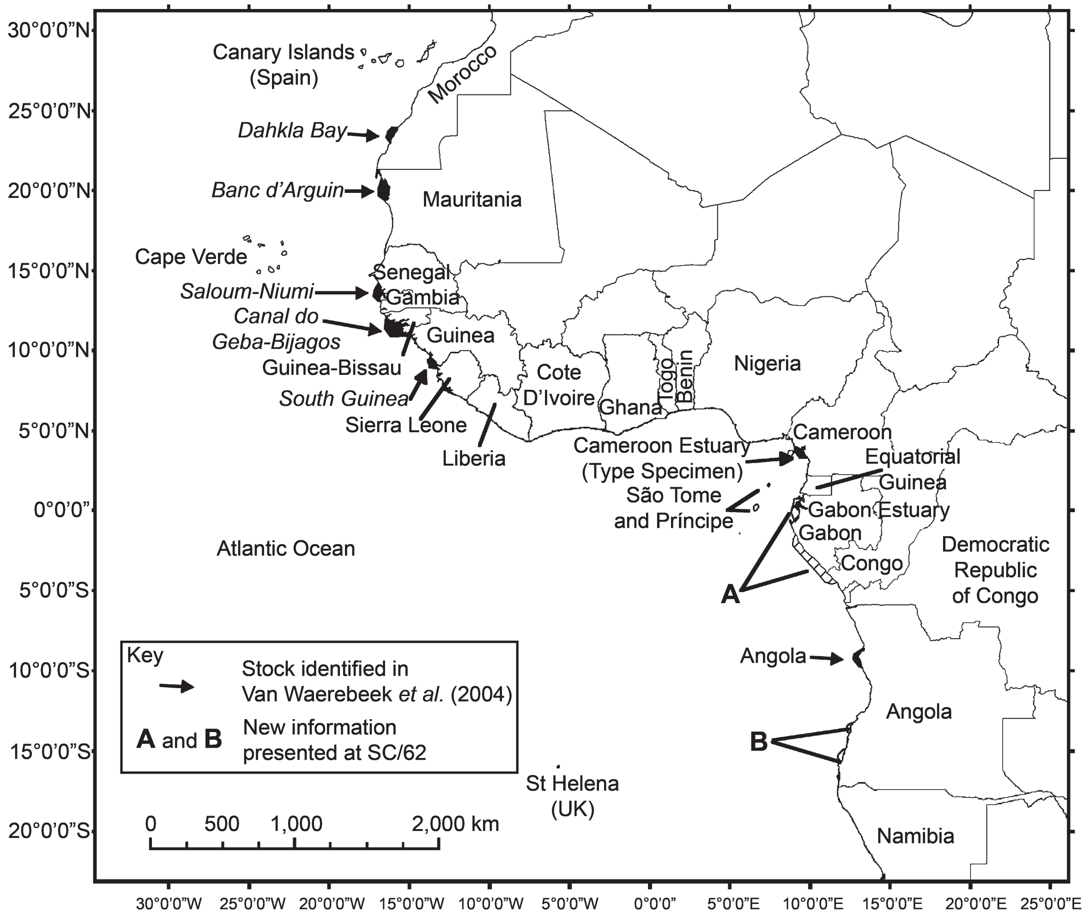


Fig. 6. Map of the northwestern and western African countries relevant to the cetacean distribution review. A=Information from SC/62/SM9. B=Information from SC/62/SM6.

Weir (2010) reviewed cetacean occurrence (sightings, strandings, direct captures, bycatch) in West African waters from the Gulf of Guinea to Angola, updating Jefferson *et al.* (1997). At least 21 odontocetes (including at least 17 delphinids) have been documented in the region. The author stressed that the region's cetaceans face several threats including bycatch, direct capture (e.g. in Ghana and Togo) and threats to them and their habitat, e.g. due to oil and gas development. Moore *et al.* (2010) reported information on cetacean bycatch from interview surveys in 2007 and 2008 in fishing communities of seven countries: Sierra Leone, Cameroon, Nigeria, Tanzania, Comoros, Malaysia and Jamaica They provided information on reported cetacean bycatches in Sierra Leone and Cameroon.

Further information on the region's cetaceans came from a number of papers focussing on country reports.

SC/62/SM9 reviewed recent information on Atlantic humpback dolphins in Gabon and Republic of Congo. Both countries have large and diverse national park systems that include protected coastal habitat. Given the low human population densities and the extent of relatively undisturbed habitat in Gabon and northern Congo, this region may represent a stronghold for the species. However, bycatch and evidence of dolphins in the bushmeat trade give cause for concern, particularly as the demand for fish in cities increases. The Committee commends the authors for their efforts in the region and **recommends** that research, monitoring and conservation efforts for humpback dolphins along the coast of Gabon and Congo continue.

The Committee received two papers covering Nigeria (SC/62/SM12 and SM1). Cetaceans occur throughout Nigerian coastal waters in the Gulf of Guinea, although there has been little directed cetacean research. Potential threats include: bycatches (a reported zero bycatch rate for Nigeria obtained in an interview survey by Moore *et al.* (2010) is not credible, probably due to low sample size); direct catches of delphinids (SC/62/SM1) for sale as 'marine bushmeat' (Clapham and van Waerebeek, 2007) which may be widespread; and habitat degradation (e.g. uncontrolled trawling operations, indiscriminate dumping of non-biodegradable nylon and plastic products and household items). The absence of monitoring may explain the lack of detailed information on direct catches. SC/62/SM1 reiterated the suggestion by Van Waerebeek *et al.* (2004) that Atlantic humpback dolphins inhabited the Niger Delta before large-scale oil exploration and extraction altered the coastal environment.

Information on Ghana was provided in SC/62/SM10 with an emphasis on the captures of small cetaceans in artisanal fisheries, mainly using drift gill nets. Cetaceans have been documented from three fish landing ports since 1995 but these landings do not represent the total for the country. It is often unclear if 'bycaught' cetaceans in Ghana are the result of unintentional or intentional taking. The species most frequently 'bycaught' are the clymene dolphin (24.5%), pantropical spotted dolphin (12.3%) and common bottlenose dolphin (12.3%). SC/62/SM10 suggested an increasing trend in the scale of landings between 1999 and 2010, and particularly since 2002-03. Once the practice of catching and marketing cetacean products becomes established, it can escalate rapidly as implied in the existing catch series. Although aquatic mammals are protected by law, there are no explicit regulations concerning the use of cetaceans killed in nets and the use of dolphin meat as bait in shark fisheries and for human consumption is not considered illegal. This means that catches are not concealed for fear of sanctions and therefore catch statistics can be obtained. This makes it feasible to study trends and carry out biological studies based on carcass sampling protocols.

As stated in SC/62/SM10, traditional taboos against catching dolphins are rapidly eroding in the Volta Delta region. This seems to happen in some areas of Nigeria as well. One important development is that the monetary value of a small cetacean is now roughly equivalent to that of a similar-sized large billfish. In fact, more money can be earned by selling the cetacean carcasses for shark bait as the export market in Asia for shark fins is lucrative and growing.

The Committee thanks the researchers working in Ghana for their efforts and notes that the evidently close cooperation with fisheries officials is encouraging.

Tchibozo summarised the current knowledge on small cetaceans along the 124km coastline of Benin (Tchibozo and van Waerebeek, 2007). The presence of four species has been confirmed: Atlantic spotted dolphins, common bottlenose dolphins, false killer whales and *Delphinus* sp. There have been no systematic studies on the distribution, abundance or ecology of small cetaceans in Benin. Although bycatch of cetaceans is known to occur in fisheries along the entire coast, no monitoring programme is in place.

SC/62/SM11 confirmed the presence of four small cetaceans in Togo's coastal waters: pantropical spotted dolphins, common dolphins, pilot whales and killer whales. However, there is no information concerning abundance, natural history or ecology. The main potential threats are:

(1) bycatch in fisheries, with the possibility that this has led or soon will lead to directed taking as has been observed elsewhere; and
(2) severe chemical pollution due to the mining of phosphorites and discharge of phosphate-rich mud into coastal waters.

Bamy *et al.* (2010) reported that four odontocetes occur along Guinea's 300km coastline: common bottlenose dolphins, Atlantic humpback dolphins, Atlantic spotted dolphins and pygmy sperm whales. It is probable that short-finned pilot whales, rough-toothed dolphins and common dolphins also occur there. This information comes mainly from observations during irregular, largely opportunistic surveys of fishing communities in 2001-03 by personnel from Guinea's Centre National des Sciences Halieutiques de Boussoura (CNSHB). There is no evidence of substantial directed or incidental takes (e.g. at the scale reported in Ghana) but monitoring and reporting have been limited. There is evidence that bycaught small cetaceans and a stranded whale were used for human consumption. The authors expressed concern about even occasional catches of Atlantic humpback dolphins.

During discussion, reference was made to the study by Brashares *et al.* (2004) on the relation between declining fish supplies in West African waters and the increase in hunting for 'bushmeat' and consequent declines in wildlife populations.

SC/62/SM8 updated Picanço *et al.* (2009) with information on small cetaceans off São Tomé and Príncipe. At least four species of small cetaceans are known to occur there with the common bottlenose dolphin and pantropical spotted dolphin being the most numerous.

Several species of small cetaceans were hunted historically in the Cape Verde Islands using hand harpoons. Despite protective legislation, cetaceans are still captured occasionally and their meat is sold and consumed (Hazevoet and Wenzel, 2000; Reiner *et al.*, 1996).

Vely summarised cetacean occurrence in Mauritania between 1987-95 based on dedicated surveys in two main areas: (a) between the southern border with Senegal and the village of Nouamghar at the northern entrance of the National Park of Banc d'Arguin (PNBA); and (b) within the PNBA. Species observed at sea were common bottlenose dolphins, Atlantic humpback dolphins and killer whales. Stranded specimens included harbour porpoises, clymene dolphins, common dolphins, Risso's dolphins, melon-headed whales, short-finned pilot whales, pygmy sperm whales, dwarf sperm whales and Cuvier's and Gervais' beaked whales.

Smit *et al.* (2010) summarised information on the presence and distribution of small cetaceans off the coast of La Gomera (Canary Islands), where a total of 21 species were observed at sea. The five most abundant species (87% of sightings) were common bottlenose dolphins, short-finned pilot whales, Atlantic spotted dolphins, short-beaked common dolphins and rough-toothed dolphins.

The Committee thanks all of the contributors but noted that its review was characterised by rather scarce information from the northwest African countries (see Annex L). However, enough new information was available from West Africa to update and make some corrections to the existing state of knowledge on cetaceans along the west African coast (see table 1 of Annex L).

IUCN Red List status for 21 out of 22 species is either Least Concern or Data Deficient (2008). The Atlantic humpback dolphin is listed as Vulnerable. There is a general lack of relevant information on many of the species, not only for western African waters but also globally, on taxonomy, population structure, abundance, life history and ecology.

The scarcity of information prevented the Committee from being able to make a reliable evaluation of the status of any of the species in the region. That being said, the information available in the review showed that nearly all species are taken either intentionally or unintentionally (SC/62/SM1, SM10 and SM11; see also Bamy *et al.*, 2010; Van Waerebeek *et al.*, 2008; and Weir, 2010). Especially for one species, the clymene dolphin, the Committee **expresses serious concern** about the ongoing observed landings in Ghana.

The Committee then reviewed two species on which there was a little more information.

Killer whales

Killer whales observed off Angola, Gabon and São Tomé were similar in external appearance to, and their appearance was consistent with, the Type A 'nominate' killer whale form described by Pitman and Ensor (2003). Weir *et al.* (2010) summarised published records from Liberia, Côte d'Ivoire, Ghana, Annobón Island (Equatorial Guinea) and Gabon as well as 31 sightings from Angola, Gabon and São Tomé, and a single record from Cameroon. De Boer (2010) provided an additional record of killer whales in the offshore waters of Gabon. Most sightings have been recorded since 2001, corresponding with the onset of dedicated survey work in the region. Bamy *et al.* (2010) found no confirmed records for the stretch of coast from southern Senegal (Casamance) to Liberia. They also questioned whether killer whales venture into the shallow waters of Guinea-Bissau, Guinea and Sierra Leone.

No information was received regarding recent intentional takes although one killer whale was recorded as landed in Ghana between 1998 and 2000 (SC/62/SM8).

The killer whale can be considered a regular component of the cetacean community off Angola and in the Gulf of Guinea. However, more survey work is required throughout the region to clarify its status and biology off tropical West Africa (Weir *et al.*, 2010). The IUCN Red List status of the species is Data Deficient.

Atlantic humpback dolphin

The Atlantic humpback dolphin - an endemic species for this region - was a priority species in 2002 (IWC, 2003b) but at that time the review focused on the Indo-Pacific humpback dolphin.

The taxonomy of the genus *Sousa* remains largely unresolved. Although three putative or nominal species have been widely discussed (*chinensis*, *plumbea* and *teuszii*), the IWC presently recognises only two, the Atlantic species *S. teuszii* and a geographically widespread Indo-Pacific species *S. chinensis*. Although the Committee was informed by Rosenbaum of a collaborative study to clarify the taxonomy of *Sousa*, the Committee **agrees** to retain its present nomenclature until formal publication of this information. It also **recommends** that samples from *S. teuszii* be provided to Rosenbaum as soon as possible so that they can be included in the ongoing efforts described above, which are essential for resolving questions questions concerning taxonomy and population structure.

Van Waerebeek *et al.* (2004) reviewed the state of knowledge on Atlantic humpback dolphins and proposed eight provisional management stocks based on the fragmentary information available to them. Six were confirmed as extant based on recent records: Dakhla Bay (Western Sahara), Banc d'Arguin (Mauritania), Saloum-Niumi (Senegal, Gambia), Canal do Gêba-Bijagos (Guinea-Bissau), South Guinea and Angola. The other two – Cameroon Estuary and Gabon – were considered historical. Those authors also noted the 'potential existence' of a western Togo stock. They concluded that there were nine confirmed range states: Morocco (including Western Sahara), Mauritania, Senegal, The Gambia, Guinea-Bissau, Guinea-Conakry, Cameroon, Gabon and Angola.

Van Waerebeek *et al.* (2004) stated that the species was limited to tropical and subtropical waters very near shore from Western Sahara in the north to Angola in the south; the distribution is patchy and limited to particular stretches of coastline separated by gaps of absence or very low density. In many cases, it was unclear whether the absence of records from an area means the species naturally does not occur there, or it has been extirpated in the area, or search effort and reporting have been insufficient.

Bamy *et al.* (2010) considered as uncertain the degree of distributional continuity and gene flow between the provisionally defined 'South Guinea stock' and other provisionally defined stocks (Van Waerebeek *et al.*, 2004). As in Guinea-Bissau, most of Guinea's coastline has features suitable as humpback dolphin habitat: warm and shallow waters on a shelf extending up to 200km from shore, with extensive mangrove creeks around four main river mouths. The lack of sighting records is probably partly due to the small amount of near-shore survey effort. Ghana represents a confirmed gap (SC/62/SM10).

Although much remains unknown about distribution and the extent to which it has changed over time as a result of human activities (e.g. bycatch, habitat degradation), current understanding is that there are regional pockets of relatively high density, such as in Senegal-The Gambia-Guinea-Bissau-Guinea-Sierra Leone, Gabon-Congo and Cameroon-Angola-Namibia.

Although its typical habitat was thought to be shallow coastal waters, especially estuaries, mangrove systems and sheltered bays (Van Waerebeek *et al.*, 2004), new information on the presence, distribution and behaviour of Atlantic humpback dolphins was received from Flamingos (southern Angola), Gabon and Congo (SC/62/SM9), also see Weir *et al.* (2009). In Gabon, Congo and elsewhere in the southern range of the species, humpback dolphins are regularly observed on open coastlines.

The loss and fragmentation of habitat due to expanding coastal communities, coastal development, dredging, trawling, deforestation, mangrove destruction, pollution, eutrophication and oil spills also threaten this species. Its preference in many areas for shallow, nearshore and estuarine habitat would render it particularly vulnerable to ubiquitous inshore set gillnets, beach seines and disturbance.

The Committee **agrees** that there is ample evidence for serious concern about the conservation status of this species (SC/62/SM1; SM6; SM9-SM11, and see also Bamy *et al.*, 2010). Although quantitative data or even good qualitative data (e.g. confirmation of species presence/absence) are lacking for much of the known or suspected range, the information available from areas where cetaceans have been consistently studied (e.g. Ghana, Guinea) indicates that the overall population is fragmented, bycatch (if not also directed catch) is occurring, and habitat conditions are deteriorating. Populations in Gabon and northern Congo appear healthy, but recently documented bycatches and utilisation in Congo may be indicative of a growing reliance on non-fish marine wildlife, including dolphins, as food.

In view of the growing concern (e.g. summarised in SC/62/SM6) that the Atlantic humpback dolphin faces some of the same threats that led to the extinction of the baiji and caused the vaquita to become critically endangered, the Committee **recommends** that IUCN reassess the Atlantic humpback dolphin's status in the light of new information.

It also **recommends** the following items for further conservation and research action for Atlantic humpback dolphins, taking into account *inter alia* the CMS regional action plan for the conservation of West African small cetaceans[4].

(1) Coordinated data collection should be facilitated in order to improve knowledge of the abundance, distribution and conservation status of *S. teuszii* throughout its known range. Specifically:
   (a) estimates of abundance and distribution are urgently required (including where feasible photo-id);
   (b) tissue samples should be obtained at every opportunity from stranded or bycaught Atlantic humpback dolphins. These need to be appropriately preserved and provided to scientists for genetic analyses investigating population structure;
   (c) critical habitats should be identified, including areas of high density and regular occurrence ('hotspots') and migratory pathways (if such exist), as candidates for focused conservation effort; and
   (d) overviews of existing knowledge, national species lists, specimen collections, research centres and protected areas should be compiled.

(2) Identify and mitigate known and potential threats to *S. teuszii*, particularly entanglement in fishing gear, and directed take and anthropogenic noise. Specifically this should include:

[4]Action Plan for the Conservation of Small Cetaceans of Western Africa and Macronesia, ratified in 2008 by West African member nations of CMS.

(a) improving the understanding of the causes, levels and impacts of bycatch on *S. teuszii*;
(b) assessment of the causes, level and intensity of directed small cetacean takes;
(c) efforts should be made to minimise the ecological impacts of fisheries on, and direct takes of, *S. teuszii* through the implementation of explicit fisheries management measures; and
(d) ensure that all littoral developments and activities take into account their potential for having negative effects on small cetaceans and the environment.

(3) The designation and management of national and transboundary marine protected areas that include *S. teuszii* habitat based on scientific data and broad stakeholder involvement should be encouraged.

The Committee also specifically **recommends** that regional or sub-regional research projects be conducted that would allow the preparation of management plans for the conservation of Atlantic humpback dolphins in particular areas. Candidate areas are: (a) off Flamingos, Angola; (b) along the coasts of Gabon-Congo; (c) Senegal-The Gambia-Guinea-Bissau-Guinea-Sierra Leone where the humpback dolphin population(s) may be transboundary and where bycatch is a serious concern; and (d) Mauritania where humpback dolphins were observed regularly in Banc d'Arguin National Park and environs over many years, but may have declined recently (Van Waerebeek and Perrin, 2007).

The Committee **strongly encourages** scientists in the range states to submit collaborative proposals for funding so that transboundary problems can be addressed in a comprehensive way, possibly cooperating with the staff of National Parks.

General recommendations relevant to all species

In general, the Committee **acknowledges** that the failure to manage industrial fisheries sustainably has often caused coastal artisanal and subsistence fisheries to suffer and, in turn, has led local people to seek alternative resources for consumption, including cetaceans.

Given the observed threats and the existing knowledge, the Committee makes the following general **recommendations** applicable to all small cetacean species in the west and northwestern Africa.

(1) The tallying of cetacean landings should be implemented as a standard procedure for fisheries observers at the national level, including the collection of photographic material, recognizing that small cetaceans are a *de facto* exploited marine living resource and therefore need to be monitored on a permanent basis.
(2) An intensive biological sampling programme based on fresh carcasses, collecting data on morphological variation, reproduction, growth, feeding, stock identification, genetics, migratory habits, etc. of cetacean species should be implemented.
(3) Use of platforms of opportunity should be intensified to collect data on distribution, relative abundance and behaviour of cetaceans.
(4) Further assessment of the links between declining fish catches and increasing takes of small cetaceans in West Africa should be made.

In at least three west African countries, Ghana, Togo and Guinea, the ongoing activities represented good examples of how the first two of these recommendations could be realised. The Committee **acknowledges** the contributions already being made by scientists in Nigeria and Benin and recognised that there is a great need for capacity building and financial support before such programmes can be implemented. The same is true for São Tomé and Príncipe where the status of small cetacean populations has not been fully assessed and for the Cape Verde Islands, where no study of small cetaceans has ever been conducted. With regard to the third recommendation, the Committee noted and commended the published work by Weir (2007; 2010) and de Boer (2010), much of which was based on data from platforms of opportunity (e.g. seismic survey vessels, oceanographic research vessels); these are seen as excellent examples of how this recommendation can be realised in more areas.

In conclusion, the Committee **recommends** international collaboration for funding and capacity building to support programmes for monitoring, management and conservation of coastal marine living resources in this region.

14.2 Review report from the working group on climate change and small cetaceans

The Committee received a summary on the ongoing plans for an IWC workshop on the effects of climate change on small cetaceans. The workshop plan (10-12 invited participants meeting for 3 days) was agreed last year but the workshop was not held in the last intersessional period as the final *tranche* of funding was only confirmed late in the year. The steering group and convener (Simmonds) are now finalising plans for the workshop, which will probably be held in Vienna in November 2010 (see Appendix 2 of Annex L). The focal topics are: (a) restricted habitats; (b) range changes; and (c) the Arctic region. During discussion it was suggested that pathogens should also be discussed.

The Committee **re-confirms** its support for the meeting and looks forward to receiving a full report of this workshop at the next annual meeting in 2011.

14.3 Review progress on previous recommendations

IWC Resolution 2001-13 (IWC, 2002b) directs the Scientific Committee to review progress on previous recommendations related to critically endangered species and stocks of cetaceans on a regular basis and the Committee noted that its previous recommendations stand until new information is received and considered.

14.3.1 Vaquita

The Committee reviewed new information on the critically endangered vaquita. SC/62/SM3 reported on a survey in the Upper Gulf of California that was conducted from mid-September, through October and November 2008 in a joint effort between the governments of Mexico and the US. The primary objective was to test alternative acoustic detection technology as a means of monitoring trends in vaquita abundance. Total abundance (based on both acoustic and visual data) was estimated as 250 animals (95% CI 110, 564). The estimate for waters inside the Vaquita Refuge was 123 (95% CI=64-239). The total estimate for 1997 had been 567 (95% CI=177-1,073). Analyses strongly support a population decline over the 11 years from 1997 to 2008. The overall distribution did not change between the two surveys, indicating that the apparent decline was not an artifact of a distributional shift. Approximately half of the population appears to be present inside the Vaquita Refuge area at any time, with individuals moving freely into and out of the refuge. Hence, they are at risk of interaction with fishing operations when outside of the refuge, and this means that protection from bycatch is only partial. Fishermen consider waters inside the Refuge to be a prime shrimping area and thus fishing activity is very intensive immediately outside its borders. The buyout programme begun by the Mexican government in 2007 has reduced the fishing effort by about 40%, but over 600 artisanal boats (*pangas*) are still fishing and those fishermen who remain active are strongly committed and unlikely to accept the buy-out offers from the government. This makes it crucial to develop alternative fishing methods that do not involve the risk of vaquita bycatch.

The Mexican government made a commitment to reduce the vaquita bycatch to zero within three years starting in 2008. There are no data to confirm that the bycatch rate has been reduced apart from an inference from the reduction in fishing effort; because of the regulatory situation, fishermen generally no longer report and deliver bycaught vaquitas to authorities. This makes the implementation of regulations particularly challenging.

SC/62/SM5 reported on the development of a monitoring plan to assess trends in vaquita abundance based on acoustics using C-POD. It is anticipated that the scheme will be in operation by the end of this year (2010). Jaramillo-Legorreta acknowledged the financial support provided to this work by a number of agencies and organisations in addition to the Mexican government: National Marine Fisheries Service, WWF, the Cousteau Society, Ocean Foundation, US Marine Mammal Commission and International Fund for Animal Welfare.

The Committee thanks Jaramillo-Legorreta for this update and commends those involved for their hard work and commitment to saving the vaquita. The Committee **agrees** that it would be useful to document (in working papers or publications) all of the costs of the vaquita conservation and monitoring efforts for future reference for other Countries with similar bycatch problems.

The Committee **remains gravely concerned** about the fate of the vaquita and it **reiterates its previous recommendation** (IWC, 2010h, p.324) that, if extinction is to be avoided, all gillnets should be removed from the upper part of the Gulf of California. The Committee further **recommends** intensified development and testing of alternative fishing gear (e.g. through a smart-gear competition) that fishermen can use in place of entangle gears. It **strongly encourages** Mexico to continue and intensify its efforts to conserve the vaquita.

14.3.2 Harbour porpoise

No primary papers on harbour porpoises were presented at this meeting.

A joint workshop of ASCOBANS/ECS recommended a revision of EU regulation 812/2004 on monitoring and mitigation of cetacean bycatch in gillnet and pelagic trawl fisheries, as at present it does not include small vessels of less than 15m length. The Committee **recommends** that the EU regulation should be reviewed if realistic total estimates of bycatch are to be provided.

Available information for the German North Sea and Baltic from 2003 to 2009 suggests an increasing trend in bycatch. As last year, the Committee **expresses concern** about the ongoing evidence of large-scale bycatch in this region, including the western Baltic (as discussed last year when the Committee called for more research). The Committee **notes**, in particular, that the harbour porpoise population in the Baltic proper is considered Critically Endangered. Better information on both the scale of incidental mortality and the stock affinities of the affected porpoises is essential.

Attention was drawn to the vulnerability of the recently identified a isolated Iberian population of harbour porpoises. The Committee **recommends** further study of this population.

14.3.3 Franciscana

The franciscana, endemic to the eastern coasts of Brazil, Uruguay and Argentina, is regarded as one of the most threatened small cetaceans in South America due to high bycatch levels as well as increasing habitat degradation throughout its range. It is classified as Vulnerable by IUCN. Secchi *et al.* (2003) proposed four management stocks (known as Franciscana Management Areas or FMAs): three in Brazil (FMA I-III), one in Uruguay (FMA III) and one in Argentina (FMA IV).

Mendez *et al.* (2010) stressed that considering all franciscana genetic analyses to date, there is strong evidence for the existence of at least three populations in Brazil (FMAs I, II and III), one in Uruguay (FMA III) and three in Argentina (FMA IV).

The Committee welcomes the new information concerning franciscana stocks in Argentina and encourages the continuation of research and conservation efforts on the species there, particularly in light of the high bycatch rates. It **recommends** that the possibility of further population structure within the range of the franciscana be investigated.

SC/62/SM7 presented information on distribution and provided the first estimate of abundance of franciscanas in FMA II (Brazil) from aerial surveys conducted in December 2008 and January 2009. Coverage included an area believed to correspond to a hiatus in the distribution between FMA I and FMA II. Sightings were confined to the coastal stratum, but offshore effort was low due to poor weather conditions. Corrected abundance was estimated to range between 8,000 and 9,000 individuals (CVs=0.32-0.35) although some additional sources of possible bias require investigation. Current estimates of incidental mortality in FMA II correspond to 3.3-6.2% of the estimated population size presented here, which is likely unsustainable.

The Committee **welcomes** this paper that addresses recommendations from previous years (IWC, 2005g, p.309). It notes that the estimates of abundance were probably negatively biased because of limited coverage of the offshore stratum and because estimates of group size from aircraft are consistently smaller than those from boats and land observation sites.

With regard to the aerial surveys in FMA II, the sub-committee commends Zerbini and his co-workers for their excellent work and **recommends** that further studies be carried out to:

(1) improve estimates of visibility bias;
(2) evaluate potential biases in the estimation of group sizes; and
(3) estimate franciscana diving parameters in areas where such information is not available.

The Committee also **recommends** that bycatch be estimated in additional areas and assessments be carried out of other possible threat factors such as underwater noise, chemical pollution from coastal development and industrial and human waste discharge, oil and gas exploration activities and vessel traffic.

14.3.4 Narwhal

Last year (IWC, 2010h, p.325), the Committee noted that new estimates of narwhal abundance had recently become available. Subsequently, the results of aerial surveys in Canada indicating total abundance greater than 60,000 narwhals were published (Richard *et al.*, 2010). The NAMMCO Scientific Committee considered new estimates from Greenland in its management advice given in April 2009 (IWC/62/4). At its 2009 meeting, the NAMMCO Council (NAMMCO Annual Report 2009, pp.96-97) considered the new information on narwhal abundance and revised its management advice accordingly. The 2005 NAMMCO assessment had concluded that narwhals in West Greenland were highly depleted and that annual sustainable harvest levels would be as low as 15-75 animals. However, population modelling with the new survey data from 2007 and 2008 indicated that overall abundance was at 51% (95% CI: 27-79%) of carrying capacity, with a 2009 modelled abundance of 12,000 (95% CI: 6,200-26,000), and NAMMCO concluded that its management objectives would be met at 70% probability with annual total removals of 310 (West Greenland) and 85 (East Greenland).

The Committee **thanks** the NAMMCO observer for providing information and **encourages** closer links between the NAMMCO and IWC Secretariats in sharing information, e.g. catch data. The possibility of a joint special meeting or workshop on monodontids (involving IWC, NAMMCO, Canada-Greenland Joint Commission on Narwhal and Beluga) should be considered in the near future, assuming that a data availability agreement can be established in advance. The next meeting of the Joint NAMMCO SC and JCNB scientific working group on narwhal and beluga will probably be in 2012, leaving adequate time to explore the potential of a joint meeting/workshop. The Committee **agrees** that an e-mail working group convened by Bjørge will follow up this possibility during the intersessional period and report back next year.

14.3.5 Irrawaddy dolphin

The freshwater population of Irrawaddy dolphins in the Mekong River is Critically Endangered (Smith and Beasley, 2004).

SC/62/WW4 reported on dolphin-watching tourism in the Mekong where photo-id studies indicate dolphins exhibit high site fidelity to particular deep-water pool areas that are very limited in size (1-2 km^2). The authors argued that an adaptive, precautionary approach is essential to managing tourism that targets small, closed, resident communities of cetaceans such as in this case. SC/62/WW4 recommended a range of management interventions, all aimed at decreasing the exposure of dolphins to dolphin-watching vessels.

The Committee received information from World Wide Fund for Nature (WWF)-Cambodia indicating that there are fewer than 100 dolphins based on a photographic mark-recapture analysis. At least 92 dolphins (>63% of them classified as calves) died in the period 2003-09, likely due primarily to entanglement in fishing gear and conservation efforts have focussed on the elimination of gill nets in the core habitat for dolphins in the 200km stretch of the Mekong between Kratie town and the Lao border. The conservation of dolphins in the Mekong is primarily the responsibility of the Commission on Dolphin Conservation and Ecotourism Development (Dolphin Commission). Despite its efforts, the mortality rate has remained high and the population apparently is continuing to decline. Dolphin conservation efforts in Cambodia reportedly have been hindered by inadequate funding for the Dolphin Commission and the lack of regulations that could help to reduce or eliminate the use of gill nets. There is also a need for much better cooperation among the Dolphin Commission, the Fisheries Administration and WWF. WWF and the Fisheries Administration are currently working to develop protected areas and other regulatory tools to protect dolphins. WWF and local NGOs are also working with local communities to reduce gill net use and to develop alternative livelihoods in order to reduce fishing pressure in core dolphin habitat.

The Committee **expresses grave concern** about the rapid and not fully explained decline of this riverine population. It commends the efforts by Cambodian government agencies and WWF-Cambodia to diagnose the cause(s) of the decline, and **strongly recommends** that every effort be made to stop and reverse it, e.g. by immediately eliminating entangling fishing gear in the pool areas used most intensively by the dolphins and by taking immediate steps to reduce the exposure of the dolphins to tour boat traffic.

14.3.6 Other

The Committee received an update (SC/62/SM2) of Amaral *et al.* (2009), the goal of which is to revise the model of worldwide population structure of common dolphins, genus *Delphinus,* using a multilocus approach. It has become clear that the long-beaked population in the northeastern Pacific is highly differentiated from all other populations based on both nuclear and mitochondrial markers. The differentiation between short-beaked populations occurring in different oceans is even higher than suggested in Amaral *et al.* (2009). Future analyses will estimate divergence times and migration rates between the different populations. This study also highlighted the difficulty of obtaining informative molecular markers other than mitochondrial DNA and microsatellites, due to the low overall level of polymorphism in the nuclear genome of common dolphins.

The Committee **encourages** the continuation of this global study of the genus. It also **recommends** that efforts should be made to obtain samples from regions where both short-beaked and long-beaked forms occur, as is the case in West Africa and the southeastern Pacific.

14.4 Other information presented

SC/62/BC6 presents a preliminary global review of operational interactions between odontocetes and the longline fishing industry and potential approaches to mitigation. This is a global problem for both cetaceans and fishermen. Mitigation strategies are needed to ensure the sustainability of both the odontocete populations and the longline fisheries. Bycatch occurs in many longline fisheries and involves at least 13 species but there are few quantitative data. The inadequacy of life history and population data adds to the difficulty of assessing the sustainability of the bycatch in most cases. Considerable effort has been devoted to solving the depredation problem and potential solutions have included acoustic and physical tools. Acoustic approaches to mitigation have proven problematic but recent trials using physical depredation mitigation devices have yielded promising results.

In discussion it was noted that longline fisheries for halibut and Greenland halibut in the northern North Atlantic have increasingly experienced problems with depredation of catches by northern bottlenose whales (*Hyperoodon ampullatus*).

New information was presented on the ongoing commitment of the Italian government (Ministry of the Environment) to conduct systematic abundance aerial surveys of small cetaceans in Italian waters (Ligurian, Tyrrhenian, Sardinian and Ionian seas) and in the Pelagos Sanctuary. Initial scientific and technical support was provided by the IWC Head of Science. The surverys are a priority action common to the Sanctuary Management Plan, ACCOBAMS and RAC/SPA UNEP. Among the preliminary conclusions from the completed surveys were: (1) the Sanctuary does not cover the full population range of striped dolphins; and (2) there is substantial seasonal variation in the density and abundance of striped dolphins (higher in summer). These density and distribution data from the surveys will be instrumental to the proposed ACCOBAMS basin-wide survey and will help guide the development of a long-term monitoring programme. The Committee also **welcomes** news of a complete survey of the Adriatic Sea funded by the Italian Government in July-August 2010.

The ACCOBAMS observer reported that a basin-wide survey of cetaceans in the Mediterranean and Black Seas remains one of ACCOBAMS' highest priorities. Activities are underway with the aim to start such a survey in the next triennium (2011-13).

The Committee **welcomes** the new information and **supports** continuation of such efforts in the Mediterranean Sea and adjacent areas. It specifically **endorses**, as it has in the past, implementation of the ACCOBAMS basin-wide survey, as soon as possible.

14.5 Review of takes of small cetaceans

At the last meeting, the sub-committee discussed various problems associated with the compilation of data on takes of small cetaceans including both direct catches and bycatch (IWC, 2010h, pp.326-28). It recommended a series of changes in how the data should be compiled, reported and interpreted. The process of setting up a system for direct electronic submission of these data by national representatives is still ongoing. The information retrieved by the Secretariat from national progress reports was reviewed. Data on bycatch of small cetaceans was presented in 12 National Progress Reports (Annex L, table 2).

The Committee **reiterates** the importance of having these data submitted and **encourages** all countries to do so.

The observer from NAMMCO advised that catch data from member countries are routinely published in the NAMMCO Annual Reports that are available on the website *http://www.nammco.no*.

Concern was expressed about the information from 12 West African countries indicating human consumption of cetaceans, exchange of cetacean meat in markets or direct capture of cetaceans (see Annex L, table 1); consumption and exchange can lead to targeted and unregulated direct hunting.

Information was received on small cetacean interactions with fishing gear in Machalilla National Park, Ecuador. Four species of cetaceans were caught incidentally: common bottlenose dolphins, dwarf sperm whales, Risso's dolphins and pantropical spotted dolphins. The Committee **expresses concern** about the implications of the bycatch documented in this preliminary study and looks forward to a more detailed report next year on the scale of the fisheries involved and therefore the implied magnitude of the cetacean bycatch.

14.6 Voluntary Fund for Small Cetaceans Conservation Research

The Committee discussed a proposed mechanism and procedure for allocating project support for high priority conservation projects (e.g. improving status of threatened species, capacity building) from the IWC Small Cetacean Research Fund. Australia's recent contribution to the fund is intended to support high priority research that demonstrably links to improving conservation outcomes for small cetaceans globally, particularly those that are threatened or especially vulnerable to human activities. Preference for funding will be based on a determination of need, the quality of the research application and the demonstration of links between research and conservation outcomes. Proposals that demonstrate a capacity building legacy will be viewed favourably.

In order to maximise the number of projects supported by the fund, and hence enhance conservation outcomes for small cetaceans, any single proposal will be limited to a maximum of £34,000. Other IWC member governments will also be encouraged to provide additional voluntary donations to the fund to further support small cetacean research.

A funding application form is being developed and made available via the IWC Secretariat. Applications should be received by the Secretariat at least 60 days prior to the start of the Committee's Annual Meeting. A Review Group will be appointed by the Convenor of the Small Cetacean sub-committee to review proposals in accord with agreed criteria. The group will make recommendations for funding to the Small Cetaceans sub-committee. It may suggest improvements to proposals where appropriate and can solicit the assistance of other researchers in the review process if necessary.

The recommended projects and budgets will be reviewed by the Small Cetacean sub-committee and the full Scientific Committee. Recommended proposals will be added to the Committee's budget as a specific request to the Voluntary Research Fund for Small Cetaceans. The Secretariat will organise contracts for the projects that are approved for funding by the Commission.

The Committee **emphasises** the importance of ensuring that proposal review and project selection meet the criteria and priorities of the sub-committee on small cetaceans. In addition to a call for proposals via a circular from the IWC Secretariat to all members of the Scientific Committee, a broader announcement mechanism will be developed.

The Committee **expressed** its gratitude to the Government of Australia for its generous contribution to the Voluntary Fund for Small Cetacean Conservation Research, which will make a significant difference to the Fund's ability to pursue its conservation priorities.

The Committee also **emphasises** the importance of building the Fund by obtaining donations from other sources. It was noted that good outcomes from the funded research should encourage more countries to contribute.

14.6.1 Project Proposal for the Voluntary Fund for Small Cetacean Conservation Research

A proposal for funding by the Small Cetacean Conservation Research Fund entitled '*Threatened Franciscanas: Improving Estimates of Abundance to Guide Conservation Actions*' was presented (Annex L, Appendix 3). The proposed work is directly linked to previous recommendations of the sub-committee, and responds directly to recommendations made at the present meeting based on consideration of SC/62/SM7 (see Annex L).

The sub-committee **strongly supports** the proposal, based on the following considerations:

(1) the franciscana is threatened by a variety of human activities in the region, particularly artisanal fishing;
(2) the proposal addresses a clear conservation need as expressed in present and previous recommendations; and

(3) more robust estimates of franciscana abundance (along with improved, more nearly complete estimates of bycatch as well as assessments of other threat factors) are needed to assess the status of populations and develop appropriate mitigation efforts.

The proponents have a strong track record (e.g. as reflected in the quality of the work described in SC/62/SM7).

The Committee therefore **recommends** that the proposal be funded by the Voluntary Fund for Small Cetacean Conservation Research and that a full report on the results be provided for consideration at a future meeting.

14.7 Work plan

The sub-committee on small cetaceans reviewed its schedule of priority topics which currently includes:

(1) systematics and population structure of *Tursiops*;
(2) status of ziphiids worldwide; and
(3) fishery depredation by small cetaceans.

The Committee **agrees** that the priority topic for the next annual meeting will be the status of ziphiids (beaked and bottlenose whales) worldwide.

Further discussion of potential future topics can be found in Annex L. As part of the discussion it was agreed to establish an intersessional correspondence group convened by Ritter to consider whether the issue of the consumption of cetaceans ('marine bushmeat') as some type of substitute for other resources that are becoming scarce should be added to the priority topic list. The group will collate information intersessionally and report back at the next annual meeting.

The Committee will also review the report from the Workshop on climate change and small cetaceans.

15. WHALEWATCHING (WW)

The report of the sub-committee on whalewatching is given as Annex M. Scientific aspects of whalewatching have been discussed formally within the Committee since a Commission Resolution in 1994 (IWC, 1995b).

15.1 Proposal for a large-scale whalewatching experiment (LaWE; including reports from the intersessional steering group and the advisory group)

The Committee received a proposal from the large-scale whalewatching experiment (LaWE) intersessional steering group. The report elaborated on the objectives, aims, methodology, design, management and funding considerations for this initiative (Annex M, Appendix 2).

Three options were presented for procedural mechanisms to manage the different components of the LaWE project, ranging from top-down (in which the IWC would play a steering group role) to decentralised (in which the IWC would play a coordinating role (Annex M, item 5.1, fig. 1). After discussion, the Committee **agrees** that a transitional process is preferable, with a top down approach (hierarchical structure) at the initial stage of the project progressing into a mechanism where the IWC would play more of a coordinating role (network structure). Discussions are detailed in Annex M, item 5.1.

IWC member nations will be able to use the results of the project as the basis for appropriate scientific management of whalewatching. The information collected during LaWE will also provide data on general biology and life history parameters of cetaceans that are relevant to other aspects of the Committee's work. There are a variety of potential funding sources for the LaWE effort including:

(1) IWC membership: funding derived from fees/contributions from member nations;
(2) national/regional initiatives: funding derived from national or regional governments involved in the support/promotion of whalewatching;
(3) NGOs: funding derived from national/international NGOs involved in the conservation of cetaceans;
(4) whalewatching operators: funding derived from whale/dolphin-watching operators; and
(5) hybrid model: targets key operators in high profile whalewatching areas with additional funding sought from host countries, IWC, NGOs, and other sources.

The Committee **recommends** that an e-mail correspondence group be formed to further develop the budget for the LaWE, although it noted that until power analyses are completed and species and sites are chosen, only approximate budgets can be created.

The Committee **agrees** to combine the two previous LaWE intersessional groups into one 'steering group' to maximise collaborative discussions (see Annex M, item 5.1).

The budget request to assist the LaWE intersessional work to develop procedural mechanisms to centralise data received from research groups relevant to LaWE with the Secretariat and commence power analysis for key parameters depending on data received is discussed under Item 24. In addition, funding is requested for a pre-meeting of the LaWE steering committee to review and advance intersessional progress on all aspects of the project, including reviewing data received, advancements in power analysis, and the selection of appropriate study species and sites.

There was no formal report from the advisory group, as the LaWE is not yet at the point of selecting research sites.

15.1.1 Other

SC/62/WW5 presented a summary of progress from a working group tasked with developing a formal mathematical structure from the US National Academy of Sciences Population Consequences of Acoustic Disturbance (PCAD) conceptual framework. The working group decided to develop three statistical models to provide the linkages from disturbance to population dynamics. Work has focused on the first models (disturbance to physiological conditions). First implementations with simple systems (southern elephant seals at-sea movement) proved extremely successful and body condition time series could be estimated and validated against body weight when the seals returned to the colony. A similar, albeit more complex, model was developed for coastal dolphin population case studies and will be implemented over the next year.

Discussions on the motivational state-space approach to the PCAD model and concern about the restrictions on the remit of the PCAD project are detailed in Annex M, item 5.1.

15.2 Review of whalewatching off North Africa

SC/62/SM8 reported on cetacean sightings, local human activities and conservation off São Tomé (São Tomé and Príncipe), Gulf of Guinea, West Africa. This region seems to be an important area for cetaceans; however, the status of species or populations has not been assessed due, in part, to lack of information and effort. A similar situation may exist in the Cape Verde Islands where there are resorts and a significant number of tourists. It was noted that several measures regarding the conservation of natural populations of cetaceans are needed for these areas (including international standards of operation, educational programmes and research) to reinforce a change to a more conservation-oriented perspective with direct involvement of local communities.

The Committee welcomed the report and noted the lack of information on whalewatching activities in western and northern Africa. Furthermore, it **expresses concern** at the potential for expansion of whalewatching activities in the region without sufficient scientific information on cetaceans and called for an assessment of the scope of activities to be made by relevant authorities as soon as possible.

An overview of whalewatching activities in the Mediterranean will be prepared under ACCOBAMS. More information is available on the Agreement's official website, *http://www.accobams.org*.

15.3 Assess the impact of whalewatching on cetaceans

SC/62/WW4 reported on the critically endangered Irrawaddy dolphin population inhabiting the Mekong River. Studies indicate dolphins exhibit high site fidelity during the dry season, have low genetic diversity and a high mortality rate. The locations of dolphin-watching areas are at two of the critical habitats for the remaining population in the river, numbering less than 100 individuals. Initially, at both locations, the dolphin-watching industry was land-based, with a few row-boats occasionally taking tourists into the pool to view dolphins. By the early 2000s this expanded to approximately 15 larger motorised boats that offered dolphin tours. Now it numbers more than 20. The authors believe that an adaptive, precautionary approach is essential to managing tourism that targets small, closed, resident communities of cetaceans and that for this Critically Endangered population, a 'no vessel-based dolphin tourism' policy is desirable. It was noted that the issues associated with Cambodian cetacean-watching tourism may be generic to developing countries.

The Committee reiterated **its concern** over the critically endangered Mekong River Irrawaddy dolphin population. In 2006, it had noted that there was compelling evidence that the fitness of individual odontocetes repeatedly exposed to tour vessel traffic can be compromised and that this can lead to population level effects (IWC, 2007b). It also stated that, in the absence of data, it should be assumed that such effects are possible until indicated otherwise – particularly for small, isolated and resident populations. Accordingly, the Committee **strongly recommends** that the Cambodian government and relevant agencies make every effort to reduce the exposure of dolphins to vessel-based tourism in deep-water pools in the Mekong River.

SC/62/WW1 reported on behavioural responses of southern right whales to human approaches in Bahia San Antonio, Rio Negro, Argentina. Results are listed in Annex M, item 6. The Committee noted the small sample size but commended the before-during-after experimental design.

SC/62/WW2 summarised recent advances in whale-watching research. Noren *et al.* (2009) investigated the prevalence of 'surface active behaviours' (e.g. spy hops, breaches) in the vicinity of boats in southern resident killer whales; Arcangeli and Crosti (2009) conducted a study on an Australian common bottlenose dolphin (*Tursiops truncatus*) population in the coastal waters of Bunbury; Christiansen *et al.* (2010) used a Markov chain analysis to investigate changes in Zanzibar Indo-Pacific bottlenose dolphin (*T. aduncus*) behavioural states in relation to boat traffic; Scarpaci *et al.* (In press) reported on the impact of swim-with-cetacean tourism on bottlenose dolphins within a 'sanctuary zone' in Port Phillip Bay, Australia; Sousa-Lima and Clark (2009) used automated acoustic recordings to monitor and track the singing behaviour of male humpback whales in Abrolhos Marine National Park, Brazil, a major humpback whale breeding ground; Stamation *et al.* (2010) monitored the behaviour of groups of humpback whales off Queensland Australia from both whalewatching vessels and land-based platforms; Filla and Monteiro (2009) investigated various types of whalewatching on estuarine or 'guianensis' dolphins (*Sotalia guianensis*) in Cananéia, southeast Brazil; and Jensen *et al.* (2009) found that common bottlenose dolphin and pilot whale (*Globicephala macrorhynchus*) communication calls could be masked substantially by small outboard engine noise. Summaries are presented in Annex M, item 7.

The Committee **welcomes** this review and encouraged the author to prepare a similar review for the next meeting. It was clarified that these reviews are not critiques of methods or results but rather a compilation of new research results of interest.

SC/62/WW3 reported on the US National Oceanic and Atmospheric Administration's efforts to develop management plans to reduce the exposure of resting spinner dolphins (*Stenella longirostris*) to human activity in Hawaiian waters. One management approach under consideration focuses on time-area closures to reduce the number and intensity of interactions between humans and dolphins during critical rest periods in particular bays. Research will combine boat-based and land-based visual observations with passive acoustic monitoring and is an international collaboration between researchers from American, Australian and Scottish universities. Time area closures will not be implemented until a full year of pre-closure data collection has been completed. The authors highlighted this study as a possible candidate project for inclusion in the Large-scale Whalewatching Experiment (LaWE) initiative, as it incorporates many facets that the LaWE initiative strives to achieve.

The Committee **commends** this study and deems it relevant to the LaWE initiative.

SC/62/WW8 presented a precaution on interpreting the results of impact study data analysis. The paper discussed the possibility of confounding variables when interpreting correlations between whalewatching exposure and reproductive parameters of female humpback whales (see Weinrich and Corbelli, 2009). Discussion is presented in Annex M, item 7.

The Committee **welcomes** this paper as an important consideration in impact analyses. It was noted that this contribution clarifies that whalewatching is essentially another habitat variable, and should be treated as such in multivariate models.

Parrot *et al.* (2010) report on an agent-based simulation platform to assess the characteristics of interactions between whales and vessels under different scenarios. The simulation is composed of a spatial environment in which a whale individual-based model and a boat agent-based model can evolve. It simulates the spatiotemporal movement of marine mammals and vessel traffic in the St Lawrence Estuary. It estimates movement parameters from long-term data collected using both onboard GPS and vessel monitoring systems for vessels and a variety of land-based and boat-based focal follows as well as sightings for marine mammals from whalewatching boats.

This platform can be used to inform decision-making by simulating different vessel and whalewatching traffic scenarios.

This project is highly relevant to the LaWE objectives and offers an avenue to simulate boat interaction consequences for cetaceans using behavioural statistical models of disturbance effects. The Committee **welcomes** this effort.

The Committee noted that its work on whalewatching has been influential with other research initiatives to understand effects of disturbances on cetacean populations.

At last year's meeting, there was discussion on the impacts of aerial whalewatching (IWC, 2010i). Groch noted that she was not able to analyse behavioural data collected in previous years during southern right whale photo-id surveys from a helicopter in Brazil. Sironi reported that a trial was conducted to record before-during-after behavioural observations during the 2009 southern right whale photo-id aerial survey in Argentina from a fixed-winged aircraft. Dedicated flights are required to obtain more accurate behavioural data.

15.4 Review reports of intersessional working groups

15.4.1 Online database for worldwide tracking of commercial whalewatching/associated data collection

Robbins summarised the status of an online database for tracking whalewatching operations and associated data collection programmes. This database was originally described in Robbins and Frost (2009) and is intended to facilitate studies of whalewatching impact as well as to allow better assessments of the scientific value of data collection programmes. Database development has made considerable progress intersessionally and should be available to go online prior to next year's meeting. The Committee **recommends** that the intersessional working group continue and report back next year (see Annex Q).

15.4.2 Swim-with-whale operations

Rose reported that due to time constraints, no progress was made intersessionally on field-testing a questionnaire to further assess the extent of swim-with-whale operations. However, a draft questionnaire is ready to be distributed and plans are in place to do so in the Dominican Republic and possibly Australia before next year's meeting. The Committee welcomes the commitment of funding for this effort by the Pacific Whale Foundation and **recommends** that the intersessional working group continue and report back next year (see Annex Q).

15.5 Other issues

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

Progress continues in efforts to stimulate submission of opportunistic data from ecotourism cruise ships in the Southern Ocean to the Antarctic Humpback Whale Catalogue (AHWC). The availability of these data has broadened understanding of the exchange between areas and in some cases provided information that was previously not available. Ritter (2010) reported on a near-miss event involving a large vessel and humpback whales off Antarctica (see Annex M, item 9.1).

Smit *et al.* (2010) reported on opportunistic research off the coast of La Gomera, Canary Islands (Annex M, item 9.1). The study highlights the importance and the potential of mutual long-term co-operation between whalewatching operators and scientists. The Committee welcomes the reports and reiterated the value of collaboration between researchers and whalewatching operations and other platforms of opportunity.

15.5.2 Review of whalewatching guidelines and regulations

The compendium of whalewatching guidelines and regulations around the world is in the process of being updated and will be available on the IWC's website in August. SC/62/WW2 described several papers relating to guidelines and compliance including Noren *et al.* (2009), Williams *et al.* (2009a); Stamation *et al.* (2010); Sousa-Lima and Clark (2009); and Jensen *et al.* (2009).

Summaries of the reports are found in Annex M, item 9.2.

15.5.3 Review of risk to cetaceans from collisions with whalewatching vessels

No new information was brought to the meeting this year. Some members indicated that papers on this item would be submitted to next year's meeting. The Committee noted that this issue will be discussed at a joint workshop with ACCOBAMS in Monaco from 21-24 September 2010.

15.5.4 Future of the sub-committee on whalewatching

The Committee took note of IWC/62/CC8 and the possible interface between the Conservation Committee's work and its own work on whalewatching. The Conservation Committee has established a Standing Working Group on Whalewatching and intends to develop a draft strategic plan for five years (2010-15). IWC/62/CC8 made reference to the work of the Committee and various scientific issues and the section on Capacity Building and Development states that actions 'may include… provision of expert assistance through the Scientific Committee's sub-committee on whalewatching'.

The Committee requests clarification on the mechanism by which this expert assistance will inform the work of the Standing Working Group. It welcomes the opportunity to liaise with the Conservation Committee and Commission, but noted its own terms of reference, and believes that the advice it offers should be within that framework. One possible mechanism, for example, would be to designate a representative from the Committee to work directly with the CC on this issue, thereby providing a formal interface.

The Committee is also seeking clarification on the envisioned management objectives for whalewatching, as IWC/62/CC8 states both 'growth' and 'sustainability' objectives. Clarification will guide the scientific work of the Committee for Objective 7 of the LaWE project ('Develop an integrated and adaptive management framework for whalewatching that accounts for uncertainties, and includes monitoring and feedback mechanisms').

The Committee draws the attention of the Conservation Committee to the definitions of whale ecotourism developed at previous meetings (IWC, 2006c) and considered it important that the Conservation Committee takes a strategic view of what it might achieve in the five years. It also **stresses** the importance of a good scientific basis for the work that it is recommending to the Commission.

It was noted that it would be valuable to increase communication with and explore possibilities for collaborate with the UN World Tourism Organisation, as its remit complements the work of the sub-committee in a number of aspects. Lusseau agreed to liaise for this purpose.

15.5.5 Other

Eisfield *et al.* (2010) reported on the behaviour of a female solitary sociable dolphin studied on the southeast coast of England in 2007, previously addressed by the Committee. The report is summarised in Annex M, item 9.5.

The Committee **reiterates its recommendation** of 2008: habituation of solitary dolphins can make them vulnerable to harm, including being killed, and should be avoided.

16. DNA TESTING (DNA)

The report of the Working Group on DNA is given as Annex N. This particular Agenda Item has been considered since 2000 (IWC, 2001d; 2001e; 2001h) in response to a Commission Resolution (IWC, 2000).

16.1 Review genetic methods for species, stock and individual identification

No new documents were submitted under this Item this year. Last year, the Committee had reviewed Cipriano and Pastene (2009), which provided a comprehensive review of current knowledge of techniques to extract DNA from 'difficult' samples.

16.2 Review results of the amendments of sequences deposited in GenBank

During the first round of sequence assessment (IWC, 2009i, p.347), some inconsistencies were found for some sequences assigned to right and minke whales. These appeared to have been due to a lag in the taxonomy recognised by *GenBank* or uncertainty in taxonomic distinctions currently under investigation (e.g. the number of species and appropriate names for recently described species of 'Bryde's whales').

Last year, the Committee noted that the original submitter would be notified of the inconsistencies and a suggestion made that an amendment be made to the entry. Pastene reported that he had contacted *GenBank* officers to make the above indicated amendments. He was informed that only the original submitters of the sequences can make amendments to their submissions. In view of this he contacted the relevant scientists encouraging them to make the relevant amendments. As a result, the notification regarding Bryde's whale taxonomy (IWC, 2010c, p.73) was made. Amendment work by the original submitters of right and minke whale sequences is ongoing and this work will be completed during the next intersessional period.

The Committee thanked Pastene for his work in this regard.

16.3 Collection and archiving of tissue samples from catches and bycatches

The collection of tissue samples in Norway is from the commercial catches of North Atlantic common minke whales from 1997 to 2009. A total of 484 whales were landed in 2009 (see Annex N, Appendix 2).

The collection of samples in Japan is from special permit whaling in the Antarctic (JARPA II) and North Pacific (JARPN II), bycatches and strandings. The collection includes complete coverage for 2009 and the 2009/10 Antarctic season. A total of 506 genetic samples of the Antarctic minke whale and one of the fin whale were collected from the 2009/10 austral summer survey of JARPA II. From JARPN II in the western North Pacific (NP) samples stored in 2009 were: NP common minke whale, n=162; NP Bryde's whale, n=50; NP sei whale, n=100; and NP sperm whale, n=1. The samples from bycatch stored in 2009 were: NP common minke whale, n=119; NP humpback whale, n=3. Genetic samples were stored for the following stranded whales in 2009: NP common minke whale, n=3; NP humpback whale, n=1 and NP sperm whale, n=1 (see Annex N, Appendix 3).

The collection of samples from Iceland in 2009 was from commercial catches of North Atlantic common minke whales (n=81) and fin whales (n=125). Samples are currently in hand for all whales taken in 2003-09 (see Appendix 4 of Annex N).

The Committee welcomes this information from Norway, Japan and Iceland.

16.4 Reference databases and standards for diagnostic registries

Genetic analyses have been completed and data on mtDNA, microsatellites and sex entered in the Norwegian register for years up to 2007. The laboratory work on the 2008 samples is completed but has not yet been analysed. Laboratory work is ongoing for the 2009 samples (see Annex N, Appendix 2).

For the Japanese register, the genetic analyses based on mtDNA have been completed for North Pacific common minke, Bryde's, sei and sperm whales taken by special permit whaling up to 2009. Laboratory work on microsatellites for these samples is ongoing.

The genetic samples of Antarctic minke whales obtained by JARPA II have not yet been analysed, except for sex and for microsatellites of 190 samples taken in 2006-07 (six loci) and 551 taken in 2007-08 (six loci). For bycatch samples, genetic analyses based on mtDNA have been completed for all samples up to 2009. Laboratory work on macrosatellites for these samples is ongoing. Laboratory work is ongoing for stranded animals in 2009 for both mtDNA and STR (see Annex N, Appendix 3).

For the Icelandic register, genetic analyses (mtDNA and microsatellites) have been completed for common minke whales taken by special permit whaling in 2003-07. Laboratory work of samples taken under commercial whaling in 2006-09 is ongoing. Genetic analyses were completed for fin whale commercial samples collected in 2006 and 2009 (see Appendix 4 in Annex N). It was noted that only whales intended for export from Iceland were currently being genotyped for inclusion in that country's registry and that other whale samples will be genotyped as soon as possible.

The Committee **recommends** the adoption of a standard format for the updates of national DNA register to assist with the review of such updates in the future and agrees that the format used by the Norwegian registry update provides a suitable model. Pastene will work intersessionally with colleagues from Norway, Japan and Iceland to agree on the standard format. In addition, the Committee **agrees** that it would be useful to add a 'per cent completed' column for genetic analysis of tissue samples to assist in the annual review.

Whilst agreeing with these recommendations, Víkingsson reminded the Committee that Norway, Japan and Iceland are providing updates of their registries to the Committee on a voluntary basis.

The Committee noted that full technical specifications for the Japanese and Icelandic DNA registries have not been received or reviewed. Although such information is provided voluntarily, such a review would be helpful for the Committee's annual review of the status of DNA registries under its standing agenda items. The Committee recalled that updates of registers should include a list of references including the relevant documents on protocols used.

16.5 Other

SC/62/O19 describes a proposal to the IWC DAG under Procedure B, requesting access to the Japanese DNA register for the purposes of evaluating the technical aspects of traceability/trackability of sei, fin and Antarctic minke whale products purchased at commercial outlets in Santa Monica, USA and Seoul, South Korea. SC/62/O19 requested that the proposal be considered for endorsement by the Group.

The Committee could not reach an agreement on whether or not to endorse the proposal in SC/62/O19 of the current policy of Japan, Norway and Iceland regarding DNA registers access and market survey, although it recognised that the matching exercise proposed would, in principle, be valuable for testing functionality of DNA registers for identifying and tracking whale products.

16.6 Work plan

Members of the Committee were encouraged to submit papers in response to requirements placed on the Committee by the IWC Resolution 1999-8 (IWC, 2000). Results of the 'amendments' work on sequences deposited in *GenBank* will be reported next year.

17. SCIENTIFIC PERMITS (SP)

This Agenda Item was discussed by the Working Group on Special Permits in an evening session to enable all Committee members who wished to do so to attend. Bjørge was elected Chair of the Working Group. Reeves acted as Rapporteur, and the report has been directly incorporated here.

17.1 Review of activities under existing permits

All cruise reports from Japanese scientific permits from 1987 to the present are publicly available on the website of the Institute for Cetacean Research[5]. As in recent years, documents describing activities carried out in the preceding year were received by the Committee but not presented or discussed, except for points of clarification. Authors' summaries are included below. Full discussions will occur during the periodic reviews (see Item 17.3).

17.1.1 JARPN II

SC/62/O4 presented the results of the eighth full-scale survey of the Japanese Whale Research Program under Special Permit in the Western North Pacific-Phase II (JARPN II)-offshore component-, which was conducted from 10 May to 29 July 2009 in sub-areas 7, 8 and 9 of the western North Pacific. A total of five research vessels was used: one trawl survey vessel equipped with scientific echo sounder (TSV), one dedicated sighting vessel (SV), two sighting/sampling vessels (SSVs) and one research base vessel. A total of 6,374n.miles was surveyed. During that period 63 common minke, 482 sei, 93 Bryde's and 287 sperm whales were sighted. A total of 43 common minke, 100 sei, 50 Bryde's and one sperm whales was caught by the SSVs. All whales caught were examined on board the research base vessel. A total of 53 kinds of samples and data were obtained from each whale. A total of 16 skin biopsy samples were collected from blue (6), sei (9) and sperm (1) whales. As in previous surveys, common minke whales fed mainly on Pacific saury (*Cololabis saira*) and Japanese anchovy (*Engraulis japonicus*). Bryde's whales fed mainly on Japanese anchovy and oceanic lightfish. Sei whales fed mainly on copepods, Japanese anchovy and mackerels. Dominant preys in the stomach of one sperm whale were various kinds of squids, which inhabit the mid- and deep-waters. Qualitative and quantitative data on stomach contents will be used in the development of ecosystem modelling.

SC/62/O5 outlined the results of the sixth JARPN II survey (coastal component), conducted off Sanriku, northeastern Japan (i.e. the middle part of sub-area 7). The survey was carried out from 22 April to 21 May 2009 using four small sampling vessels and one echo sounder-trawl survey vessel. The research area was set within 50n.miles of Ayukawa port in the Sanriku district. The prey species survey was also conducted by the echo sounder-trawl survey vessel. A total of 4,756n.miles (464 hours) was surveyed and 111 schools (112 individuals) of common minke whales were sighted. No other large cetacean species was sighted. A total of 60 common minke whales were caught (27 males and 33 females) and landed at the JARPN II research station for biological examination. Only one individual in each sex was sexually mature. In addition the female was pregnant. The dominant prey species found in the forestomach was adult Japanese sand lances (*Ammodytes personatus*). The Japanese anchovy (*Engraulis japonicus*) and krill (*Euphausia pacifica*) were also observed but their frequency of occurrence was much lower. The prey species survey revealed high density of Japanese anchovy in the sampling area for common minke whale. These results suggest that during the 2009 survey common minke whales had prey preference for Japanese sand lance.

SC/62/O6 reported the results of the seventh JARPN II survey (coastal component), conducted off Kushiro, northeastern Japan (i.e. the northern part of sub-area 7). The survey was conducted from 5 September to 17 October 2009 using four small sampling vessels. The research area was set within 50n.miles of Kushiro port. The total searching effort by the sampling vessels was 5,136n.miles (494 hours) and 106 schools of common minke whales (107 individuals) were sighted; 59 animals were caught (36 males and 23 females) and landed at the research station. Of the males, 12 were sexually mature. None of the females sampled had attained sexual maturity. The walleye pollock (*Theragra chalcogramma*) was the most dominant prey species in the forestomach, followed by krill (*Euphausia pacifica*), Japanese anchovy (*Engraulis japonicus*), and Japanese common squid (*Todarodes pacificus*). Pacific saury (*Cololabis saira*) was not observed this year. All the animals feeding on walleye pollock were sexually immature. These results were almost the same as in the previous coastal surveys off Kushiro. The results suggest differences in feeding habits between immature and mature common minke whales off Kushiro in autumn. During the survey, other baleen whales were also sighted: 51 fin, 5 sei, and 22 humpback whales. They were observed in the vicinity of sampling positions of common minke whales that were feeding on krill.

17.1.1.1 POINTS OF CLARIFICATION

In response to a question regarding what new information of value in ecosystem modelling could be learned from the taking of one sperm whale last year (relative to the large number that had been caught and examined, with similar results regarding prey, in previous commercial whaling), the proponents stated that previous data on sperm whale diet from commercial catches were non-quantitative and did not consistently identify prey items to species level. They stated that this limited their utility in models such as ECOSIM and ECOPATH, and that data obtained from JARPN II were effectively used for ecosystem modelling. Others considered that this was not the case, and reiterated their view, and that of the JARPN II Review Panel (IWC, 2010a), that the catch of sperm whales in JARPN II is not scientifically justified.

[5] *http://www.icrwhale.org/CruiseReportJARPA.htm* and *http://www.icrwhale.org/CruiseReportJARPN.htm*.

17.1.2 JARPA II

SC/62/O3 presented the results of the third full-scale survey of the Japanese Whale Research Program under the Special Permit in the Antarctic-Second Phase (JARPA II), which was conducted during the 2009/10 austral summer season. Two dedicated sighting vessels (SVs), two sighting and sampling vessels (SSVs) and one research base ship were engaged in the research for 97 days from 14 December 2009 to 20 March 2010 in Areas III East (35°E-70°E), IV (70°E-130°E), V West (130°E-165°E) and part of Area V East (165°E-175°E). The total searching distance was 8,232n.miles. Eleven species including six baleen whales (Antarctic minke, blue, fin, sei, humpback and southern right whales) and two toothed whales (sperm and southern bottlenose whales) were identified during the research period. A total of 986 groups (2,242 animals) of Antarctic minke whales were sighted. It was the dominant species in the research area followed by the humpback whales (603 groups, 1,187 animals), and fin whales (56 groups, 186 animals). The number of sightings of the Antarctic minke whales was about 1.9 times higher than that of humpback whales in this survey. A total of 506 Antarctic minke whales and one fin whale were caught. All whales caught were examined on board the research base vessel. A total of 55 kinds of samples and data were obtained from each whale sampled. A total of 8 blue, 110 humpback and two southern right whales was photographed for natural marks. A total of 86 skin biopsy samples were collected from fin (1), humpbacks (84) and southern right (1) whales. To investigate vertical sea temperature profiles oceanographic surveys were conducted at 57 points using TDR. The main results of this survey were as follows: (1) whale composition in the research area was stable compared to previous JARPA II surveys in this area; (2) the ice-free extent of the research area was substantially larger than in past seasons and high density areas of Antarctic minke whales were observed near the continental shelf; (3) mature females of Antarctic minke whale were dominant in Prydz Bay; and (4) humpback whales were widely distributed in the research area and its density index was higher than that of the Antarctic minke whales in Areas IV West and V East. The 1994/95 IWC/SOWER cruise was conducted in similar areas and periods as in the present survey. In 1994/95 Antarctic minke whales were the most dominant species. The number of sightings of Antarctic minke whales in 1994/95 was about five times higher than that of humpback whales. According to the authors of SC/62/O3, comparison of whale abundance between these two surveys suggests that humpback whales were increasing and expanding into the research area.

17.1.2.1 POINTS OF CLARIFICATION

In response to a question on information on whether vomiting and faecal observations (SC/62/O3 table 7) referred to 'natural' events or were due to harpooning, the proponents explained that the recording of such observations was for the purpose of helping to evaluate the relative merits of lethal versus non-lethal sampling, and thus that there was no value in including observations of vomiting due to harpooning.

17.1.3 Planning for final review of results from Iceland's scientific take of North Atlantic common minke whales

Víkingsson summarised the status of Iceland's analytical work on the 200 common minke whales taken as part of its scientific research programme between 2003 and 2007; annual reports had been provided while the programme was still active. Last year it had been expected that most analyses would be completed and available in 2011; this would have allowed a formal review of the programme in 2012 following the Committee's guidelines (IWC, 2009j) provided the appropriate deadlines had been met. He reported that most of the laboratory analyses are either completed or in a final stage (see SC/62/ProgRepIceland). There had been changes and delays in some components, particularly those involving outsourced chemical analyses that required CITES permits. In addition, the serious economic difficulties experienced by Iceland in recent years have affected the programme and delayed completion of some analyses. Nonetheless, the necessary adjustments had been made to the workplan and he remained optimistic that the work would be completed on schedule.

In discussion, Víkingsson clarified that some of the analyses indicated in SC/62/ProgRep Iceland concerned species and specimens other than the 200 minke whales caught and sampled under Special Permit. Iceland's Special Permit programme had ended when the last of the 200 minke whales was taken in 2007.

In summary, an update on progress will be provided at the next Annual Meeting and approximately three months later a document will be submitted by Iceland that initiates the process leading to external review of the final results of this programme.

17.2 Review of new or continuing proposals

The Chair noted that both JARPA II and JARPN II are continuing on the basis of plans already submitted and reviewed in the Scientific Committee. There was no further discussion of this item. However, a statement in relation to this Agenda Item was received and can be found in Annex U. This statement reflects the view of many members. The response to this statement can be found in Annex U.

17.3 Procedures for reviewing Scientific Permit proposals

The Chair recalled that the Scientific Committee had spent considerable time in the past discussing this matter, and agreement on a process had been reached in 2009 (IWC, 2009j, colloquially known as 'Annex P') that had been used for the review of results of JARPN II. He noted that criticism by some members following the JARPN II review centred on how the procedures in 'Annex P' had been implemented rather than on the adequacy of the procedures themselves. Specifically, concerns had been expressed about the 'independence' of the specialists who served on the review panel, the Chair's decision not to request panel members to submit a conflict-of-interest declaration and the Chair's decision not to allow additional observers to attend the specialist workshop. The Chair noted in that regard that he also had not allowed scientists affiliated with the JARPN II programme to attend the deliberations of the expert panel.

Last year, it had been agreed to revisit at this meeting the question as to whether changes are needed to 'Annex P'. However, the Chair identified two factors weighing against the idea of having a full discussion at this time. First, given the ongoing discussions of the 'consensus package' prepared by the Commission Chair and Vice-Chair, it would be sensible to wait for outcome of those discussions before further discussion of 'Annex P'. Secondly, he believed that the dissatisfaction of some with the performance of the procedures for reviewing JARPN II was related to how these were implemented, rather than the wording of procedures themselves. In any event, Bjørge stressed that if the Committee decides to open 'Annex P' to revision, in his view such revision should be limited to only those aspects that have been controversial, i.e. the selection of experts to the review panel and the admission of observers. In discussion, it was further noted that given the schedule for reviewing the Iceland programme (as summarised under Item 17.1.3), there should be no need to implement 'Annex P' during the upcoming intersessional period. The Committee **agrees** that no further discussion of the procedures was needed at this time.

Childerhouse asked whether the adoption of a 'consensus package' would mean that Special Permit whaling would therefore end and preparations for reviews should begin. Bjørge replied that he was not in a position to advise on that, but he assumed that if the Commission reaches a decision that includes Special Permit whaling, it would then be incumbent on the Commission to provide guidance to the Scientific Committee on how permit reviews should be handled in the future.

18. WHALE SANCTUARIES

In the major discussion about sanctuaries in 2004, the Committee recommended procedures to facilitate the review of future proposals and future sanctuary reviews (IWC, 2005a, pp50-51). No new proposals for Sanctuaries were received this year. The item will remain on the Agenda for future meetings.

19. SOUTHERN OCEAN RESEARCH PARTNERSHIP

The Southern Ocean Research Partnership (SORP) was proposed by the Australian Government to the IWC in 2008 (IWC/60/16) with the aim of developing a multi-lateral, non-lethal scientific research programme that will improve the coordinated and cooperative delivery of relevant scientific information to the IWC. A framework and set of objectives for SORP were presented, discussed and endorsed last year (IWC, 2010c, pp.80-82).

At this year's meeting it was agreed to hold discussions at an evening session to allow all members who wished to attend to be able to do so without conflict with other sub-group meetings; that session was chaired by Gales and rapporteured by Childerhouse. It was agreed that the report of those discussions would be incorporated directly into the Plenary report.

19.1 Intersessional progress

SC/62/O9 reported on the intersessional progress on SORP. Progress was made on the following major items:

(1) establishment of a SORP Steering Group (SSG) with associated terms of reference;
(2) the holding of a Workshop further develop the SORP in Seattle in December 2009 (SC/62/O8);
(3) identification of seven proposed projects that will form the basis for SORP work into the future (SC/62/O10);
(4) the development of a funding mechanism for SORP projects (see below); and
(5) the holding of a first cruise of the joint Australia-New Zealand Antarctic Whale Expedition, AWE (SC/62/O12).

These items are covered in more detail below. It was noted that a full discussion of SC/62/O12 had taken place in the sub-committee on Southern Hemisphere whales (Annex H). The brief discussion under the present item focussed on suggested improvements in future cruises related to estimating abundance, the representativeness of the study area, the use of faecal sampling, the effect of satellite tagging on animals and some comments on the ability of the project to meet its objectives.

19.2 Report of the SORP Workshop, Seattle, December 2009

The SORP workshop (SC/62/O8) was hosted and supported by the Government of the USA and attended by 15 people from five nations. Its main aims were to continue developing the mechanism by which SORP would conduct its business and achieve its objectives. The workshop agreed that a focused approach to the research was required and this was best achieved through the development of research projects that were consistent with both the agreed SORP objectives and priority issues identified by the IWC Scientific Committee. To address this latter issue, a summary document of recommendations relevant to the Southern Ocean had been compiled. The proposed draft SORP projects that were developed at the workshop are described below.

19.3 Summary and consideration of proposed SORP projects

Several draft research projects were presented to the Committee in order to obtain comments and advice (SC/62/O10). The selection process had followed a lengthy consultation process starting at the Sydney SORP workshop (Southern Ocean Research Partnership, 2009) where broad themes were developed and these themes were endorsed by the Committee last year (IWC, 2011). *Inter alia* these draft projects developed at the Seattle SORP workshop are those that were considered to benefit from large scale, multi-regional participation and were consistent with both SORP objectives and IWC priority issues. The purpose of presenting these draft projects to the Committee this year was to seek initial comments and perhaps general endorsement of the overall approaches. The intention is that the project leaders will take any comments made into account when developing the projects intersessionally. It was clarified that there was no intention for the Committee to approve the draft budgets appended to the projects at this stage. These and other aspects of the proposals would require further development and should be re-submitted using the agreed funding mechanism (see Item 19.4) at the 2011 Annual Meeting.

19.3.1 Killer whales in the Southern Ocean

A short project description of 'Distribution, relative abundance, migration patterns and foraging ecology of three ecotypes of killer whales in the Southern Ocean' was presented. There are three ecotypes of killer whales described from Antarctic waters. Little is known about these ecotypes and it is important to understand these populations as killer whales play a key role in the Antarctic marine ecosystem. This is especially true with respect to the impacts that they have on prey populations including marine mammals, fish and penguins.

This project will investigate factors related to their ecosystem impact in Antarctica and adjacent waters, by focusing on their systematic relationships, abundance, distribution, movement patterns and prey preferences. It will include analyses of lipid, isotopes and contaminants from biopsy samples. Collaborators are from USA, Brazil, France and Brazil/Canada.

In discussion, it was agreed that this was an ambitious and valuable project outline. It was noted that the proposal required considerably more detail on the proposed analytical methods before it can be properly evaluated and that this was true for most of the draft projects presented. It is also important that any final proposal includes information on the conceptual and analytical and framework linking the sub-projects together. Suggested additional potential collaborators included Lauriano from the Italian Antarctic Programme and Bester from South Africa who is undertaking related work at Marion Islands.

19.3.2 Foraging ecology and predator prey interactions of whales and krill

A short project description of 'Foraging ecology and predator/prey interactions between baleen whales and krill: a multiscale comparative study across Antarctic regions' was presented. Little is known about the dynamics of predator-prey interactions and the response of baleen whales to the distribution of their prey in the Antarctic. As an important marine ecosystem (e.g. with respect to issues of climate change impacts as well as international management of marine living resources), research focused on cetacean foraging ecology in the Antarctic should help to fill a critical data gap. The project will use novel tagging technologies combined with traditional scientific hydroacoustic methods to quantify the types and frequency of prey consumed and daily consumption rates of poorly understood yet ecologically integral and recovering krill predators in the Antarctic: the humpback whale and the Antarctic minke whale. Collaborators are from USA and Australia for phase 1 and potentially Brazil, South Africa and Germany for phase 2.

In discussion, it was noted that this was an ambitious and valuable project. In addition, the proposal generally provides a good example of the level of detail required to allow for a full scientific evaluation. There were some methodological issues that required additional thought, including how the results from detailed studies collected at a fine spatial scale would be expanded to the medium and large scale, and also about the reliability of the method for estimating gulp volume. In response, it was noted that this project represents a step along the line in estimating consumption rates and that moving out from very fine to middle to large scale will be represent a challenge and needs further consideration. The similarity between aspects of this project and the Committee's SOWER 2000 project (IWC, 2000) developed but never implemented was noted and it was suggested that this may provide some useful additional ideas and information for the developers of the current project.

19.3.3 Oceania humpback mixing

A short project description of 'What is the distribution and extent of mixing of Southern Hemisphere humpback whale populations around Antarctica? Phase 1: East Australia and Oceania' was presented. An improved understanding of the movements and mixing of humpback whales around Antarctica has been identified as a priority for the Committee as part of its Comprehensive Assessment of Southern Hemisphere stocks. This information is integral to assessing the recovery of depleted populations. A key step in assessing recovery is estimating pre-exploitation size which requires knowledge of stock identity and appropriate allocation of historic catches to correct stocks. An improved understanding of the migratory and feeding behaviour of humpback whales should allow an appropriate allocation of catches made in this region to breeding stocks, which will improve the accuracy of recovery assessments and estimates of pre-whaling population sizes. Collaborators include New Zealand, Australia, USA, France, Samoa, Tonga and Chile.

In discussion, it was noted that when exploring allocation of past catches to breeding stocks, additional information would need to be considered given the potential temporal and spatial mixing of different breeding stocks and sexes on the feeding grounds and given the relatively small number of SOWER/IDCR samples available from this region. Similar work was being undertaken by other researchers (e.g. low to high latitude matches from Japanese and SOWER/IDCR data sets) which would help broaden the context for this work. It was noted that the outline study presented represents only Phase One; the focus is on Oceania and will include all the SOWER/IDCR data available. Future work is already being planned and there are plans to collaborate with researchers across the Southern Hemisphere (e.g. Africa, Chile, Brazil, Australia) using both mitochondrial and microsatellite data. It was suggested that the telemetry component of the study would be better structured if animals were tagged on the feeding rather than breeding grounds as this would provide more information on mixing. In response, it was noted that this had been the plan of the AWE but due to technical failure with the tags this had not been achieved. The issue of collaboration and inclusiveness was raised (as it had been at the IWC workshop on Southern Hemisphere humpback whales held in 2006) and it was noted that the proposal did not include all potentially valuable datasets. The Committee agreed that it was important that SORP projects are open to all researchers who hold appropriate datasets.

19.3.4 Fin and blue whale acoustics

A short project description of 'Acoustic trends in abundance, distribution, and seasonal presence of Antarctic blue whales and fin whales in the Southern Ocean' was presented. This initiative aims to implement a long term acoustic research programme that will examine trends in Southern Ocean blue and fin whale population growth, distribution, and seasonal presence through the use of passive acoustic monitoring techniques. Current understanding of blue and fin whale life history characteristics, population abundance, and any post-whaling recovery is extremely limited. While obtaining accurate absolute abundance estimates is currently beyond the reach of passive acoustic methods, measures of relative abundance and trends are more easily obtainable and can be conducted in a consistent manner. Comparison of relative abundance estimates from individual locations across many years collected by acoustic surveys can provide a precise measure of population growth. Comparison of relative abundance estimates within and between locations and years can further be used to assess trends in distribution and seasonal presence over time. Collaborators are from Australia, France, USA and Germany.

In discussion, it was noted that the primary focus was on the Indian Ocean. The Committee agreed that it would be useful to consider including similar acoustic data from other sources (e.g. the GLOBEC acoustic data that had been collected for six years at the Antarctic Peninsula) and was pleased to hear that the inclusion of such data is planned and that GLOBEC researchers will be approached soon. The plan to develop less expensive acoustic loggers was welcomed as an excellent step forward in the use of acoustics as a tool for monitoring. There was some thought that the timetable to complete the feasibility stage of the project (one year) may be too ambitious. As for other projects, more detail of the analytical methodology was requested. In terms of assessing the extent to which the project would meet its objectives (i.e. estimation of trends), it was noted that it would be helpful to see the detection range of the loggers as the small number of loggers planned to be deployed would cover a relatively small part of the Southern Ocean. It was recognised that complete coverage of the South Ocean was not possible given logistical constraints (i.e. the limited number of vessels in the area and where they go) but part of the future planning was to consider the best sites for deployment to maximise the usefulness and representativeness of those sites and to try and capture representative variability. It was suggested that it would be useful for the loggers to collect environmental as well as acoustic data which would help to provide context for any variability seen, provided this could also accommodate the objective of keeping the units small and affordable. The Committee noted that using such data to estimate absolute abundance is a long term and extremely ambitious objective of the project. The project leaders acknowledged that this would not be easy, noting that the project would start by estimating relative abundance to quantify trends and work towards absolute abundance. With respect to the long-term aim, it was suggested that the developers of the programme approach scientists such as Len Thomas (University of St Andrews) who had made some progress in the development of new analytical approaches to estimate density from acoustic data.

19.3.5 Year of the Blue Whale 2013/14

As one of the major initiatives within the SORP, the Committee discussed a proposal for a multi-vessel, circumpolar research project to focus on Antarctic blue whales in the austral summer of 2013/14. The proposed objectives for this 'Year of the Blue Whale' would be to:

(1) provide a circumpolar abundance estimate of Antarctic blue whales based on data collected during a single-season, multi-vessel survey design that incorporates acoustic localisation of blue whales and traditional sightings surveys;
(2) improve our understanding of Antarctic blue whale stock structure through the collection of genetic, photographic and acoustic data;
(3) improve understanding of linkages between blue whale feeding and breeding grounds using satellite telemetry; and
(4) characterise foraging habitat of blue whales on the basis of sightings surveys and satellite telemetry data.

It was recognised that any research effort to satisfy these ambitious objectives in a single year of field work will require substantial methodological development (e.g. to determine how to combine visual and acoustic survey techniques) as well as a need to build in provisions for substantial 'off-survey' activities (e.g. satellite tagging, biopsy sampling and individual photo-id). The project will also require substantial logistical planning to access and coordinate shipping and research activities around Antarctica within a single season. It had been proposed that a small scientific steering committee be established with the task of: (1) developing a full research proposal for the Year of the Whale; (2) determining the optimal scale of shipping and research effort required to fulfil the objectives; (3) initiate processes towards accessing these shipping resources; and (4) reporting back to the 2011 Annual Meeting.

In discussion, there was broad agreement about the general concept and draft proposal and several members expressed an interest in participating in planning for the SORP Year of the Whale. There was a short discussion of a suggestion that fin whales could be included in the proposal but it was noted that high density areas of blue and fin do not always overlap and that to include fin whales might dilute the effort with respect to blue whales. The Committee agreed that the inclusion of other species, while desirable, must be considered in light of the primary objective of assessing blue whales. Recent experience during the AWE had demonstrated that acoustics was a practical method of finding blue whales and that this would allow a blue whale cruise to minimise the amount of time searching and maximise the amount of time spent with blue whales. Recognising the ambitious nature of the project, it was suggested that the timeframe of 2013/14 was optimistic and that a delay in 1-2 years might be considered, given the enormous coordination and organisational effort required to ensure the success of such a large project. Consideration may also need to be given to spreading effort out over two years. The Committee **agrees** that until the proposal is more fully developed, it will not be possible to assess the logistical requirements necessary to complete the work. It was suggested that a small group of survey and other specialists, including those familiar with organising large multi-vessel multinational projects, should work together to further develop the proposal and report back to the SSG and the Committee next year (see Item 21); Gales agreed to co-ordinate this. Their task would *inter alia* be to determine the level of resources required, provide an outline of research methods (and analyses) and survey design, and assess the feasibility and timeframe of the project (if that group deemed it necessary, a short workshop might be considered).

19.3.6 Whales and climate change

This project has been identified as a potential project since the Sydney SORP workshop and it has been further discussed at the second IWC climate change workshop (IWC, 2010c), last year's Scientific Committee meeting and the recent Seattle SORP workshop. Long-term southern right whale datasets have been identified as the most likely existing data for correlation with long term climate changes. Leaper *et al.* (2006) demonstrated the utility of the long-term Argentinean study for assessing correlations with climate variables. It has been proposed that a project along these lines could be developed using a common method that can be applied to the Australian, South African and Brazilian long-term datasets, provided an initial examination revealed them suitable for this purpose. In this regard, consideration should be given to the development of recommendations about how existing programmes/datasets could be improved/modified to make them more suitable for future work along these lines.

As the Committee has previously recognised, an understanding of these issues requires long-term data on prey and/or climate as well as long-term whale data; this will require incorporation of relevant experts in these fields in the project. The Committee also agreed that it was worth examining the potential use of time series of whale oil production, provided that suitable climate data over the same period can be found. Investigation of long-term datasets from other species in the same ecosystem could also be valuable. The Committee **agrees** that formal proposals for work under a climate change project would be welcome for consideration at the 2011 Annual Meeting.

19.3.7 Non-lethal research techniques workshop

This proposal is for a technical conference/workshop to review the strengths and weaknesses of available non-lethal research methods for studies of living whale in the Southern Ocean and their ecological roles in the Southern Hemisphere. The objectives are to advance the synergies of non-lethal methods for investigations addressing a range of research themes. Presentations at the workshop will focus on methodological or technological advances to non-lethal methods, including those that are still under development, or with specific applications to populations in the Southern Hemisphere. Preliminary planning has been undertaken and it is likely to be held in Chile in late 2011.

It was suggested that the workshop could take place in association with the proposed Assessment workshop on southern right whales planned for Argentina in September 2011. A draft Agenda for this workshop can be found in Annex R.

19.4 Funding mechanism for SORP

The Committee **endorses** the process for evaluating requests for funding under the IWC/SORP research fund given in Annex R. It agrees that the IWC Head of Science and Chair of Scientific Committee should be included in the SORP Steering Committee.

20. ACTIONS ARISING FROM INTERSESSIONAL REQUESTS FROM THE COMMISSION

As part of the Commission's work on the Future of the IWC, the Chair and the Vice-Chair of the Commission, based on discussions within the Chair's Support group and the Small Working Group on the Future of the IWC, developed the 'Proposed Consensus Decision to Improve the Conservation of Whales'. The Committee received a short PowerPoint presentation explaining the background to the document, focussing on issue of relevance to the Scientific Committee. In particular, the Committee was asked, via the Small Working Group on the Future of the IWC, to provide scientific advice on a number of aspects of the proposed Consensus Decision; the Terms of Reference for our work are given in Annex G of IWC/62/6 rev. They are also given as Annex S to this report.

The parts of the report requiring review and advice, along with the sub-groups of the Committee that took the initial review can be summarised as follows:

(1) Review of Annex {DNA} on DNA registers and market sampling – jointly by the Working Group on DNA and the Working Group on the estimation of bycatch and other human induced mortality – see Annex N, item 9;
(2) Reviews of Annex {SI} on scientific information required from the catch and Annex {OI} review of operational information – the sub-committee on the RMP – see Annex D;
(3) Review of the potential workplan for the Scientific Committee – relevant sections were reviewed by the sub-committee on the RMP and the sub-committee on in-depth assessments (Annexes D, and G, respectively); and
(4) Review of the report of the Scientific Assessment Group (IWC/M10/SWG6) in the light of the numbers in table 4 of IWC/62/7rev (the table of catch limits) - relevant sections were reviewed by the sub-committee on the RMP, the working group on the *pre-Implementation assessment* of common minke whales in the western North Pacific, the sub-committee on in-depth assessments, the sub-committee on other Southern Hemisphere whale stocks (Annexes D, D1, G, and H, respectively).

The discussions within the sub-committees form the basis of the Committee's advice given below.

With respect to tasks (1)-(3) above, the complete Annexes incorporating our recommendations are included in Annex T, as is an updated timetable.

20.1 Review of Annex {DNA} on DNA registers and market sampling schemes

The Committee was requested to review Annex {DNA} of IWC/62/7rev for clarity and completeness. Annex {DNA} of IWC/62/7rev is based on the report of an earlier specialist workshop held from 7-9 March 2005 (IWC/M05/RMSWG 5). The objective of the review is to ensure that the Annex remains a cost-effective, robust, independent and transparent system in conjunction with the other monitoring and control measures.

To address the above objectives, the Committee **recommends** that the text given in Annex S replaces Annex {DNA} of IWC/62/7rev. Here follows a summary of the recommended changes.

1. SPECIFICATIONS FOR THE ESTABLISHMENT/ MAINTENANCE OF A DIAGNOSTIC DNA REGISTER/ TISSUE ARCHIVE
1.1 Laboratories
1.1.1 Minimal laboratory requirements

1.1.1 (6)	to clarify the length of time that archived samples were to be stored;
1.1.1 (7)	to clarify requirements that a variety of error-checking procedures should be followed and that sample quality should be checked routinely prior to genetic analysis.
1.1.1 (9)	to take into account several different factors in calibration exercises.
Footnote text	a more comprehensive definition of 'diagnostic DNA register'.

1.2 Sample collection
1.2.1 Size of the samples
1.2.2 Preservations

1.2	to specify training of and information to be collected by persons who may be involved in the collection of genetic samples for DNA registries other than commercial, scientific and indigenous catches (e.g. bycatches or stranded animals).
1.2.1 and 1.2.2	to clarify the sample preservation requirements.

1.4 Markers and methods of analysis
1.4.1 Mitochondrial DNA
1.4.2 Microsatellites
1.4.3 Sex identification

1.4.1, 1.4.2 and 1.4.3	to clarify that the analytical methods adhering to the quality standards as specified in the IWC genetic data quality guidelines must be approved by the international expert group.

1.7 External audit of DNA registers

1.7	to specify that the international expert group shall submit an annual report to the Secretariat of the IWC for distribution to contracting governments and the Commission (and, if necessary subsidiary bodies of the Commission) at least two months before it must be considered.

1.8 Submission procedure for samples for comparison with registers

The Committee considered all of section 1.8 in light of the stated objective of Annex {DNA}: 'to ensure a robust, independent and transparent system'. Item 1.8 makes a crucial contribution to these objectives, by providing a mechanism for sample verification that is not reliant on national market sampling schemes, and is also not reliant on the international expert panel, whose role is to audit the system rather to focus on individual samples. The Committee **agrees** that the current wording of item 1.8 does not fully make clear the intent of the mechanism and has thus provided new clarifying wording (including in the heading).

It also **agrees** to a new item 1.9, to specify the submission of DNA profiles to the IWC' central register from contracting governments under whose jurisdiction whales and whale products may be legally marketed.

2. SPECIFICATIONS FOR THE ESTABLISHMENT/ MAINTENANCE OF MARKET SAMPLING SCHEME
2.2 Development of appropriate market sampling schemes including audit

New 2.2 (4)	to take into account that some 'degraded' and/or 'processed' samples from market surveys could not be analyzed using exactly the same procedures as those currently used for 'fresh' and 'unprocessed' samples, but that methods could be developed to allow accurate comparison of such samples with profiles in DNA registries.

2.4 Reporting

2.4	a slight revision of the text concerning reporting to the IWC by the international expert group: the international expert group shall submit an annual report to the Secretariat of the IWC for distribution to contracting governments and the Commission (and, if necessary bodies of the Commission) at least two months before it must be considered.

20.2 Review of Annex {SI} to IWC/62/7rev – scientific information requirements

The draft Annex was based on previous recommendations of the Committee in the context of RMS discussions (IWC, 1995d). The Committee reviewed the Annex. In discussion it was recalled that the Committee has previously agreed that bulla do not provide a reliable means for estimating age (IWC, 2002c, p.12). It also noted that earplugs do not provide reliable age estimates for North Atlantic common minke whales. Walløe and Víkingsson reported that lengths could not always be recorded for minke whales in North Atlantic in the manner specified, although estimates of length are reported to the Secretariat.

Given the above the Committee **recommends:**

(1) reference to 'bulla' be removed from point 2(b); and
(2) the following footnote be added to point (a) 'Onboard small coastal whaling vessels such as those participating in Norwegian and Icelandic operations, it may be difficult to obtain accurate length measurements because whales are handled on a limited space. It is recognised that measurements in these cases may not be as accurate as those taken in ideal situations.'

The full revised Annex is given as Annex T.

20.3 Review of Annex {OI} to IWC/62/7rev – operational information requirements

The Committee **endorses** the operational information requirements as given in the proposed Annex.

20.4 Review of proposed timetable for future *Implementations* and *Implementation Reviews* (IWC/62/7rev Appendix B, p. 37)

The Committee **concurs** with the SAG that the schedule in Section 5 of IWC/62/7rev, updated following its deliberations as Table Y below, is ambitious. It noted that *Implementations* and *Implementation Reviews* can (and do) involve considerable time and resources from national scientists and, especially in cases when *Implementation Simulation Trials* are required, the Secretariat. Moreover, delays can occur when conducting *Implementations* given that the same members of the Committee are involved in many of the *Implementations* and *Implementation Reviews*.

The Committee has previously agreed that it can only conduct one *Implementation* at a time. The schedules for Western North Pacific Bryde's whales, and for North Atlantic common minke and fin whales given in IWC/62/7rev match the schedules expected from the *Implementations* for these species in terms of the Committee's agreed guidelines (IWC, 2005b). The Committee has previously been able to complete an *Implementation Review* during a single meeting, provided that no *Implementation Simulation Trials* are required.

The Committee therefore cannot conduct *Implementations* for Western North Pacific sei and Antarctic minke whales at the same time. The SAG had considered it more important to conduct an *Implementation* for Western North Pacific sei whales first given the size of current catches and the estimates of abundance for this stock. However, the Committee noted that there are also reasons to conduct an *Implementation* for Antarctic minke whales starting in 2012. After discussion of the relative amount of preparatory work required for *In-depth* and *pre-Implementation assessments* of North Pacific sei whales compared to Antarctic minke whales, the Committee **recommends** to deal with North Pacific sei whales before minke whales, as in IWC/62/7rev, and further **recommends** the schedule given in 20.5.3.4 below.

The Committee **recommends** that two years should be allowed for the *pre-Implementation assessment* for Antarctic minke whales irrespective of when the *Implementation* for these whales starts (under the current schedule, the first year of the *pre-Implementation assessment* would be 2014). It was also recognised that the current *Implementation* for these whales is sufficiently dated (1993) that it was unreasonable to expect that this 1993 *Implementation* can simply be reviewed after almost 20 years of developments in how to *Implement* the RMP.

The Committee therefore **recommends** that '/IR' (for *Implementation Review*) be deleted from the box for 2015 for Antarctic minke whales.

20.5 Review of the Scientific Assessment Group (SAG) Report

As part of the Commission's discussions on the Future of the IWC, the Commission's Chair and Vice-Chair developed the document 'Proposal Consensus Decision to Improve the Conservation of Whales' (IWC/62/7rev). During the development process but before finalisation of IWC/62/7rev, a small Scientific Assessment Group (SAG) was established to provide a report (IWC/M10/SWG6) of a concise scientific review on whether proposed catches were such that the long-term status of the populations concerned would be negatively affected. The numbers in table 4 of the proposed consensus decision (i.e. proposed whale catches for the period 2010/11-2019/20) are below those considered by the SAG. The terms of reference developed by the Small Working Group on the Future of the IWC (SWG) for the Committee's review of the SAG report in the light of the numbers in table 4 of IWC/62/7rev are given in Annex S and summarised below.

The Committee shall follow the terms of reference of the SAG (IWC/M10/SWG, Annex B), recognising:

(a) the need to be concise;
(b) the fact that there are a number of different approaches to evaluating short-term catches and no single method will be appropriate in all circumstances; and

(c) that the report should provide an integrated, pragmatic view on whether or not the proposed short-term catches (i.e. before the RMP can be used) are likely to negatively affect the long-term (i.e. RMP simulation framework timeline of 100 years) status of the stock *given* the timetable for RMP work.

It had also been requested that the Chair of the Scientific Committee should ensure that the time spent on this review should be such that it does not interfere with the Committee's focus on completing RMP-related work as soon as possible.

The SAG had noted that there were two categories of stocks for which advice was required: those for which the RMP could be applied immediately, and those for which it could not. The report below follows a similar pattern, focussing initially on the application of the RMP (western North Pacific Bryde's whales, North Atlantic common minke whales, North Atlantic fin whales) and then turning to those stocks for which it cannot immediately be applied (Antarctic minke whales, Southern Hemisphere fin whales, western North Pacific common minke whales, and western North Pacific sei whales).

20.5.1 General issues related to using the RMP

20.5.1.1 CATCH LIMIT CALCULATIONS (ACTIVATION, YEARS, INPUTS AND OUTPUTS)

As part of the SAG process, the RMP was applied to three species-Region combinations (western North Pacific Bryde's whales; North Atlantic minke whales; and North Atlantic fin whales) upon instruction from the Chair of the Commission. The calculations reported are therefore the results of applying the RMP itself, although results are also shown for tunings other than the Commission-agreed 0.72 tuning (the 0.6 tuning). The Committee repeated the RMP catch limit calculations for these stocks. Differences from the SAG's calculations are documented in the following sections. When applying the *CLA*, the phase-out rule was applied for each *Small Area* after the catch limit was cascaded to the *Small Areas* from the *Medium Area* rather than applying the phase-out rule before cascading the *Medium Area* catch limit to *Small Areas*, in accordance with RMP specifications (RMP specification 3).

20.5.1.2 TUNING LEVELS

The SAG report (and Annex D, Appendix 8) provides results for the 0.72 and 0.6 tunings of the RMP because the whaling countries in the Commission's support group had requested the latter tuning. This issue is discussed more fully in the SAG report.

The Committee noted that although the 0.6, 0.66 and 0.72 tunings of the *CLA* were recommended to the Commission by the Committee, having been subjected to testing during the development of the RMP, the *Implementation Simulation Trials* have only been conducted by the Committee for the 0.72 tuning of the RMP. Norwegian scientists have run the *Implementation Simulation Trials* for minke whales in the Northeast Atlantic for the 0.6 tuning of the RMP, but these calculations were not undertaken nor reviewed in detail by the Committee. In addition, which RMP variants are 'acceptable' may change if the tuning level is changed. The Committee **agrees** that the tuning level which was used when calculating catch limits using the *CLA* should be that which is tested in *Implementation Simulation Trials*; in this case only the 0.72 tuning. In principle, the *Implementation Simulation Trials* could be repeated for a new tuning if requested by the Commission. However, the criteria used to evaluate whether performance of an RMP variant is 'acceptable', 'borderline' or 'unacceptable' is linked to the 0.6 and 0.72 tunings of the RMP. The present criteria may need to be investigated if the Commission requested that a different tuning of the RMP should be considered.

20.5.1.3 OTHER ISSUES

The Committee notes that its advice is based on the schedule of RMP *Implementations* proposed in Appendix B of the Chair's and Vice-Chair's proposal (IWC/62/7rev). The Committee brings to the attention of the Commission its concern that delays in completion of these implementations may increase risks to whale populations. Attention is drawn to the two-year schedule for completion of an *Implementation* as set out in the Committee's agreed guidelines (IWC, 2005b) - proposals made in this report follow from the Committee's intent to progress work in terms of this schedule.

On a more general issue, the Committee draws the Commission's attention to the fact that the RMP and AWMPs are designed to provide advice on catch and strike limits for periods of up to 6 years. Further work may be needed to assess the risks associated with setting catch limits for longer periods than 6 years.

20.5.2 Application of Stocks/Regions for which the RMP can immediately be applied

The Committee reviewed the specifications (provided by the Secretariat) of how the RMP was applied during the SAG meeting to western North Pacific Bryde's whales, North Atlantic minke whales, and North Atlantic fin whales. The following items summarise the modifications to the initial applications by the Secretariat made by the Committee in reaching its agreed applications: these primarily involve clarifications with respect to time-stamps of abundance estimates and the addition of newly agreed abundance estimates. Table 7 lists the resulting catch limits from the 0.72 and 0.6 tunings of the *CLA*. The format used to document the input and present the results (see Annex D, Appendix 8 for the final format) illustrates the calculations made, and emphasises the results calculated using the Commission-agreed 0.72 tuning.

20.5.2.1 WESTERN NORTH PACIFIC BRYDE'S WHALES

The application of the RMP to western North Pacific Bryde's whales was based on a single abundance estimate for the *Region* (time-stamped at 2000). The Committee requested that the time-stamps for the *Small Areas* when applying catch cascading be set to the effort-weighted years.

It was noted that survey data were available for 1988-96 and some of these data were used when computing the additional variance for the 1998-2002 surveys (Shimada *et al.*, 2008). An abundance estimate can be computed for 1988-96, but the Committee has only accepted the estimate from the 1998-2002 surveys (IWC, 2009b). Although abundance estimates could be calculated using the 1988-96 data, account would need to be taken of the correlation of these estimates with those for 1998-2002 if they were included in RMP calculations of catch limits. However, the presently-coded version of the RMP does not allow input of a variance-covariance matrix for the abundance estimates. The Committee therefore **recommends** that:

(1) the program for the *CLA* be modified to allow variance-covariance matrices to be input (Annex D, item 2.4); and
(2) the data and resulting abundance estimates from the 1988-96 surveys should be reviewed for possible use in the RMP during the next *Implementation Review*.

Table 7

Summary of the application of the RMP (full details of the inputs to the RMP as well as relevant intermediate calculations are given in Annex D, Appendix 8). Phaseout has been applied where applicable.

Year	WNP Bryde's whales	North Atlantic fin whales		North Atlantic minke whales					
Sub-area	1W+1E	WI (variant 6)	WI (variant 2)	CIC	CM	ES	EB	EW	EN
Catch limits based on the 72% tuning (Commission's agreed value)									
2010	**5**	**46**	**87**	**224**	**135**	**58**	**92**	**152**	**70**
2011	**3**	**46**	**87**	**224**	**135**	**58**	**92**	**152**	**70**
2012	**1**	**46**	**87**	**224**	**135**	**46**	**92**	**152**	**70**
2013	**0**	**46**	**87**	**224**	**135**	**35**	**92**	**152**	**56**
2014	**0**	**46**	**87**	**224**	**108**	**14**	**92**	**152**	**42**
Catch limits based on the 60% tuning									
2010	33	90	155	345	208	122	195	322	148
2011	19	90	155	345	208	122	195	322	148
2012	4	90	155	345	208	97	195	322	148
2013	0	90	155	345	208	73	195	322	118
2014	0	90	155	345	166	29	195	322	89

The final specifications for how the RMP was applied to these whales are listed in Annex D, Appendix 8A.

20.5.2.2 NORTH ATLANTIC MINKE WHALES

The Committee **recommends** the following changes to the abundance estimates for minke whales in the Central North Atlantic:

(1) use the estimates in Annex D, Table 1 to construct an abundance estimate for *Small Areas* CG+CIP and include this abundance estimate in that for the C *Medium Area* for 2006;
(2) use the estimate for the CM *Small Area* in 2005 of 12,043 (CV 0.28) in place of the estimate of 6,174 (CV 0.36) because the former estimate is based on surveys which covered more of the CM *Small Area*; and
(3) use the revised version of the estimate of abundance for 2005 of 26,739 (CV 0.39) in place of the estimate of 24,890 (CV 0.45);

Allison recalculated the CVs for the abundance estimates for the C *Medium Area*.

The Committee **recommends** that the catch limits for the minke whales in the eastern North Atlantic be based on the latest sex ratio data (i.e. 2005-09) rather than 2004-08 as was used for the SAG report. The final specifications for how the RMP was applied to North Atlantic minke whales are listed in Annex D, Appendix 8B.

20.5.2.3 NORTH ATLANTIC FIN WHALES

The Committee had no changes to the application of the RMP used in the SAG report. The specifications for how the RMP was applied to North Atlantic fin whales are listed in Annex D, Appendix 8C. As noted under Item 6.2.1, the Scientific Committee has already confirmed that *Variant 2* would be acceptable for 10 years, followed by *Variant 1*, if accompanied by an acceptable research programme. No final research proposal to distinguish between stock structure hypotheses has yet been adopted. Therefore, *Variant 2* is not an available option at this time. However, a preliminary proposal was submitted and discussed at this meeting. The Scientific Committee made two specific recommendations for improvement. The proposal will be modified accordingly, in consultation with an advisory committee appointed by the Scientific Committee, and submitted to the next Annual Meeting for adoption.

20.5.3 Advice on Stocks/Regions for which the RMP cannot immediately be applied

20.5.3.1 ANTARCTIC MINKE WHALES

Information on the timetable for undertaking an *Implementation* of Antarctic minke whales is given under Item 20.4. If this timetable can be met, it is expected to be completed in 2016.

20.5.3.2 SOUTHERN HEMISPHERE FIN WHALES

Section 2.6 of IWC/M10/SWG6 considered Southern Hemisphere fin whales. It is proposed that catches would be taken alternately in the Indian Ocean (between 35°E-130°E) and Pacific Ocean (between 130°E and 145°W) sectors of the Antarctic. A total of 10 annual catches would be taken in the period 2010/11-2012/2013, starting in the Pacific Ocean sector. Catches would be reduced from 10 to 5 individuals from 2013/14 until 2019/2020.

The Committee noted that in the past there was extensive exploitation (nearly 750,000 fin whales were killed in the 20th Century), and that recent information on fin whales in the Southern Hemisphere is poor. The Committee also noted that there were additional abundance estimates for this population, derived from IDCR/SOWER surveys, which had not been considered by the SAG (e.g. Branch and Butterworth, 2001a; Butterworth and Geromont, 1995). Branch and Butterworth (2001) estimated that the circumpolar abundance of fin whales south of 60°S was 2,100 (CV=0.36), 2,100 (CV=0.45) and 5,500 (CV=0.53) for CPI, CPII and CPIII respectively. These estimates are negatively biased since the areas north of 60°S were not covered[6].

It is unlikely that sufficient information will become available in the interim period (up to 2020) for an RMP *Implementation* to occur. Nevertheless, some members noted that if the *CLA* of the RMP was used it would result in a catch limit of 0. The Committee **concurs** with the general conclusions of the SAG, i.e. that it is unlikely that the proposed catches will affect the long-term status of the stock[s]. Some members were concerned about providing *ad-hoc* advice on catch limits without any likelihood of a formalised procedure being available in the foreseeable future. They did not want this exercise to set a precedent for providing *ad-hoc* advice.

[6]IWC (1996b) reports IDCR estimates extended to south of 30°S by using Japanese Scouting Vessel survey results to provide an index of relative abundance.

20.5.3.3 WESTERN NORTH PACIFIC COMMON MINKE WHALES

Information on the timetable for undertaking an *Implementation Review* of western North Pacific common minke whales is given under Item 20.4. Given the progress made at this meeting (see Annex D1), it is expected that this will be completed in 2012.

The Committee noted that it was not possible to apply the RMP to the data for these minke whales owing to the considerable changes to the understanding of stock structure in recent years. It **agrees** that the present uncertainty precludes giving adequate advice regarding the catches in Table 4 of IWC/62/7rev The Committee generally **agrees** with the conclusions of the SAG; the Committee summarised its conclusions as follows.

(1) The *Implementation* process should be completed as quickly as possible. Completing the *Implementation Review* will allow advice on catches to be based on the RMP, which has been selected to ensure that catches are sustainable.

(2) A high priority should be accorded to research to determine the proportions of 'O' and 'J' stock in sub-area 12 because the implications of any proposed catches for both 'O' and 'J' stock clearly differ depending on this proportion. In this respect, the Committee welcomed the survey of sub-area 12 planned for summer 2010 and **emphasises** the importance of collecting as much data as possible to estimate stock proportions in sub-area 12.

(3) The proposed catches by coastal whalers in Table 4 of IWC/62/7rev may not help to improve the status of 'J' stock compared to current JARPN II catches. The incidence of 'J' stock in the catch decreases with distance offshore. The Committee received an analysis which estimated the number of 'J' stock animals under catch levels of 150 inshore and 70 offshore (Annex G1, Appendix 8). The Committee recognised the value of analysis such as those in Annex G1, Appendix 8 and **recommends** that further analyses be conducted using a finer spatial resolution and quantifying the uncertainty associated with the predictions, including the likely level of inter-annual variation in catches of 'J' stock animals.

(4) The Committee was unable to agree on the impact of the proposed catches on the 'O' stock. However it **agrees** that the risk to the 'O' stock will be minimised if the *Implementation Review* is completed as soon as possible so that advice can be based on the RMP and hence also **agrees** that catches of 'O' stock should not exceed present levels.

Table 8

Scientific Committee work plan for RMP *Implementations.*

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	202
Western North Pacific Bryde's whales										
			IR					IR		
NA common minke whales - eastern and central medium areas										
				IR						IR
NA fin whales - central medium area										
				IR					IR	
Western North Pacific common minke whales										
PIA		RMP	[RMP]					IR		
Western North Pacific sei whales										
	IDA		PIA	RMP	[RMP]					IR
Antarctic minke whales										
				PIA	PIA		RMP			

IR= *Implementation Review* (often possible to complete in one year). PI = *pre-Implementation assessment* (may take more than one year). RMP completed *Implementation* (takes two years once the PIA is completed IDA= in-depth assessment, usually takes two years or more and feeds in a *pre-Implementation assessment.* As explained in the text, the plan ambitious and it may not be possible to achieve all of the work by th years indicated. Square brackets are used to express possible but perhap less likely dates.

20.5.3.4 WESTERN NORTH PACIFIC SEI WHALES

Information on the timetable for undertaking an *Implementation* of western North Pacific sei whales is given under Item 20.4. If the *Implementation* turns out to be as simple as suggested there, it is expected to be completed by 2014.

The SAG report was based on the assumption that the In-depth Assessment for North Pacific sei whales would be conducted in 2010 as planned last year. This year, the Committee has concluded that in view of the relatively simple information available on the population, the In-depth Assessment and *pre-Implementation assessment* could most efficiently be combined into a single exercise, and **agrees** a compromise date of 2013 for the combined assessment, with RMP catch limits to be set the following year if no complications arise. The Committee **concurs** with the SAG that priority for the Committee should be to complete the RMP *Implementation* as soon as possible rather than to develop formal interim management advice. The Committee was unable to agree on the impact of the proposed catches on sei whales. The Committee **recommends** that as a minimum there should be no increase in the present level of catches until the RMP *Implementation* has been completed. Catches for North Pacific sei whales resumed in 2002 and the annual catch since 2004 has been 100 animals.

Table 9

Workshops and intersessional meetings planned for 2010/11.

Subject	Agenda item	Venue	Dates	Steering Group
North Pacific sighting survey workshop	Item 10.8.1; Annex G	Tokyo	28-30 September 2010	Q15
North Pacific 2011 cruise: planning	Item 10.8.2; Annex G	Tokyo	24-26 September 2010	Q15
Small cetaceans and climate change workshop	Item 12.5; Annex K	Vienna	28 November- 1 December 2010	Q24
Abundance of Antarctic minke whales workshop	Item 10.1.1; Annex G	Bergen?	January 2011	Q13
North Pacific minke whale preparatory meeting	Item 6.3; Annex D1	Tokyo	25-27 September 2010	Q4
North Pacific minke First Intersessional Workshop	Item 6.3; Annex D1	Korea	14-17 December 2010	Q4
Workshop on AWMP	Items 8.2; 8.3; Annex E	TBA	March 2011	Q1

Possible pre-meetings immediately before SC/63 depending on intersessional progress: AWMP gray whale *Implementation Review*; western North Pacific common minke whale *Implementation Review;* assessment of humpback whale Breeding Stock B.

21. RESEARCH AND WORKSHOP PROPOSALS AND RESULTS

Table 9 lists the proposed intersessional meetings and workshops. Financial implications and further details are dealt with under Item 24.

Results from last year's intersessional IWC workshops are dealt with under the relevant Agenda Items.

21.1 Review results from previously funded research proposals

Results from IWC funded projects are dealt with under the relevant agenda items.

21.2 Review proposals for 2010/11

No unsolicited research proposals were received. The Committee has **agreed** mechanisms for reviewing proposals under the SORP programme (Item 19) and the Small Cetaceans Voluntary Fund (Item 15).

22. COMMITTEE PRIORITIES AND INITIAL AGENDA FOR THE 2011 MEETING

Revised Management Procedure (RMP)

The following issues are high priority topics:

GENERAL MATTERS

(1) complete review of the range of MSYR values for use in the RMP;
(2) finalise approach for evaluating proposed amendments to the *CLA*;
(3) evaluate the Norwegian proposal for amending the *CLA*;
(4) consider implications that the phase-out rule in the RMP is applied by *Small Area* when catch cascading is applied and the abundance estimates are based on multi-year surveys; and
(5) modify the Norwegian 'CatchLimit' program to allow variance-covariance matrices to be specified for the abundance estimates.

IMPLEMENTATION REVIEW FOR NORTH PACIFIC COMMON MINKE WHALE

(1) review results of intersessional workshops; and
(2) complete the work assigned to the 'First Annual Meeting' in accord with our guidelines.

IMPLEMENTATION FOR THE WESTERN NORTH PACIFIC BRYDE'S WHALES

(1) review the research proposal for the 'variant with research'.

IMPLEMENTATION FOR THE NORTH ATLANTIC FIN WHALES

(1) review revised research proposal for the 'variant with research'; and
(2) review abundance estimates for use in the *CLA*.

IMPLEMENTATION FOR THE NORTH ATLANTIC MINKE WHALES

(1) review any new abundance estimates.

Aboriginal Whaling Management Procedure (AWMP)

The following issues are high priority topics:

(1) work on developing appropriate long-term management advice for the Greenlandic fisheries with the primary focus on:
    (a) completing work on a sex-ratio based assessment of common minke whales off west Greenland; and
    (b) progress on developing *SLA*s for West Greenland fin and common minke whales;
(3) the *Implementation Review* for the eastern North Pacific gray whales; and
(4) consider any new scientific information related to conversion factors for edible products for Greenland fisheries.

Bowhead, right and gray whales (BRG)

The following issues are high priority topics:

(1) perform the annual review of catch information and new scientific information for B-C-B stock of bowhead whales and prepare for the 2012 *Implementation Review*;
(2) review stock structure and abundance for Eastern Canada and West Greenland bowhead whales;
(3) review scientific information on North Pacific and North Atlantic right whales;
(4) review progress towards southern right whale workshop;
(5) review new information on western gray whales;
(6) review information on other stocks of bowhead whales; and
(7) review new information on eastern gray whales (not relevant to *Implementation Review*).

In-depth assessment (IA)

The following issues are high priority topics:

(1) resolve the reasons for the differences between estimates of abundance of Antarctic minke whales between the OK and SPLINTR models;
(2) continue development of the catch-at-age models of Antarctic minke whales, including sensitivity tests to examine various assumptions regarding ageing errors and age-length keys; and
(3) continue examination of the differences between minke abundance estimated from CPII and CPIII, by further investigation of the relationship between sea ice and minke whale abundance.

Bycatch and other human-induced mortality (BC)

The following issues are high priority topics:

(1) collaboration with FAO on collation of relevant fisheries data and joining FIRMS;
(2) review progress in including information in National Progress Reports;
(3) continue development of the international database of ship strike incidents;
(4) consider methods for estimating risk and rates of bycatch and entanglement;
(5) consider methods and data sources for establishing time series of bycatch;
(6) review methods to estimate mortality from ship strikes; and
(7) review methods for assessing mortality from acoustic sources and marine debris.

Stock definition (SD)

The following issues are high priority topics:

(1) furtherance of guidelines for genetic analyses;
(2) updates on guidelines for DNA Data Quality;
(3) statistical and genetic issues concerning stock definition;
(4) TOSSM; and
(5) unit-to-conserve.

DNA (DNA)

The following issues are high priority topics:

(1) review genetic methods for species, stock and individual identification;

(2) review of results of the 'amendments' work on sequences deposited in GenBank;
(3) collection and archiving of tissue samples from catches and bycatches; and
(4) reference databases and standard for diagnostic DNA registries.

Environmental concerns (E)
The following issues are high priority topics:

(1) SOCER;
(2) review progress on POLLUTION 2000+;
(3) review new information impact of oil and dispersants on cetaceans;
(4) review progress of the CERD Working Group;
(5) review progress on recommendations from 2010 focus sessions on masking sound;
(6) review approaches as available from other international forums with regard to mitigation of effects of anthropogenic sound on cetaceans;
(7) review progress on work from the 2nd Climate Change Workshop; and
(8) review of marine renewable energy development.

Ecosystem modelling (EM)
The following issues are high priority topics:

(1) review ecosystem models from the North Pacific that may be relevant to assessments and RMP *Implementations*;
(2) review other issues relevant to ecosystem modelling within the Committee; and
(3) review ecosystem modelling efforts undertaken outside the IWC.

Southern Hemisphere whales other than Antarctic minke whales (SH)
The following issues are high priority topics:

(1) humpback whales-complete the assessment of breeding stock B;
(2) blue whales (Antarctic and pygmy): population estimates and continue work on the Southern Hemisphere blue whale catalogue;
(3) prepare for assessment of humpback whale breeding stocks D, E and F;
(4) review new information on the Arabian humpback populations.

Small cetaceans (SM)
The following issues are high priority topics:

(1) the status of status of Ziphiidae (beaked and bottlenose whales) worldwide;
(2) directed takes of small cetaceans;
(3) review report from climate change-small cetaceans workshop;
(4) other topics e.g. marine bushmeat; and
(5) review of progress on previous recommendations.

Whalewatching (WW)
The following issues are high priority topics:

(1) assess the impacts of whalewatching on cetaceans;
(2) review reports from intersessional working groups:
 (a) large-scale whalewatching experiment (LaWE) Steering Group;
 (b) LaWE Budget Development Group;
 (c) on-line database for world-wide tracking of commercial whalewatching and associated data collection; and
 (d) swim-with-whale operations;
(3) consider information from platforms of opportunity of potential value to the Committee;
(4) review of whalewatching guidelines and regulations; and
(5) review of collision risks to cetaceans from whalewatching vessels.

Scientific Permits
The following issues are high-priority topics:

(1) Review of activities under existing permits.
(2) Review of new or continuing proposals.
(3) Procedures for reviewing scientific permit proposals.
(4) Planning for final review of results from Iceland's scientific take of North Atlantic common minke whales.

23. DATA PROCESSING AND COMPUTING NEEDS FOR 2010/11

The Committee identified and agreed the requests for intersessional work by the Secretariat given in Table 10.

Table 10

Computing tasks/needs for 2010/11.

RMP – preparations for *Implementation*
Run a full set of trials using the Norwegian 'CatchLimit' program for North Atlantic fin whales, Western North Pacific Bryde's whales; and North Atlantic minke whales and place the results on the IWC website (Item 5.3).
AWMP
Work in preparation for/arising from the proposed workshop (Item 21).
NPM
Update the control program for North Pacific minke whales and undertake any work arising from the Preparatory Meeting and the First Intersessional Workshop including assembling the catch data at the appropriate spatial and temporal resolutions and coding and conditioning the operating models themselves (Item 6.3.2).
In-depth assessment
Validation of the 2009/10 SOWER cruise data for incorporation into the DESS database; complete validation of the 1995-97 blue whale cruise data and incorporate into the DESS database; prepare a catch series for North Pacific sei whales (Item 10.9.1).
Southern Hemisphere whale stocks
Documentation of the catch data available for Antarctic minke whales in preparation for the *pre-Implementation assessment* (Item 20.4).
Bycatch
Input bycatch data from the last season (2009) and for previous seasons (from 2003 back) into the bycatch database (Item 7.1).

24. FUNDING REQUIREMENTS FOR 2010/11

Table 11 summarises the complete list of recommendations for funding made by the Committee. The total required to meet its preferred budget is £316,700. The Committee **recommends** all of these proposed expenditures to the Commission. This is slightly above the projected amount available for funding (£315,750). The Committee **agrees** that the final column given in the table represents a budget that will allow progress to be made by its sub-committees and Working Groups in its priority topics.

A summary of each of the items is given below, by sub-committee or standing Working Group. Full details can be found in the relevant Annexes as given in Table 11.

The Committee was pleased to note that procedures have been agreed to review proposals for funds from the Small Cetaceans Voluntary Fund and the Southern Ocean Research Partnership (Items 14 and 19). One proposal under the former has been recommended (see Item 14.6.1). The Committee was also pleased to note that funding has been found for the Workshop on Small Cetaceans and Climate Change (see Item 12.5).

Table 11

Summary of budget requests.

	Annex	Short title	Requested (£)
RMP			
1	Annex D	Analysis and use of time-series of data on calving rates and intervals for use in the MSYR review.	7,000
NPM			
2	Annex D1	Pre-meeting and 1st Intersessional Workshop towards *Implementation Review* for WNP common minke whales.	25,000
AWMP			
3	Annex E	AWMP Workshop on Greenlandic fisheries and preparing for gray whale *Implementation Review.*	12,000
4	Annex E	AWMP developers fund.	8,000
BRG			
5	Annex F	Southern Ocean right whale photo-id catalogue.	3,800
IA			
6	Annex G	Investigate the relationship between sea-ice characteristics and Antarctic minke whale abundance estimates.	5,000
7	Annex G	Resolving differences in minke whale abundance estimates.	15,000
8	Annex G	Import of 2009/10 SOWER data and assist abundance working group.	3,000
9	Annex G	North Pacific sighting cruise.	58,000
10	Annex G	Workshop to plan medium-long term North Pacific sighting survey programme.	7,000
11	Annex G	Statistical catch-at-age estimators for Antarctic minke whales.	2,500
SH			
12	Annex H	Southern Hemisphere Blue Whale Catalogue Project.	18,900
13	Annex H	Modelling of Southern Hemisphere humpback whale populations.	3,000
14	Annex H	Antarctic humpback whale catalogue.	15,000
BC			
15	Annex J	Further development and maintenance of the IWC ship strike database.	5,000
16	Annex J	Development of an online submission database for Progress Reports.	5,000
E			
17	Annex K	Risk assessment modelling to determine the impact of pollutants on cetacean populations.	52,500
18	Annex K	State of the Cetacean Environment Report (SOCER).	3,000
WW			
19	Annex L	Data compilation and power analyses for the LaWE.	4,000
ALL			
20		Invited Participants to the 2011 Annual Meeting.	64,000
Total			**316,700**

Revised Management Procedure

(1) ANALYSIS AND USE OF TIME-SERIES OF DATA ON CALVING RATES AND INTERVALS FOR USE IN THE MSYR REVIEW

The Committee is conducting a review of the range of MSYR values to include in simulation trials when selecting among variants of the RMP. The third intersessional workshop on the review of MSYR assembled a number of datasets on calving rates and calving intervals for baleen whales. Efforts were made following the workshop to fit models which accounted for both process and observation error to the data on calving rates and calving intervals. However, numerical problems were encountered when implementing these models. Funding is required for researchers to overcome these problems to provide the inputs needed to apply the Bayesian hierarchical method adopted by the Committee for computing a posterior distribution for r_0.

North Pacific minke whales

(2) PREPARATORY MEETING AND FIRST INTERSESSIONAL WORKSHOP TOWARDS THE IMPLEMENTATION REVIEW FOR WESTERN NORTH PACIFIC COMMON MINKE WHALES

The schedule for an *Implementation Review* specifies that between the finalisation of the *pre-Implementation assessment* and the following annual meeting of the Scientific Committee, an intersessional workshop shall be held to address a number of issues. Given the complexity of this *Implementation Review*, it is important to hold a preparatory meeting before the First Intersessional Workshop.

Aboriginal Whaling Management Procedure

(3) WORKSHOP ON GREENLANDIC FISHERIES/PREPARATION FOR GRAY WHALE IMPLEMENTATION REVIEW

The Committee has a number of priority areas related to Greenlandic fisheries and an intersessional Workshop is required to address:

(1) progress on developing *SLAs* for West Greenland fin and common minke whales;
(2) progress on the development of the sex-ratio method; and
(3) preparation for the *Implementation Review* for eastern North Pacific gray whales.

(4) AWMP DEVELOPERS FUND

The developers fund has been invaluable in the work of *SLA* development and related essential tasks of the SWG. It has been agreed as a standing fund by the Commission. The primary development tasks facing the SWG are for the Greenlandic fisheries. These tasks are of high priority to the Committee and the Commission. The fund is essential to allow progress to be made.

Bowhead, right and gray whales

(5) SOUTHERN OCEAN RIGHT WHALE PHOTO-ID CATALOG

For several decades, extensive photo-id surveys have been carried out for southern right whales in the coastal waters of South America, southern Africa and Australia during winter and spring, and much valuable data on the demographics of these populations has been collected. Together with genetic information, these data also provide the opportunity to investigate interchange and mixing between the coastal populations. However, because of its geographic limitations it is uninformative about the links between these populations and those found (generally at higher latitudes) in summer where extensive catches were taken in pelagic whaling. Funding is requested to address this gap by compiling images of southern right whales taken away from coastal waters of the continents, in a catalogue and associated database.

In-depth assessments

(6) INVESTIGATE THE RELATIONSHIP BETWEEN SEA ICE CHARACTERISTICS AND ANTARCTIC MINKE WHALE ABUNDANCE ESTIMATES

No conclusions have yet been reached on the reasons for the appreciable decline in abundance estimates from CPII and CPIII. Changes in sea ice characteristics, such as its extent and configuration, have been considered as one of the most likely influential factors. In order to investigate this carefully, funding is required to enable the preparation of the following sea ice related data sets:

(1) timing of the ice melt index for the entire time series of CPII and CPIII; and
(2) sea ice characteristics (e.g. area of sea-ice-field) in the south of ice edge for the entire time series of CPII and CPIII.

(7) RESOLVING DIFFERENCES IN MINKE WHALE ABUNDANCE ESTIMATES

Over the past two years, two methods have been presented to estimate abundance from the CPII and CPIII IDCR/SOWER cruise data. However, there are large differences between the estimates. These differences are much greater than statistical uncertainty, and than generally seen in the simulated datasets. Following intersessional work by correspondence a workshop is required to attempt to finally resolve the difference between the two approaches.

(8) IMPORT 2009/10 SOWER DATA AND ASSIST ABUNDANCE WORKING GROUP

Funds are required to enable the 2009/10 IWC/SOWER data to be incorporated into DESS and to provide general support to the IWC Secretariat regarding DESS. Errors will be corrected in the 'standard' and IDCR/SOWER datasets before the 2010 Scientific Committee meeting.

(9) AND (10) 2011 NORTH PACIFIC SIGHTING CRUISE AND ASSOCIATED MEETINGS

A new medium- to long-term research programme involving sighting surveys to provide annual information for cetacean stock management in the North Pacific is scheduled to commence in 2011. The cruise will last a total of about 60 days between July and August and the vessel *Kaiko Maru* will generously be provided by the Japanese Government. A two-day planning meeting for the 2011 cruise will be held in Tokyo. It will be preceded by a three-day workshop to develop the medium to long term objectives of the research programme and associated fieldwork.

(11) STATISTICAL CATCH-AT-AGE ESTIMATORS FOR ANTARCTIC MINKE WHALES

The Committee is trying to understand the reasons for the apparent large declines in abundance indicated by estimates produced from these surveys. Several of these reasons can be explored by population dynamics modelling. In 2005, Punt and Polacheck developed the statistical catch-at-age (SCAA) model, which has been refined over the last few years and is considered the most appropriate modelling framework for addressing these issues. Funding is requested for Committee's researchers to implement the recommendations so that in 2011 it will be in a position to apply the SCAA model to the most recent datasets.

Other Southern Hemisphere whale stocks

(12) SOUTHERN HEMISPHERE BLUE WHALE CATALOGUE PROJECT

Little is known about the present-day migration of blue whales, population structure and abundance or the level of interchange among populations. In 2008, the IWC supported the creation of a Southern Hemisphere blue whale catalogue and Centro de Conservacion Cetacea in Chile was tasked with developing a central web-based system by which Southern Hemisphere blue whale photo-id matching could take place. Matching will be conducted during the next two years through this platform by researchers from three Southern Hemisphere regions. Comparisons of blue whale photo-id and the significant number of individuals catalogued will be time consuming and researchers will not have enough free time to dedicate to the matching process. Therefore funding is required to ensure the matching process is completed. This will be a two-year project and a further request for funding (£11,200) will be submitted next year.

(13) MODELLING OF SOUTHERN HEMISPHERE HUMPBACK WHALE POPULATIONS

(1) Deliberations at the 2010 Annual Meeting have led to a number of proposed variants of stock-structure models for breeding stock B. Computer software needs to be developed to implement these models to take account of tag-recapture data.
(2) Simultaneous analysis of all 7 breeding stocks using the current age-aggregated model is desirable so that:
    (a) the catch allocation uncertainty is taken into account in a consistent and even-handed manner;
    (b) uncertainties in the boundaries for such allocations can be properly included in the analysis; and
    (c) likely similarities in intrinsic growth rate parameters for the different stocks can be properly factored into the analyses.

Development of this model has commenced but still needs further development. A contribution towards the salaries of researchers is requested to enable progress to be made with (1) and (2).

(14) ANTARCTIC HUMPBACK WHALE CATALOGUE

The Committee is already committed to funding this project, which represents only a partial cost of running the catalogue and is of great benefit to its in-depth assessment of Southern Hemisphere humpback whales. The funds are required to continue the cataloguing of submitted photographs and further develop and enhance the system for on-line access. The work will be carried out by Carlson and Allen.

Bycatch and other human-induced mortality

(15) FURTHER DEVELOPMENT AND MAINTENANCE OF THE IWC SHIP STRIKE DATABASE

Development of the IWC ship strike database has continued intersessionally. Funding is required for: (1) completing work on public summaries; (2) the development of a handbook; (3) data entry and validation; and (4) annual ongoing work by the data review group. The need for a global database of incidents involving collisions between vessels and whales has previously been recognised by the Committee, as well as other bodies such as the International Maritime Organization (IMO) and ACCOBAMS.

(16) DEVELOPMENT OF AN ONLINE SUBMISSION DATABASE FOR PROGRESS REPORTS
In 2009 the possibility of developing an online form/ database for submission of national Progress Reports was discussed as part of work on bycatches and small cetaceans, in addition to the general work of the Committee. Due to time constraints it was not possible to progress this further. A small group met this year to design an initial template and the Committee is now in the position to start trialling such a database. Funding is required for an expert to work with the IWC Secretariat to create this database and an initial version will be available at the next Annual Meeting.

Environment
(17) RISK ASSESSMENT MODELING TO DETERMINE THE IMPACT OF POLLUTANTS ON CETACEAN POPULATIONS
The report of the Phase II Intersessional IWC Pollution 2000+ Workshop (SC/62/Rep4) recommends that a number of modelling exercises be undertaken. This will involve the development and implementation of two demonstration projects, using the risk assessment framework (based on an individual based model approach). Funding is required to employ a post-doctoral research assistant to conduct this work under the direct supervision of Schwacke and Hall, with input and guidance from the Pollution 2000+ Steering Committee. This will be a two-year project and a further request for funding (£70,750) will be submitted next year.

(18) STATE OF THE CETACEAN ENVIRONMENT REPORT (SOCER)
The Committee regards SOCER to be a useful document that provides a 'snapshot' of environmental developments relevant to cetaceans that was requested by the Commission. Money is requested to support the production of this report.

Whalewatching
(19) DATA COMPILATION AND POWER ANALYSES FOR THE LAWE
The LaWE initiative aims to understand the possible effects of whalewatching on the demographic parameters of cetacean populations. In order to develop procedural mechanisms to centralise relevant data and to commence power analysis for key parameters, funding is required to employ a research assistant for 6 weeks.

Other
(20) INVITED PARTICIPANTS (IPs) FUND
The Committee **draws attention** to the essential contribution made to its work by the funded IPs. The IWC-funded IPs play an essential role in the Committee's work, including the critically important roles of Chairs and rapporteurs. They represent excellent value as they receive only travel and subsistence costs and thus donate their time, which is considerable. As was the case for previous meetings, where possible, effort will be made to accommodate scientists from developing countries.

25. WORKING METHODS OF THE COMMITTEE

25.1 Citation of Scientific Committee documents
SC/62/SCP1 was produced in response to the discussion last year about the Committee's policy with respect to the citation of Scientific Committee documents (IWC, 2010c, p.92). At that time the Committee had noted that *inter alia* its policy must ensure transparency with respect to advice provided by the Committee and to respect the rights of scientists to first publication of data.

The authors of SC/62/SCP1 had examined both the policy of the *Journal* and that of the Committee with respect to the question of including 'Not to be cited (or used) without the permission of the author(s)' at the top of a paper. They noted that there was some ambiguity in the present rules that required clarification and suggested that the ability to include a 'not to be cited....' restriction to a paper should be removed and replaced by a 'please inform authors when citing outside an IWC meeting' header.

There was considerable discussion of this proposal. The Committee, as before was concerned to:

(1) ensure transparency;
(2) respect rights to first publication; and
(3) avoid the possibility that authors may refuse to submit papers of value to the Committee's work.

Recognising the sensitivities involved and the need to find an appropriate balance amongst items (1)-(3) above, the Committee **agrees** that in future, all papers presented to the Scientific Committee contain the following header (this information will also be included in the Scientific Committee Handbook and when providing information on document submission to meetings and workshops):

> 'Papers submitted to the IWC Scientific Committee are produced to advance discussions within that Committee: they may be preliminary or exploratory. It is important that if you wish to cite this paper outside the context of an IWC meeting, you notify the author at least six weeks before it is cited to ensure that it has not been superseded or found to contain errors.'

The Scientific Committee List of Documents attempts to keep track of papers that have been presented to Scientific Committee meetings and can be found on the IWC website[7]. Authors who are aware of particular problems with any of their past papers are invited to inform the Secretariat who will keep an updated compilation.

25.2 Working papers, late papers and related issues
As a result of discussions during the meeting, the Committee **agrees** on the need to clarify certain issues with respect to working papers and primary papers that arrive late. The definitions and rules regarding these (and other categories of paper including 'For Info' papers) can be found in the Scientific Committee Handbook[8].

Primary papers must be submitted by the end of the first day of the Annual Meeting. Considerable flexibility has been shown by the Chair and Head of Science in the way they have dealt with papers for which a title has been submitted but which for one reason or another, arrive late. Formally, they can be called working papers because they have missed the deadline and then immediately be 'upgraded' to primary papers to minimise copying. Unfortunately, this flexibility is tending to be abused as a larger number of papers are being submitted past the deadline. For this reason, the Committee **agrees** that in future only in exceptional circumstances will late papers be accepted. In addition, Chairs will be very strict on the criteria for accepting working papers i.e. they must arise from discussions and be requested and/or be likely to expedite resolution of disagreements or stimulate debate within the meeting.

Notwithstanding the question of late papers, the Committee **agrees** that there may be circumstances in the future where it is appropriate for certain working papers to be 'elevated' to the status of a primary paper during the meeting. The Chair and Head of Science will apply the following two criteria:

[7] *http://www.iwcoffice.org/publications/pubmain.htm.*
[8] *http://www.iwcoffice.org/sci_com/handbook.htm.*

(1) the working paper has been presented and discussed within a sub-group or the plenary, such that an opportunity to comment on it has been given; and
(2) the text of the sub-group or plenary report would be significantly improved, streamlined or clarified by the ability to reference the paper as a primary document.

26. ELECTION OF OFFICERS

The Committee **agrees** that there was no need for elections this year.

27. PUBLICATIONS

Donovan reported on issues relating to the production of the *Journal*. Unfortunately, the year has been plagued by a series of problems with respect to getting the *Journal* published, due to internal problems at the printers that the IWC has used for many years. Sadly, after attempts to secure further investment, they are no longer trading but the Secretariat had very little notice in terms of finding an alternative. We have managed to find another company that we are using on a trial basis, and thanks to the page-setting abilities of Andrea Cooke, we managed to at least get the large *Supplement* out on time. We are now dealing with a different company and the *Journal* and Supplements should once again appear promptly. That being said, the Secretariat is in the process of examining a number of companies for ability and price. It is expected that the resultant backlog of papers will be reduced or eliminated in the coming year. In addition, the possibility of including electronic subscriptions is being investigated. The most efficient and cost effective way to digitise earlier reports is also being investigated. The Committee, as in previous years, **reiterates** the importance of the *Journal* to its work and encourages members to urge their institutes to subscribe.

28. OTHER BUSINESS

This is the final meeting for Nicky Grandy, Secretary of the Commission. The Scientific Committee rose in appreciation of her dedicated work in organising its meetings over the last decade. It noted the calm, efficient, good humoured way that she (and the team she ran) had assisted the Scientific Committee, even in the face of its sometimes unreasonable demands. On behalf of the Committee, its elder statesman, John Bannister, presented her with a specially painted card and a beautiful Moroccan rug, wishing her the very best for the future – she will be greatly missed.

29. ADOPTION OF REPORT

In closing the meeting, Palka thanked the Secretariat for carrying out its work in the usual efficient manner. The report was adopted at 17:20 on 11 June 2010. As is usual, final editing was carried out by the Convenors after the meeting.

REFERENCES

A'Mar, Z.T., Punt, A.E. and Dorn, M.W. 2009. The impact of regime shifts on the performance of management strategies for the Gulf of Alaska walleye pollock (*Thereagra chalcogramma*) fishery. *Can. J. Fish. Aquat. Sci.* 66: 2,222-2,242.

Aguilar, A., Bjorge, A., Donovan, G. and Reijnders, P. 1999a. Proposal to the IWC on Furthering the Recommendations of the Pollution Workshop. *J. Cetacean Res. Manage. (special issue)* 1: 47-53. [Also printed in: *Rep. int. Whal. Commn* 48:425-28].

Aguilar, A., Reijnders, P.J.H., Donovan, G.P. and Bjørge, A. 1999b. Planning workshop to develop a programme to investigate pollutant cause-effect relationships in cetaceans: POLLUTION 2000+. pp.55-72. *In*: Reijnders, P., Aguilar, A. and Donovan, G.P. (eds). *Chemical pollutants and cetaceans. J. Cetacean Res. Manage. Special Issue 1*.

Aldrin, M. and Huseby, R.B. 2007. Simulation trials 2007 for a re-tuned *Catch Limit Algorithm*. 143pp. Paper SC/59/RMP4 presented to the IWC Scientific Committee, May 2007, Anchorage, USA. 143pp. [Paper available from the Office of this Journal].

Allen, J.J. and Fulton, E.A. 2010. Top-down, bottom-up or middle-out? Avoiding extraneous detail and over-generality in marine ecosystem models. *Prog. Oceanogr.* 84: 129-33.

Alter, S.E., Simmonds, M.P. and Brandon, J.R. 2010. Forecasting the consequences of climate-driven shifts in human behavior on cetaceans. *Mar. Policy*. 34(5): 943-954.

Amaral, A.R., Beheregaray, L.B., Sequeira, M., Robertson, K.M., Coelho, M.M. and Möller, L.M. 2009. Worldwide phylogeography of the genus *Delphinus* revisited. Paper SC/61/SM11 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 12pp. [Paper available from the Office of this Journal].

Arcangeli, A. and Crosti, R. 2009. The short-term impact of dolphin-watching on the behaviour of bottlenose dolphins (*Tursiops truncatus*) in western Australia. *Journal of Marine Mammals and their Ecololgy.* 2(1): 3-9.

Bamy, I.L., van Waerebeek, K., Bah, S.S., Dia, M., Kaba, B., Keita, N. and Konate, S. 2010. Species occurence of cetaceans in Guinea, including humpback whales with southern hemisphere seasonality. *Marine Biodiversity Records* 3(e48): 10pp. [Published online.]

Barendse, J., Best, P.B., Thornton, M., Pomilla, C., Carvalho, I. and Rosenbaum, H.C. 2010. Migration redefined? Seasonality, movements and group composition of humpback whales *Megaptera novaeangliae* off the west coast of South Africa. *African J. Mar. Sci.* 32(1): 1-22.

Bernaldo de Quiros, Y., Gonzalez-Diaz, O., Saavedra, P., Arbelo, M., Sierra, E., Mendez, M. and Fernandez, A. 2010. Methodology for field-gas sampling, transport and analysis in the laboratory of gas embolism found in stranded cetaceans. Abstract presented to the European Cetacean Society, 2010.

Best, P.B. 1977. Two allopatric forms of Bryde's whale off South Africa. *Rep. int. Whal. Commn (special issue)* 1: 10-38.

Best, P.B., Peddemors, V.M., Cockcroft, V.G. and Rice, N. 2001. Mortalities of right whales and related anthropogenic factors in South African waters, 1963-1998. *J. Cetacean Res. Manage. (special issue)* 2: 171-76.

Best, P.B., Reeb, D., Rew, M.B., Palsbøll, P., Schaeff, C. and Brandão, A. 2005. Biopsying southern right whales, their reactions and effects on reproduction. *J. Wild. Mgmt.* 69(3): 1171-80.

Branch, T.A. 2006. Abundance estimates for Antarctic minke whales from three completed sets of circumpolar surveys. Paper SC/58/IA18 presented to the IWC Scientific Committee, May 2006, St. Kitts and Nevis, West Indies (unpublished). 28pp. [Paper available from the Office of this Journal].

Branch, T.A. and Butterworth, D.S. 2001a. Estimates of abundance south of 60°S for cetacean species sighted frequently on the 1978/79 to 1997/98 IWC/IDCR-SOWER sighting surveys. *J. Cetacean Res. Manage.* 3(3): 251-70.

Branch, T.A. and Butterworth, D.S. 2001b. Southern Hemisphere minke whales: standardised abundance estimates from the 1978/79 to 1997/98 IDCR-SOWER surveys. *J. Cetacean Res. Manage.* 3(2): 143-74.

Brandon, J.R. and Punt, A.E. 2009a. Assessment of the eastern stock of North Pacific gray whales: incorporating calf production, sea-ice and strandings data. Paper SC/61/AWMP2 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 29pp. [Paper available from the Office of this Journal].

Brandon, J.R. and Punt, A.E. 2009b. Testing the Gray Whale *SLA*: allowing environmental variability to influence population dynamics. Paper SC/61/AWMP3 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 14pp. [Paper available from the Office of this Journal].

Brashares, J.S., Arcese, P., Sam, M.K., Coppolillo, P.B., Sinclair, A.R.E. and Balmford, A. 2004. Bushmeat hunting, wildlife declines, and fish supply in West Africa. *Science* 306: 1180-83.

Bravington, M.V. and Hedley, S.L. 2009. Antarctic minke whale abundance estimates from the second and third circumpolar IDCR/SOWER surveys using the SPLINTR model. Paper SC/61/IA14 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 25pp. [Paper available from the Office of this Journal].

Buckley, L.J. and Buckley, L.B. 2010. Towards linking ocean models to fish population dynamics. *Prog. Oceanogr.* 84: 85-88.

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].

Carter, C.J., Wilson, B. and Black, K.D. 2008. Marine renewable energy devices: a collision risk for marine mammals? *ECS Special Publication Series* 49: 60-62. Proceedings of the ASCOBANS workshop 'Offshore wind farms and marine mammals: impacts and methodologies for assessing impacts' held at the European Cetacean Society's Annual Conference, The Aquarium, San Sebastian, Spain, 21st April 2007.

Carvalho, I., Brito, C., Dos Santos, M.E. and Rosenbaum, H.C. In review. The waters of São Tomé: a calving ground for West African humpback whales?22pp.

Choi, S.G., Kim, Z.G., An, Y.R. and Park, K.J. 2008. Plan for the Korean sighting survey in the East Sea in 2009. Paper SC/60/NPM3 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 3pp. [Paper available from the Office of this Journal].

Christiansen, F., Lusseau, D., Stensland, E. and Berggren, P. 2010. Effects of tourist boats on the behaviour of Indo-Pacific bottlenose dolphins off the south coast of Zanzibar. *Endangered Species Research* 11(1): 91-99.

Cipriano, F. and Pastene, L. 2009. A review of current knowledge of techniques to extract and amplify DNA from 'difficult' whale samples. Paper SC/61/SD2 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 5pp. [Paper available from the Office of this Journal].

Clapham, P. and van Waerebeek, K. 2007. Bushmeat and bycatch: the sum of the parts. *Mol. Ecol. Notes* 16: 2607-09.

Cooke, J.G. 2007. The influence of environmental variability on baleen whale sustainable yield curves. Paper SC/N07/MSYR1 presented to the MSYR Workshop, Seattle, USA, 16-19 November 2007 (unpublished). 19pp. [Paper available from the Office of this Journal].

De Boer, M.N. 2010. Cetacean distribution and relative abundance in offshore Gabonese waters. *J. Mar. Biol. Assoc.*: In press.

Donovan, G., Cañadas, A. and Hammond, P. 2008. Towards the development of effective conservation plans for cetaceans. Paper SC/60/O17 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 15pp. [Paper available from the Office of this Journal].

Donovan, G.P. 1991. A review of IWC stock boundaries. *Rep. int. Whal. Commn (special issue)* 13: 39-68.

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.

Filla, G. and Monteiro, E. 2009. Monitoring tourism schooners observing estuarine dolphins (*Sotalia guianensis*) in the estuarine complex of Cananeia, south-east Brazil. *Aquat. Conserv.* 19(7): 772-78.

Findlay, K., Allison, C., Baker, C.S., Bannister, J.L., Best, P.B., Butterworth, D.S., Cerchio, S., Double, M., Jackson, J., Johnston, S., Galletti Vernazzani, B., Rosenbaum, H. and Zerbini, A.N. 2010. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. Appendix 2. Report of the Working Group on Southern Hemisphere humpback whale catch allocation and boundaries. *J. Cetacean Res. Manage (Suppl.)* 11(2): 237-41.

Gedamke, J. and Robinson, S.M. 2010. Acoustic survey for marine mammal occurrence and distribution off East Antarctica (30-80°E) in January-February 2006. *Deep-Sea Res. II* 57: 968-81.

Hannah, C., Vezina, A. and StJohn, M. 2010. The case for marine ecosystem models of intermediate complexity. *Prog. Oceanogr.* 84: 121-28.

Hatanaka, H. and Miyashita, T. 1997. On the feeding migration of Okhotsk Sea-West Pacific stock minke whales, estimates based on length composition data. *Rep. int. Whal. Commn* 47: 557-64.

Hazevoet, C.J. and Wenzel, F.W. 2000. Whales and dolphins (Mammalia, Cetacea) of the Cape Verde Islands, with special reference to the humpback whale (*Megaptera novaeangliae*) (Borowski, 1781). *Contrib. Zool.* 69(3): 197-211.

International Whaling Commission. 2000. Report of the SOWER 2000 Workshop. *J. Cetacean Res. Manage. (Suppl.)* 2: 319-46.

IUCN. 2009. Report of the western gray whales range-wide workshop, 21-24 September 2008, Tokyo, Japan. Western gray whales: status, threats and the potential for recovery. 44pp. [Available at *http://www.iucn.org.wgwap/rangewide-initiative*].

International Whaling Commission. 1976. Report of the Scientific Committee, Annex M. Report by the Chairman, subcommittee on small cetaceans. *Rep. int. Whal. Commn* 26(2):55-58.

International Whaling Commission. 1989. Report of the Comprehensive Assessment Workshop on Catch Per Unit Effort (CPUE), Reykjavík, 16-20 March 1987. *Rep. int. Whal. Commn (special issue)* 11:15-20.

International Whaling Commission. 1993. Report of the Scientific Committee. *Rep. int. Whal. Commn* 43:55-92.

International Whaling Commission. 1994a. Chairman's Report of the Forty-Fifth Annual Meeting, Appendix 12. Resolution on research on the environment and whale stocks. *Rep. int. Whal. Commn* 44:35.

International Whaling Commission. 1994b. Chairman's Report of the Forty-Fifth Annual Meeting, Appendix 13. Resolution on the preservation of the marine environment. *Rep. int. Whal. Commn* 44:36.

International Whaling Commission. 1995a. Chairman's Report of the Forty-Sixth Annual Meeting, Appendix 4. IWC Resolution 1994-4. Resolution on a Review of Aboriginal Subsistence Management Procedures. *Rep. int. Whal. Commn* 45:42-43.

International Whaling Commission. 1995b. Chairman's Report of the Forty-Sixth Annual Meeting, Appendix 15, IWC Resolution 1994-14. Resolution on whalewatching. *Rep. int. Whal. Commn* 45:49-50.

International Whaling Commission. 1995c. Chairman's report of the forty-sixth annual meeting. Appendix 2. IWC Resolution 1994-2. Resolution on small cetaceans. *Rep. int. Whal. Commn* 45:41-42.

International Whaling Commission. 1995d. Report of the Scientific Committee, Annex O. Guidelines for data collection and analysis under the Revised Management Scheme (RMS) other than those required as direct input for the *Catch Limit Algorithm* (*CLA*). *Rep. int. Whal. Commn* 45:215-17.

International Whaling Commission. 1996a. Chairman's Report of the Forty-Seventh Annual Meeting. Appendix 11. IWC Resolution 1995-10. Resolution on the environment and whale stocks. *Rep. int. Whal. Commn* 46:47-48.

International Whaling Commission. 1996b. Report of the Scientific Committee. *Rep. int. Whal. Commn* 46:50-97.

International Whaling Commission. 1997. Chairman's Report of the Forty-Eighth Annual Meeting, Appendix 8. IWC Resolution 1996-8. Resolution on environmental change and cetaceans. *Rep. int. Whal. Commn* 47:52.

International Whaling Commission. 1998a. Chairman's Report of the Forty-Ninth Annual Meeting. Appendix 7. Resolution 1997-7. Resolution on environmental change and cetaceans. *Rep. int. Whal. Commn* 48:48-49.

International Whaling Commission. 1998b. Report of the Scientific Committee. Annex G. Report of the sub-committee on Comprehensive Assessment of Southern Hemisphere humpback whales. *Rep. int. Whal. Commn* 48:170-82.

International Whaling Commission. 1999a. Chairman's Report of the Fiftieth Annual Meeting. Appendix 6. IWC Resolution 1998-5. Resolution on environmental changes and cetaceans. *Ann. Rep. Int. Whaling Comm.* 1998:43-44.

International Whaling Commission. 1999b. Chairman's Report of the Fiftieth Annual Meeting. Appendix 7. IWC Resolution 1998-6. Resolution for the funding of work on environmental concerns. *Ann. Rep. Int. Whaling Comm.* 1998:44-45.

International Whaling Commission. 1999c. Chairman's Report of the Fiftieth Annual Meeting. Appendix 8. IWC Resolution 1998-7. Resolution on coordinating and planning for environmental research in the Antarctic. *Ann. Rep. Int. Whaling Comm.* 1998:45.

International Whaling Commission. 1999d. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure (RMP). *J. Cetacean Res. Manage. (Suppl.)* 1:61-116.

International Whaling Commission. 1999e. Report of the Scientific Committee. Annex N. The Revised Management Procedure (RMP) for Baleen Whales. *J. Cetacean Res. Manage. (Suppl.)* 1:251-58.

International Whaling Commission. 2000. Chairman's Report of the Fifty-First Annual Meeting. Appendix 9. IWC Resolution 1999-8. Resolution on DNA testing. *Ann. Rep. Int. Whaling Comm.* 1999:55.

International Whaling Commission. 2001a. Chairman's Report of the 52nd Annual Meeting. *Ann. Rep. Int. Whaling Comm.* 2000:11-63.

International Whaling Commission. 2001b. Chairman's Report of the Fifty-Second Annual Meeting. Appendix 1. Resolutions adopted during the 52nd annual meeting. IWC Resolution 2000-3. Resolution on the Revised Management Scheme. *Ann. Rep. Int. Whaling Comm.* 2000:55.

International Whaling Commission. 2001c. 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. Whaling Comm.* 2000:56-57.

International Whaling Commission. 2001d. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 3:1-76.

International Whaling Commission. 2001e. Report of the Scientific Committee, Annex O. Report of the working group on DNA identification and tracking of whale products. Appendix 1. Terms of reference of working group on DNA identification and tracking of whale products. *J. Cetacean Res. Manage. (Suppl.)* 3:319-20.

International Whaling Commission. 2001f. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 3:90-125.

International Whaling Commission. 2001g. Report of the Scientific Committee. Annex G. Report of the Sub-Committee on the Comprehensive Assessment of Whale Stocks - In-depth Assessments. *J. Cetacean Res. Manage. (Suppl.)* 3:177-208.

International Whaling Commission. 2001h. Report of the Scientific Committee. Annex I. Report of the Working Group on Stock Definition. *J. Cetacean Res. Manage. (Suppl.)* 3:229-38.

International Whaling Commission. 2002a. Chair's Report of the 53rd Annual Meeting. Annex C. Resolutions Adopted During the 53rd Annual Meeting. Resolution 2001-9. Proposed resolution on interactions between whales and fish stocks. *Ann. Rep. Int. Whaling Comm.* 2001:58.

International Whaling Commission. 2002b. Chair's Report of the 53rd Annual Meeting. Annex C. Resolutions Adopted During the 53rd Annual Meeting. Resolution 2001-13. Resolution on small cetaceans. *Ann. Rep. Int. Whaling Comm.* 2001:60.

International Whaling Commission. 2002c. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 4:1-78.

International Whaling Commission. 2002d. 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. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 5:1-92.

IWC. 2003b. Report of the Scientific Committee. Annex K. Report of the Sub-Committee on small cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 5: 362-81.

International Whaling Commission. 2003c. Report of the Scientific Committee. Annex M. Report of the Sub-Committee on estimation of bycatch and other human-induced mortality. *J. Cetacean Res. Manage. (Suppl.)* 5:392-401.

International Whaling Commission. 2004. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure (RMP). *J. Cetacean Res. Manage. (Suppl.)* 6:75-184.

International Whaling Commission. 2005a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 7:1-62.

International Whaling Commission. 2005b. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 2. Requirements and Guidelines for *Implementation*. *J. Cetacean Res. Manage. (Suppl.)* 7:84-92.

International Whaling Commission. 2005c. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 3. Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme. *J. Cetacean Res. Manage. (Suppl.)* 7:92-101.

International Whaling Commission. 2005d. 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). Appendix 3. Fishery Type 2: *Implementation* for Eastern North Pacific gray whales. *J. Cetacean Res. Manage. (Suppl.)* 7:127-38.

International Whaling Commission. 2005e. Report of the Scientific Committee. Annex I. Report of the Working Group on Stock Definition. *J. Cetacean Res. Manage. (Suppl.)* 7:247-53.

International Whaling Commission. 2005f. Report of the Scientific Committee. Annex K. Report of the Standing Working Group on Environmental Concerns. *J. Cetacean Res. Manage. (Suppl.)* 7:267-81.

International Whaling Commission. 2005g. Report of the Scientific Committee. Annex L. Report of the Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 7:307-17.

International Whaling Commission. 2006a. Chair's Report of the 57th Annual Meeting. Annex H. Report of the Conservation Committee. Appendix 3. Report of the Ship Strikes Working Group (SSWG) consultative meeting. *Ann. Rep. Int. Whaling Comm.* 2005:107-09.

International Whaling Commission. 2006b. Report of the Scientific Committee. Annex E. Report of the Standing Working Group (SWG) on the Development of an Aboriginal Whaling Management Procedure (AWMP). *J. Cetacean Res. Manage. (Suppl.)* 8:91-109.

International Whaling Commission. 2006c. Report of the Scientific Committee. Annex M. Report of the Sub-Committee on Whalewatching. *J. Cetacean Res. Manage. (Suppl.)* 8:241-51.

International Whaling Commission. 2007a. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 9:188-209.

International Whaling Commission. 2007b. Report of the Scientific Committee. Annex M. Report of the Sub-Committee on Whalewatching. *J. Cetacean Res. Manage. (Suppl.)* 9:326-40.

International Whaling Commission. 2008a. POLLUTION 2000+ Phase II workshop, Barcelona, 11-12 April 2007. *J. Cetacean Res. Manage. (Suppl.)* 10:573-82.

International Whaling Commission. 2008b. Report of the Scientific Committee. Annex D. Report of the sub-committee on the revised management procedure. *J. Cetacean Res. Manage. (Suppl.)* 10:90-120.

International Whaling Commission. 2008c. Report of the Scientific Committee. Annex K1. Report of the working group on ecosystem modelling. *J. Cetacean Res. Manage. (Suppl.)* 10:293-301.

International Whaling Commission. 2008d. Report of the Workshop on Cetacean Skin Diseases, 30-31 May 2008, Sheraton Santiago Hotel, Santiago, Chile. *Journal of Cetacean Research and Management (Suppl.)* 11:503-14.

International Whaling Commission. 2009a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 11:1-74.

International Whaling Commission. 2009b. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised Management Procedure (RMP). *J. Cetacean Res. Manage. (Suppl.)* 11:91-144.

International Whaling Commission. 2009c. Report of the Scientific Committee. Annex E. Report of the standing working group on the Aboriginal Whaling Management Procedures. *J. Cetacean Res. Manage. (Suppl.)* 11:145-68.

International Whaling Commission. 2009d. Report of the Scientific Committee. Annex F. Report of the sub-committee on bowhead, right and gray whales. *J. Cetacean Res. Manage. (Suppl.)* 11:169-92.

International Whaling Commission. 2009e. Report of the Scientific Committee. Annex G. Report of the sub-committee on in-depth assessment (IA). *J. Cetacean Res. Manage. (Suppl.)* 11:193-211.

International Whaling Commission. 2009f. 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. 2009g. Report of the Scientific Committee. Annex I. Report of the working group on stock definition. *J. Cetacean Res. Manage. (Suppl.)* 11:248-57.

International Whaling Commission. 2009h. Report of the Scientific Committee. Annex I. Report of the working group on stock definition. Appendix 2. Guidelines for DNA data quality control for genetic studies relevant to IWC management advice. *J. Cetacean Res. Manage. (Suppl.)* 11:252-56.

International Whaling Commission. 2009i. Report of the Scientific Committee. Annex N. Report of the working group on DNA. *J. Cetacean Res. Manage. (Suppl.)* 11:344-49.

International Whaling Commission. 2009j. Report of the Scientific Committee. Annex P. Process for the review of special permit proposals and research results from existing and completed permits. *J. Cetacean Res. Manage. (Suppl.)* 11:398-401.

International Whaling Commission. 2010a. Report of the Expert Workshop to Review the Ongoing JARPN II Programme, 26-30 January 2009, Yokohama, Japan. *J. Cetacean Res. Manage. (Suppl.)* 11(2):405-50.

International Whaling Commission. 2010b. Report of the Intersessional Workshop on MSYR for Baleen Whales, 6-8 February 2009, Seattle. *J. Cetacean Res. Manage. (Suppl.)* 11(2):493-508.

International Whaling Commission. 2010c. Report of the Scientific Committee. *J. Cetacean Res. Manage (Suppl.)* 11(2):1-98.

International Whaling Commission. 2010d. Report of the Scientific Committee. Annex D. Report of the Sub-committee on the Revised Management Procedure (RMP). *J. Cetacean Res. Manage (Suppl.)* 11(2):114-34.

International Whaling Commission. 2010e. Report of the Scientific Committee. Annex G1. Report of the Working Group on the In-Depth Assessment of Western North Pacific Common Minke Whales, with a focus on 'J' stock. *J. Cetacean Res. Manage (Suppl.)* 11(2):198-217.

International Whaling Commission. 2010f. Report of the Scientific Committee. Annex G. Report of the Sub-Committee on In-Depth Assessments. *J. Cetacean Res. Manage (Suppl.)* 11(2):180-97.

International Whaling Commission. 2010g. 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. 2010h. Report of the Scientific Committee. Annex L. Report of the Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage (Suppl.)* 11(2):306-31.

International Whaling Commission. 2010i. Report of the Scientific Committee. Annex M. Report of the Sub-Committee on Whalewatching. *J. Cetacean Res. Manage (Suppl.)* 11(2):332-45.

International Whaling Commission. 2010j. Report of the Workshop on Cetaceans and Climate Change, 21-25 February 2009, Certosa di Pontignano dal Rettore dell Universita degli Studi de Siena, Italy. *J. Cetacean Res. Manage. (Suppl.)* 11(2):451-80.

International Whaling Commission. In press. Report of the Workshop on the Comprehensive Assessment of Southern Hemisphere humpback whales, 4-7 April 2006, Hobart, Tasmania. *J. Cetacean Res. Manage. (special issue)*.

Jefferson, T.A., Curry, B.E., Leatherwood, S.E. and Powell, J.A. 1997. Dolphins and porpoises of West Africa: a review of records. *Mammalia* 61(1): 87-108.

Jensen, F.H., Bejder, L., Wahlberg, M., Aguilar Soto, N., Johnson, M. and Madsen, P.T. 2009. Vessel noise effects on delphinid communication. *Mar. Ecol. Prog. Ser.* 395: 161-75.

Kanda, N., Goto, M., Kishiro, T., Yoshida, H., Kato, H. and Pastene, L.A. 2009. Update of the analyses on individual identification and mixing of the J and O stocks of common mike whales around Japanese waters examined by microsatellite analysis. Paper SC/61/JR5 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 14pp. [Paper available from the Office of this Journal].

Kock, K.-H., Clark, J.M. and Moreno, C.A. 2008. Interactions between cetaceans and fisheries in the Southern Ocean - progress report 2008. Paper SC/60/O9 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 13pp. [Paper available from the Office of this Journal].

Kock, K.H., Purves, M.G. and Duhamel, G. 2006. Interactions between cetaceans and fisheries in the Southern Ocean. *Polar Biol.* 29(5): 379-88.

Koski, W.R., Mocklin, J., Davis, A.R., Zeh, J., Rugh, D.J., George, J.C. and Suydam, R. 2009. Abundance of Bering-Chukchi-Beaufort bowhead whales (*Balaena mysticetus*) in 2004 estimated from photo-identification data. *J. Cetacean Res. Manage.* Submitted: 11pp.

Laake, J., Punt, A., Hobbs, R., Ferguson, M., Rugh, D. and Breiwick, J. 2009. Re-analysis of gray whale southbound migration surveys 1967-2006. *NOAA Tech. Mem. NMFS-AFSC* 203. 55pp.

Leaper, R., Cooke, J., Trathan, P., Reid, K. and Rowntree, V. 2006. Global climate change drives southern right whales (*Eubalaena australis*) population dynamics. *Biology Letters* 2: 289-92.

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.

Lehodey, P. and Senina, I. 2009. An update of recent developments and applications of the SEAPODYM model. Fifth regular session of the Scientific Committee of the Western and Central Pacific Fisheries Commission, 10-21 August 2009, Port Vila, Vanuatu, WCPFC-SC5-2009/EB-WP-10. 44pp.

Lehodey, P., Senina, I. and Murtugudde, R. 2008. A spatial ecosystem and populations dynamics model (SEAPODYM) - modelling of tuna and tuna-like populations. *Prog. Oceanogr.* 78: 304-18.

Lehodey, P., Senini, L., Sibert, J., Bopp, L., Calmettes, B., Hampton, J. and Murtugudde, R. 2010. Preliminary forecasts of Pacific bigeye tuna population trends under the A2 IPCC scenario. *Prog. Oceanogr.* In press: 14pp.

Mendez, M., Rosenbaum, H.C., Subramaniam, A., Yackulic, C. and Bordino, P. 2010. Isolation by environmental distance in mobile marine species: molecular ecology of franciscana dolphins at their southern range. *Mol. Ecol.*: 17pp.

Minton, G., Collins, T., Findlay, K., Baldwin, R., Ersts, P.J., Rosenbaum, H., Berggren, P. and Baldwin, R.M. In press. Seasonal distribution, abundance, habitat use and population identity of humpback whales in Oman. *J. Cetacean Res. Manage. (special issue)*: 35pp.

Minton, G., Collins, T., Pomilla, C., Findlay, K., Rosenbaum, H., Baldwin, R. and Brownell, R.L., Jr. 2008. *Megaptera novaeangliae* (Arabian Sea sub-population). *IUCN Red List of Threatened Species*. Version 2009.1. Downloaded on 17 July 2009 from *http://www.iucnredlist.org.*

Moore, J.E., T.M., C. and R.L., L. 2010. An interview-based approach to assess marine mammal and sea turtle captures in artisanal fisheries. *Biol. Cons.* 143: 795-805.

Noren, D.P., Johnson, A.H., Rehder, D. and Larsen, A. 2009. Close approaches by vessels elicit surface active behaviours by southern resident killer whales. *Endangered Species Research* 8(3): 179-92.

Okamura, H. and Kitakado, T. 2009. Abundance estimates and diagnostics of Antarctic minke whales from the historical IDCR/SOWER survey data using the OK method. Paper SC/61/IA6 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 58pp. [Paper available from the Office of this Journal].

Parrott, L., Chion, C., Martins, C.C.A., Lamontangne, P., Turgeon, S., Landry, S., Zhens, B., Marceau, D.R.M., Cantin, G., Menard, N. and Dionne, S. 2010. 3MTSim: An agent-based model of marine mammals and maritime traffic to assist managment of human activities in the Saint Lawrence Estuary, Canada. *Environmental Modelling & Software*: 22pp.

Pastene, L.A., Kitakado, T. and Hatanaka, H. 2008. Research proposal accompanying management variant 2 of the RMP *Implementation* for western North Pacific Bryde's whale. Paper SC/60/PFI9 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 10pp. [Paper available from the Office of this Journal].

Pettis, H. 2009. North Atlantic right whale consortium annual report card (01 November 2007 - 30 April 2009). Paper SC/61/BRG11 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 7pp. [Paper available from the Office of this Journal].

Picanço, C., Carvalho, I. and Brito, C. 2009. Occurrence and distribution of cetaceans in São Tomé and Príncipe tropical archipelago and their relation to environmental variables. *J. Mar. Biol. Assoc. UK* 89(5): 1071-76.

Pitman, R.L. and Ensor, P. 2003. Three forms of killer whales (*Orcinus orca*) in Antarctic waters. *J. Cetacean Res. Manage.* 5(2): 131-39.

Pritchard, J.K., Stephens, M. and Donnelly, P. 2000. Inference of population structure using multilocus genotype data. *Genetics* 155: 945-59.

Purves, M.G., Agnew, D., Balguerias, E., Moreno, C.A. and Watkins, B. 2005. Killer whale (*Orcinus orca*) and sperm whale (*Physeter macrocephalus*) interactions with longline vessels in the Patagonian toothfish fishery at South Georgia, South Atlamtic. *CCAMLR Science* 11: 111-26.

Reijnders, P.J.H., Donovan, G.P., Aguilar, A. and Bjorge, A. 1999. Report of the Workshop on Chemical Pollution and Cetaceans, March 1995, Bergen, Norway. *J. Cetacean Res. Manage. (special issue)* 1: 1-42.

Reiner, F., Dos Santos, M.E. and Wenzel, F.W. 1996. Cetaceans of the Cape Verde archipelago. *Mar. Mammal Sci.* 12(3): 434-43.

Richard, P.R., Laake, J.L., Hobbs, R.C., Heide-Jørgensen, M.P., Asselin, N.C. and Cleator, H. 2010. Baffin Bay narwhal population distribution and numbers: aerial surveys in the Canadian High Arctic, 2002-04. *Arctic* 63(1): 85-99.

Ritter, F. 2010. Short description of a near-miss event involving a large vessel and humpack whales (*Megaptera novaengliae*) off Antarctica. Poster presented to the ECS Annual Conference, Stralsund, Germany, 22-24 March 2010.

Robbins, J., Dalla Rosa, L., Allen, J.M., Mattila, D.K. and Secchi, E.R. 2008. Humpback whale photo-identification reveals exchange between American Samoa and the Antarctic Peninsula, and a new mammalian distance record. Paper SC/60/SH5 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 4pp. [Paper available from the Office of this Journal].

Robbins, J. and Frost, M. 2009. An on-line database for world-wide tracking of commercial whalewatching and associated data collection programs. Paper SC/61/WW7 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 2pp. [Paper available from the Office of this Journal].

Scarpaci, C., Nugegoda, D. and Corkeron, P. In press. Nature-based tourism and the behaviour of bottlenose dolphins, *Tursiops* sp., in Port Phillip Bay, Victoria, Australia. *Victorian Field-Naturalist*.

Secchi, E.R., Danilewicz, D. and Ott, P.H. 2003. Applying the phylogeographic concept to identify franciscana dolphin stocks: implications to meet management objectives. *J. Cetacean Res. Manage.* 5(1): 61-68.

Shimada, H., Okamura, H., Kitakado, T. and Miyashita, T. 2008. Abundance estimate of western North Pacific Bryde's whales for the estimation of additional variance and *CLA* application. Paper SC/60/PFI2 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 34pp. [Paper available from the Office of this Journal].

Smit, V., Ritter, F., Ernert, A. and Strueh, N. 2010. Habitat partitioning by cetaceans in a multi-species ecosystem around the oceanic island of La Gomera (Canary Islands). Poster presented to the ECS Annual Conference, Stralsund, Germany, 22-24 March 2010.

Smith, B.D. and Beasley, I. 2004. *Orcaella brevirostris* (Mekong River sub-population). *In*: IUCN (eds). *IUCN Red List of threatened species version 2009.1*.

Song, K., Kim, Z., Zhang, C.I. and Kim, Y.H. 2010. Fishing gears involved in entanglements of minke whales (*Balaenoptera acutorostrata*) in the East Sea of Korea). *Mar. Mammal Sci.* 26: 282-95.

Sousa-Lima, R.S. and Clark, C.W. 2009. Whale sound recording technology as a tool for assessing the effects of boat noise in a Brazilian marine park. *Park Science* 26(1): 59-63.

Southern Ocean Research Partnership. 2009. Report of the planning workshop of the Southern Ocean Research Partnership (SORP), Sydney, Australia, 23-26 March 2009. Paper SC/61/O16 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 63pp. [Paper available from the Office of this Journal].

Stamation, K.A., Croft, D.B., Shaughnessy, P.D., Waples, K.A. and Briggs, S.V. 2010. Behavioural responses of humpback whales (*Megaptera novaeangliae*) to whale-watching vessels on the southeastern coast of Australia. *Mar. Mammal Sci.* 26(1): 98-122.

Tchibozo, S. and van Waerebeek, K. 2007. La baleine a bosse et le lamantin d'Afrique, des potentielles resources de tourisme de la nature au Benin. Abstract, Convention on Migratory Species meeting WATCH, Adeje, Tenerife, Spain, 16-20 Octover 2007. [In French]

Van Waerebeek, K., Bamy, I.L., Jiddou, A.M., Sequeira, M., Diop, M., Ofori-Danson, P.K., Tchibozo, S. and Campredon, P. 2008. Indeterminate status of West African populations of inshore common bottlenose dolphins *Tursiops truncatus* cautions against opportunistic live-capture schemes. Report to the Fondation Internationale du Banc d'Arguin.

Van Waerebeek, K., Barnett, L., Camara, A., Cham, A., Diallo, M., Djiba, A., Jallow, A.O., Ndiaye, E., Samba Ould Bilal, A.O. and Bamy, I.L. 2004. Distribution, status and biology of the Atlantic humpback dolphin, *Souza teuszii* (Kükenthal, 1892). *Aquat. Mamm.* 30(1): 56-83.

Van Waerebeek, K. and Perrin, W.F. 2007. Conservation status of the Atlantic humpback dolphin, a compromised future? CMS Scientific Council Document CMS/ScC14/Doc.6, Bonn, Germany, 14-17 March 2007, 10 pp.

Wade, P.R., Kennedy, A., LeDuc, R.G., Barlow, J., Carretta, J., Shelden, K., Perryman, W.L., Pitman, R., Robertson, K.M., Rone, B., Salinas, J.C., Zerbini, A.N., Brownell Jr, R.L. and Clapham, P.J. 2010. The world's smallest whale population? *Biology Letters* In review: 6pp.

Weinrich, M. and Corbelli, C. 2009. Does whale watching in Southern New England impact humpback whale (*Megaptera novaeangliae*) calf production or calf survival? *Biol. Conserv.* 142: 2931-40.

Weir, C.R. 2007. Occurrence and distribution of cetaceans off northern Angola, 2004/05. *J. Cetacean Res. Manage* 9(3): 225-39.

Weir, C.R. 2009. Distribution, behaviour and photo-identification of Atlantic humpback dolphins *Sousa teuszii* off Flamingos,Angola. *African Journal of Marine Science* 31(3): 319-31.

Weir, C.R. 2010. A review of cetacean occurrence in West African waters from the Gulf of Guinea to Angola. *Mammal Rev.* 40(1): 2-39.

Weir, C.R., Collins, T., Carvalho, I. and Rosenbaum, H. 2010. Killer whales (*Orcinus orca*) in Angolan and Gulf of Guinea waters, tropical West Africa. *J. Mar. Biol. Assoc. UK*. 90: 1,601-1,611.

Williams, R., Bain, D., Smith, J.C. and Lusseau, D. 2009a. Effects of vessels on behaviour patterns of individual southern resident killer whales *Orcinus orca*. *Endangered Species Research* 6(3): 199-209.

Williams, R., Branch, T.A., Zerbini, A.N. and Findlay, K. 2009b. Model-based abundance estimates and an assessment of minimum population status of blue whales off Chile from the 1997/98 SOWER survey. Paper SC/61/SH32 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 9pp. [Paper available from the Office of this Journal].

Witting, L. 2005. An assessment of minke whales off West Greenland. Paper SC/57/AWMP4 presented to the IWC Scientific Committee, June 2005, Ulsan, Korea (unpublished). 22pp. [Paper available from the Office of this Journal].

Yasunaga, G., Kato, H., Kishiro, T., Yoshida, H., Nishiwaki, S., Saito, T., Tabata, S., Okamoto, R., Maeda, H., Nakamura, G., Inoue, S., Otani, S., Iwasaki, T., Kanaji, Y., Mogoe, T., Murase, H., Wada, A., Nakai, K., Matsumoto, A., Gokita, A., Yamasaki, K., Oikawa, H., Onodera, K., Shiraishi, K. and Nagashima, H. 2009. Cruise report of the second phase of the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN II) in 2008 (part II) - coastal component off Sanriku. Paper SC/61/O6 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 24pp. [Paper available from the Office of this Journal].

Yatsu, A., Hiramatsu, K. and Hayase, S. 1994. A review of the Japanese squid driftnet fishery with notes on the cetacean bycatch. *Rep. int. Whal. Commn (special issue)* 15: 365-79.

Annex A

List of Participants

ARGENTINA
Miguel Iñíguez (H)

AUSTRALIA
Nick Gales (H)
Jason Gedamke
Simon Childerhouse
Natalie Kelly

AUSTRIA
Michael Stachowitsch (H)

BELGIUM
Fábian Ritter (H)

BRAZIL
Fábia de Oliveira Luna (H)
Alexandre Zerbini
Milton Marcondes
Paulo Flóres

CROATIA
Ana Štrbenac (H)

DENMARK
Lars Witting (H)
Lutz Bachmann

FRANCE
Vincent Ridoux (H)
Jean-Benoît Charrassin
Michel Vély

GERMANY
Karl-Hermann Kock (H)
Petra Deimer-Schütte
Justin Cooke
Alexander Liebschner

ICELAND
Gisli Víkingsson (H)
Thorvaldur Gunnlaugsson
Christophe Pampoulie
Bjarki Thor Elvarsson

ITALY
Caterina Fortuna (H)
Bruno Cozzi
Maria Cristina Fossi
Giancarlo Lauriano
Simone Panigada
Michela Podestá

JAPAN
Hidehiro Kato (H)
Joji Morishita (AH)
Yoshihiro Fujise
Dan Goodman
Takashi Hakamada
Hiroshi Hatanaka
Naohisa Kanda
Toshihide Kitakado
Koji Matsuoka
Tomio Miyashita
Hiroto Murase
Hideaki Okada
Hiroshi Okamura
Luis Pastene
Toshinori Uoya
Yuji Uozumi
Hideyoshi Yoshida
Saemi Baba (I)
Yoko Yamakage (I)
Hiroko Yasokawa (I)

REPUBLIC OF KOREA
Seok-Gwan Choi (H)
Yong-Rock An
Jung-Youn Park

LUXEMBOURG
Pierre Gallego (H)

MEXICO
Lorenzo Rojas-Bracho (H)
Armando Jaramillo-Legorreta

NEW ZEALAND
Louise Chilvers (H)
Mike Donoghue

NORWAY
Lars Walløe (H)
Arne Bjørge
Hans Julius Skaug
Nils Øien

RUSSIAN FEDERATION
Rudolf Borodin (H)
Olga Tyurneva
Valeriy Vladimirov
Anastasia Nikulina (I)

ST VINCENT AND THE GRENADINES
Lucine Edwards

ST LUCIA
Thomas Nelson

SPAIN
Santiago Lens (H)
Renaud De Stephanis
José Antonio Vázquez
Manuel Castellote

SWEDEN
Thomas Lyrholm (H)

SWITZERLAND
Patricia Burkhardt-Holm (H)

UK
Beatriz Roel (H)
Phil Hammond
Russell Leaper
David Lusseau
Chris Parsons
Mark Simmonds

USA
Robert Brownell (H)
Debra Palka
Scott Baker
John Bickham
Jeff Breiwick
Phil Clapham
Megan Ferguson
Alyson Fleming
Craig George
Geof Givens
Aimee Lang
David Matilla
Sue Moore
William Perrin
Jooke Robbins
Cheryl Rosa
Howard Rosenbaum
Teri Rowles
Jonathan Scordino
Robert Suydam
Jaclyn Taylor
Paul Wade
Robin Waples
Dave Weller
Gina Ylitalo

INVITED PARTICIPANTS
Ana Amaral
Rob Baldwin
Idrissa Bami

John Bannister
Jaco Barendse
Lars Bejder
Peter Best
Anabela Brandão
John Brandon
Mark Bravington
Louise Burt
Cristina Brito
Doug Butterworth
John Campbell
Ana Cañadas
Carole Carlson
Ines Carvalho
Salvatore Cerchio
Frank Cipriano
Tim Collins
Jim Darling
Yara Bernaldo de Quirós
Carryn De Moor
Paul Ensor
Tim Frasier
Nakao Funahashi
Oscar Gaggiotti
Karina Groch
Sharon Hedley
Rus Hoelzel
Susan Holloway
Yulia Ivashchenko
Jennifer Jackson
Toshio Kasuya
Greg Kaufman
Bill Koski
Patrick Lehodey
Christina Lockyer
Bruce Mate
Andrea Muller
Patrick Ofori-Danson
Andre Punt
Randall Reeves
Naomi Rose
Keiko Sekiguchi
Mario Sironi
Bolu Solarin
Severin Tchibozo
Jorge Urbán-Ramirez
Mason Weinrich
Sandra Werner
Øystein Wiig
Rob Williams
Andrew Wright
John Young

OBSERVERS

Ana Štrbenac (ACCOBAMS)
Karl-Hermann Kock (CCAMLR)
Justin Cooke (IUCN)
Finn Larsen (IUCN)
Mario Acquarone (NAMMCO)
Hidehiro Kato (PICES)

IWC

Cherry Allison
Simon Brockington
Greg Donovan
Nicky Grandy
Marion Hughes
Jemma Jones

(I)=Interpreter
(H)=Head of Delegation
(AH)=Alternate Head

Annex B1

Agenda

1. Introductory items
   - 1.1 Chair's welcome and opening remarks
   - 1.2 Appointment of rapporteurs
   - 1.3 Meeting procedures and time schedule
   - 1.4 Establishment of sub-committees and working groups
   - 1.5 Computing arrangements

2. Adoption of Agenda

3. Review of available data, documents and reports
   - 3.1 Documents submitted
   - 3.2 National Progress Reports on research
   - 3.3 Data collection, storage and manipulation
     - 3.3.1 Catch data and other statistical material
     - 3.3.2 Progress of data coding projects
     - 3.3.3 Progress on program verification projects
     - 3.3.4 Archiving of simulated datasets to test abundance estimation methods

4. Cooperation with other organisations
   - 4.1 Convention on the Conservation of Migratory Species (CMS)
     - 4.1.1 Scientific Council
     - 4.1.2 Conference of Parties
     - 4.1.3 Agreement on Small Cetaceans of the Baltic and North Seas (ASCOBANS)
     - 4.1.4 Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS)
     - 4.1.5 Memorandum of Understanding on the Conservation of the Manatees and Small Cetaceans of Western Africa and Macronesia
   - 4.2 International Council for the Exploration of the Sea (ICES)
   - 4.3 Inter-American Tropical Tuna Commission (IATTC)
   - 4.4 International Commission for the Conservation of Atlantic Tunas (ICCAT)
   - 4.5 Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)
   - 4.6 Southern Ocean GLOBEC
   - 4.7 North Atlantic Marine Mammal Commission (NAMMCO)
   - 4.8 World Conservation Union (IUCN)
   - 4.9 FAO – Committee on Fisheries (COFI)
   - 4.10 Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)
   - 4.11 North Pacific Marine Science Organisation (PICES)
   - 4.12 Eastern Caribbean Cetacean Commission (ECCO)
   - 4.13 Protocol on Specially Protected Areas and Wildlife (SPAW) of the Cartagena Convention for the Wider Caribbean
   - 4.14 Indian Ocean Commission (IOC)
   - 4.15 Permanent Commission for the South Pacific (CPPS)
   - 4.16 International Maritime Organization (IMO)
   - 4.17 Other

5. Revised Management Procedure (RMP) – general issues
   - 5.1 Review MSY rates
   - 5.2 Version of *CLA* to be used in trials
   - 5.3 Finalise the approach for evaluating proposed amendments to the *CLA*
   - 5.4 Work plan

6. RMP – preparations for *Implementation*
   - 6.1 Western North Pacific Bryde's whales
     - 6.1.1 Complete *Implementation*
     - 6.1.2 Recommendations
   - 6.2 North Atlantic fin whales
     - 6.2.1 Complete *Implementation*
     - 6.2.2 Recommendations
   - 6.3 North Pacific common minke whales (NPM)
     - 6.3.1 Initiate *pre-Implementation*
     - 6.3.2 Recommendations
   - 6.4 Work plan

7. Estimation of bycatch and other human-induced mortality
   - 7.1 Collaboration with FAO on collation of relevant fisheries data
   - 7.2 Progress on joining the Fisheries Resource Monitoring System (FIRMS)
   - 7.3 Estimation of bycatch mortality of large whales
   - 7.4 Estimation of risk and rates of entanglement
   - 7.5 Review progress on including information in National Progress Reports
   - 7.6 Review methods to estimate mortality from ship strikes
   - 7.7 Continue to develop global database of ship strike incidents
   - 7.8 Other issues
     - 7.8.1 Continue to consider methods for assessing mortality from acoustic sources
     - 7.8.2 Continue to consider methods for assessing mortality from marine debris
   - 7.9 Work plan

8. Aboriginal Subsistence Whaling Management Procedure (AWMP)
   - 8.1 Complete work on sex ratio methods for common minke whales off West Greenland
   - 8.2 Conduct *Implementation Review* for eastern North Pacific gray whales

8.3 Continue work on developing *SLA*s for the Greenland fisheries
8.4 Consider lessons learned from the bowhead whale *Implementation Review*
8.5 Work plan

9. Aboriginal Subsistence Whaling management advice
9.1 Eastern Canada and West Greenland bowhead whales
9.1.1 Assess stock structure and abundance of Eastern Canada and West Greenland bowhead whales
9.1.2 Review recent catch information
9.1.3 Management advice
9.2 Eastern North Pacific gray whales
9.2.1 Provide information to the SWG on AWMP for *Implementation Review*
9.2.2 Review of recent catch information
9.2.3 Management advice
9.3 Bering-Chukchi-Beaufort Seas Bowhead whales
9.3.1 Review catch information and new scientific information
9.3.2 Management advice
9.4 Common minke whale stocks off Greenland
9.4.1 New information
9.4.2 Sex-ratio based assessment of common minke whales
9.4.3 Management advice
9.5 Fin whales off West Greenland
9.5.1 New information
9.5.2 Management advice
9.6 Humpback whales off West Greenland
9.6.1 New information
9.6.2 Management advice
9.7 Humpback whales off St. Vincent and The Grenadines
9.7.1 New information
9.7.2 Management advice
9.8 Work plan

10. Whale stocks
10.1 Antarctic minke whales
10.1.1 Produce agreed abundance estimates of Antarctic minke whales using IDCR/SOWER data
10.1.2 Conduct an analysis of ageing errors that could be used in catch-at-age analyses
10.1.3 Continue development of the catch-at-age models
10.1.4 Continue to examine the difference between abundance estimates from CPII and CPIII
10.1.5 Work plan
10.2 Southern Hemisphere humpback whales
10.2.1 Complete assessment of Breeding stock B
10.2.2 Review new information on other breeding stocks
10.2.3 Work plan
10.3 Southern Hemisphere blue whales
10.3.1 Review new information
10.3.2 Work plan
10.4 Western North Pacific gray whales
10.4.1 Review any newinformation
10.4.2 Work plan
10.5 Southern Hemisphere right whales
10.5.1 Review any new information
10.5.2 Work plan
10.6 Other stocks of right whales and small stock of bowhead whales
10.6.1 Review any new information
10.6.2 Work plan
10.7 SOWER cruises
10.7.1 General review of 2009/10 cruise
10.7.2 Review results from previous cruises
10.8 North Pacific cruise
10.8.1 Recommendations for 2010 cruise and short-term objectives
10.8.2 Mid- to long-term plans for the North Pacific Survey Programme
10.9 Other
10.9.1 Planning of in-depth assessment of sei whales

11. Stock definition
11.1 Statistical and genetic issues related to stock definition
11.2 Progress on the TOSSM project
11.3 Criteria for unit-to-conserve
11.4 Work plan

12. Environmental concerns
12.1 Receive the State of the Cetacean Environment Report (SOCER)
12.2 Review progress in planning for the POLLUTION 2000+ PhaseII
12.3 Review report from CERD working group
12.4 Review new information on anthropogenic sound and cetaceans, focusing on masking sounds (e.g. noise from shipping and other low frequency sources)
12.5 Review progress on work from the Second Climate Change Workshop
12.6 Other habitat related issues
12.7 Work plan

13. Ecosystem modelling
13.1 Review ecosystem models relevant to the Committee's work
13.2 Review issues related to functional responses
13.3 Recommendations on the role of this working group within the Committee
13.4 Work plan

14. Small cetaceans
14.1 Review taxonomy, population structure and status of small cetaceans in the eastern tropical Atlantic
14.2 Review report from the Working Group on climate change and small cetaceans
14.3 Review progress on previous recommendations
14.4 Review takes of small cetaceans
14.5 Work plan

15. Whalewatching
15.1 Discuss the proposal for a large-scale whale-watching experiment (LaWE)
15.2 Review whalewatching off North Africa
15.3 Assess the impact of whalewatching on cetaceans
15.4 Review reports of intersessional working groups

- 15.5 Other issues
  - 15.5.1 Consider information from platforms of opportunity of potential value to the Scientific Committee
  - 15.5.2 Review of whalewatching guidelines and regulations
  - 15.5.3 Review risks to cetaceans from collisions with whalewatching vessels
- 15.6 Work plan

16. DNA testing
    - 16.1 Review genetic methods for species, stock and individual identification
    - 16.2 Review results of the 'amendments' of sequences deposited in GenBank
    - 16.3 Collection and archiving of tissue samples from catches and bycatches
    - 16.4 Reference databases and standards for diagnostic DNA registries
    - 16.5 Work plan

17. Scientific permits
    - 17.1 Review of results from existing permits
      - 17.1.1 JARPN II
      - 17.1.2 JARPA II
      - 17.1.3 Planning for a final review of results from Iceland – North Atlantic common minke whales
    - 17.2 Review of new or continuing proposals
      - 17.2.1 JARPA II
      - 17.2.2 JARPN II
    - 17.3 Procedure for reviewing scientific permit proposals
    - 17.4 Work plan

18. Whale sanctuaries

19. Southern Ocean Research Partnership (SORP)

20. Actions arising from intersessional requests from the Commission

21. Research and Workshop proposals and results
    - 21.1 Review results from previously funded research proposals
    - 21.2 Review proposals for 2010/11

22. Committee priorities and initial agenda for the 2011 meeting

23. Data processing and computing needs for 2010/11

24. Funding requirements for 2010/11

25. Working methods of the committee

26. Election of officers

27. Publications

28. Other business

29. Adoption of Reports

Annex B2

Relationship Between Commission and Scientific Committee Agendas

This table is intended to assist readers in finding information relative to the Commission Agenda (IWC/62) in the Scientific Committee Report (SC/62) and the Chair's Report (2010) of IWC/61 (2009). Commission Agenda items not in this summary were not addressed at the Scientific Committee meeting.

No.	Commission Agenda	Scientific Committee Agenda Item and Annex	Chair's Report (2010: Agenda Item)
4.	WHALE STOCKS		4
4.1	Antarctic minke whales		4.1
4.1.1	Report of the Scientific Committee	10.1; Annex G	
4.2	Southern Hemisphere humpback whales		4.3
4.2.1	Report of the Scientific Committee	10.2; Annex H	
4.3	Southern Hemisphere blue whales		4.4
4.3.1	Report of the Scientific Committee	10.3; Annex H	
4.4	Western North Pacific gray whales		4.5.1
4.4.1	Report of the Scientific Committee	10.4; Annex F	
4.5	Southern Hemisphere right whales		4.5.2.1
4.5.1	Report of the Scientific Committee	10.5; Annex F	
4.6	Other stocks of right whales and small stocks of bowhead whales		
4.6.1	Report of the Scientific Committee		
	• Right whales	10.6; Annex F	4.5.2
	• Bowhead whales	9.1, 9.3, 10.6; Annex F	4.5.3
	• Gray whales	8.2, 9.2, 10.4; Annexes E, F	
4.6.2	Report of the Conservation Committee (southern right whales of Chile-Peru)		
4.7	Research cruises (SOWER and North Pacific)		
4.7.1	Report of the Scientific Committee	10.7, 10.8; Annex G	
4.8	Other		
5.	WHALE KILLING METHODS AND ASSOCIATED WELFARE ISSUES		5
6.	ABORIGINAL SUBSISTENCE WHALING		6
6.1	Aboriginal Subsistence Whaling Management Procedure		6.1
6.1.1	Report of the Aboriginal Subsistence Whaling Sub-committee	8; Annex E	6.1.1
6.2	Aboriginal Whaling Scheme		6.2
6.2.1	Report of the Aboriginal Subsistence Whaling Sub-committee	8.5; Annex E	
6.3	Aboriginal subsistence whaling catch limits		6.3
6.3.1	Report of the Aboriginal Subsistence Whaling Sub-committee	9; Annexes E, F	6.3.1.1
6.4	Other		
7.	REVISED MANAGEMENT SCHEME (RMS)		7
7.1	Revised Management Procedure (RMP)		7.1
7.1.1	Report of the Scientific Committee		7.1.1
	• General issues	5; Annex D	7.1.1.1
	• *Implementation* process		7.1.1.2
	• Western North Pacific Bryde's whale	6.1; Annex D	
	• North Atlantic fin whales	6.2; Annex D	
	• Western North Pacific common minke whales	6.3; Annex D	4.2
	• Bycatch	7; Annex J	7.1.1.3
7.2	Other		
8.	SANCTUARIES		8
8.1	Issues raised in the Scientific and Conservation Committees		
8.1.1	Report of the Scientific Committee	18	
8.1.2	Report of the Conservation Committee		
8.2	South Atlantic Whale Sanctuary		
9.	SOCIOECONOMIC IMPLICATIONS AND SMALL-TYPE WHALING		9
10.	SCIENTIFIC PERMITS		10
10.1	Report of the Scientific Committee	17	
10.1.1	Review of results from existing permits	17.1	10.1, 10.2
10.1.2	Review of new or continuing proposals	17.2	10.3
10.1.3	Procedures for reviewing scientific permit proposals	17.3	10.4
10.1.4	Other		
11.	SAFETY ISSUES AT SEA		11

No.	Commission Agenda	Scientific Committee Agenda Item and Annex	Chair's Report (2010: Agenda Item)
12.	ENVIRONMENTAL AND HEALTH ISSUES		12
12.1	Climate Change		12.1.1.1
12.1.1	Report of the Scientific Committee	12.5; Annex K	
12.2	POLLUTION 2000+: Phase II Planning Workshop		12.1.1.3
12.2.1	Report of the Scientific Committee	12.2; Annex K	
12.3	State of the Cetacean Environment (SOCER)		12.1.1.3
12.3.1	Report of the Scientific Committee	12.1; Annex K	
12.4	Anthropogenic sound		
12.4.1	Report of the Scientific Committee	12.4, 12.6; Annex K	
12.5	Other environmental-related issues		12.1.1.3
12.5.1	Report of the Scientific Committee	12.6; Annex K	
12.6	Ecosystem modelling		12.1.1.2
12.6.1	Report of the Scientific Committee	13; Annex K1	
12.7	Reports from Contracting Governments on national and regional efforts to monitor and address the impacts of environmental change on cetaceans and other marine mammals		
12.8	Health issues – Commission discussions and action arising		12.3
12.9	Other		
13.	CONSERVATION MANAGEMENT PLANS		
13.1	Report of the Scientific Committee	10.2.2.4, 10.4; Annexes F, H	
13.2	Report of the Conservation Committee		
14.	WHALEWATCHING		13
14.1	Report of the Scientific Committee	15; Annex M	13.1.1
15.	COOPERATION WITH OTHER ORGANISATIONS		14
15.1	Report of the Scientific Committee	4	14.1
16.	OTHER SCIENTIFIC COMMITTEE ACTIVITIES, ITS FUTURE WORK PLAN AND ADOPTION OF SCIENTIFIC COMMITTEE REPORT		15
16.1	Small cetaceans		15.1
16.1.1	Report of the Scientific Committee	14; Annex L	15.1.1
16.2	Regional non-lethal research partnerships		15.2
16.2.1	Report of the Scientific Committee	10.8; 19; Annex G	15.2.2
16.3	Other activities		15.3
16.3.1	Report of the Scientific Committee	11, 16, 21, 23, 25-28	15.3.1
16.4	Scientific Committee Future Work Plan		15.4
16.4.1	Report of the Scientific Committee	22	15.4.1
17	CONSERVTION COMMITTEE		16
18.	CATCHES BY NON-MEMBER NATIONS		17
19.	INFRACTIONS, 2009 SEASON		18
20.	ADMINISTRATIVE MATTERS		20
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22.	FINANCIAL STATEMENTS AND BUDGETS AND OTHER MATTERS CONSIDERED BY THE BUDGETARY SUB-COMMITTEE	24	23
23.	ADOPTION OF THE REPORT OF THE FINANCE AND ADMINISTRATION COMMITTEE		24
24.	DATE AND PLACE OF ANNUAL AND INTERSESSIONAL MEETINGS		25
25.	ADVISORY COMMITTEE		26
26.	SUMMARY OF DECISIONS AND REQUIRED ACTIONS		27
27	OTHER MATTERS		28

Annex C

List of Documents

SC/62/AWMP

1. Frasier, T.R., Koroscil, S.M., White, B.N. and Darling, J.D. Population structure in the eastern North Pacific gray whale: Implications for management of aboriginal whaling. 14pp [plus corrections].
2. Punt, A.E. and Wade, P.R. Population status of the eastern North Pacific stock of gray whales in 2009. 24pp.

SC/62/BC

1. [NO PAPER].
2. Píngaro, R.G., Juri, E., Le Bas, A., Bianco, J., Ortiz, J. and Palazzo, J.T., Jr. Records of collisions between large vessels and southern right whales (*Eubalaena australis*) in Uruguayan waters, 2003-2007. 7pp.
3. [NO PAPER].
4. Leaper, R. and Donovan, G.P. A short update on the IWC ship strike database. 2pp.
5. Williams, R. and Ashe, E. Marine mammals and debris in the Inside Passage, British Columbia, Canada. 25pp.
6. Hamer, D.J., Childerhouse, S.J. and Gales, N.J. Mitigating operational interactions between odontocetes and the longline fishing industry: a preliminary global review of the problem and of potential solutions. 30pp.

SC/62/BRG

1. Perryman, W.L., Reilly, S.B. and Rowlett, R.A. Results of surveys of northbound gray whale calves 2001-2009 and examination of the full sixteen year series of estimates from the Piedras Blancas Light Station. 11pp.
2. Bradford, A.L., Weller, D.W., Lang, A.R., Tsidulko, G.A., Burdin, A.M. and Brownell, R.L., Jr. Comparing observations of age at first reproduction in western gray whales to estimates of age at sexual maturity in eastern gray whales. 6pp.
3. Bradford, A.L., Ivashchenko, Y.V., Kirichenko, V.Y. and Burdin, A.M. Review of cetacean distribution and occurrence off the western coast of Kamchatka, eastern Okhotsk Sea. 54pp.
4. Vladimirov, V.A., Starodymov, S.P., Kornienko, M.S. and Muir, J.E. Distribution and abundance of western gray whales in the waters off northeast Sakhalin Island, Russia, 2004-2009. 15pp.
5. Kanda, N., Goto, M., Ilyashenko, V.Y. and Pastene, L.A. Update of the mitochondrial DNA analysis in gray whales using new acquired data. 8pp.
6. Burdin, A.M., Tsidulko, G.A., Sidorenko, M. and Dzhikiya, E. Status of western gray whales off northeastern Sakhalin Island, Russia in 2009. 7pp.
7. [NO PAPER].
8. Durban, J., Lang, A.R., Weller, D.W., Rugh, D., Hobbs, R. and Perryman, W.L. Comparing two methods of shore-based counts of eastern North Pacific gray whales. 6pp.
9. Tyurneva, O.Y., Yakovlev, Y.M., Vertyankin, V.V., Gailey, G., Sychenko, O. and Muir, J.E. Photographic identification of the Korean-Okhotsk gray whale (*Eschrichtius robustus*) offshore northeast Sakhalin Island and southeast Kamchatka peninsula (Russia), 2009. 12pp.
10. Lang, A.R., Weller, D.W., Leduc, R.G., Burdin, A.M. and Brownell, R.L., Jr. Delineating patterns of male reproductive success in the western gray whale (*Eschrichtius robustus*) population. 22pp.
11. Lang, A.R., Weller, D.W., Leduc, R.G., Burdin, A.M. and Brownell, R.L., Jr. Genetic differentiation between western and eastern (*Eschrichtius robustus*) gray whale populations using microsatellite markers. 18pp.
12. [NO PAPER].
13. Clarke, J.T. and Ferguson, M.C. Aerial surveys of large whales in the northeastern Chukchi Sea, 2008-2009, with review of 1982-1991 data. 18pp.
14. Clarke, J.T. and Ferguson, M.C. Aerial surveys for bowhead whales in the Alaskan Beaufort Sea: BWASP update 2000-2009 with comparisons to historical data. 11pp.
15. Valenzuela, L.O., Sironi, M., Rowntree, V.J., La Sala, L., Pozzi, L., Mohamed, N., Musmeci, L., Andrejuk, J., Uhart, M., Chirife, A., Maron, C. and Segers, J. Population genetic structure of live and dead southern right whales (*Eubalaena australis*) off Península Valdés, Argentina. 12pp.
16. Carroll, E., Alexander, A., Childerhouse, S., Patenaude, N., Steel, D., Smith, S., Dunshea, G., Constantine, R. and Baker, C.S. Genetic identity and genotype matching of southern right whales (*Eubalaena australis*) from mainland New Zealand and the Auckland Islands. 8pp.
17. Clark, C.W., George, C. and Suydam, R. Acoustic monitoring of the bowhead spring migration off Pt. Barrow, Alaska: results from 2009 and status of 2010 field effort. 9pp.
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25. Wiig, Ø., Bachmann, L., Heide-Jørgensen, M.P., Laidre, K.L., Postma, L.D., Dueck, L. and Palsbøll, P.J. Within and between stock re-identifications of bowhead whales in Eastern Canada and West Greenland. 7pp.
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SC/62/E

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SC/62/NPM

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SC/62/RMP
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SC/62/SCP
1. Wade, P.R., Baker, C.S., Clapham, P.J., Brownell, J.R., Gales, N., Rosenbaum, H., Childerhouse, S. and Childers, L. Citation of Scientific Committee Documents. 2pp.

SC/62/SD
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1. [NO PAPER].
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9. [NO PAPER].
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6. Lusseau, D., Bejder, L., Bjørge, A., Weinrich, M., Williams, R. and Rose, N.A. Report from the intersessional LaWE steering group. 9pp.
7. [NO PAPER].

8. WEINRICH, M. A brief note on the interpretation of studies of impacts of whale watching on life history parameters: a consideration of the importance of habitat. 5pp.

SC/62/O

1. GUNNLAUGSSON, T., VÍKINGSSON, G., ÓLAFSDÓTTIR, D. AND SIGURJÓNSSON, J. Sei whale (*Balaenoptera borealis*) discovery markings in the Central Atlantic. 8pp.
2. BEST, P.B. Assessing struck-and-lost rates in early modern whaling: examination of first-hand accounts. 6pp.
3. NISHIWAKI, S., OGAWA, T., BANDO, T., ISODA, T., WADA, A., KUMAGAI, S., YOSHIDA, T., NAKAI, K., KOBAYASHI, T., KOINUMA, A., MORI, M., YOSHIMURA, I., OHSHIMA, T., TAKAMATSU, T., KONAGAI, S., AKI, M. AND TAMURA, T. Cruise report of the Japanese Whale Research Program under Special Permit in the Antarctic - second phase (JARPA II) in 2009/10. 13pp.
4. BANDO, T., KIWADA, H., MOGOE, T., ISODA, T., MORI, M., TSUNEKAWA, M., YOSHIMURA, I., NAKAI, K., SATO, H., TANAKA, H., INAGAKI, M., TAMAHASHI, K., YOSHIDA, K., MORINE, G., WATANABE, H., FUJIWARA, G., EGUCHI, K. AND TAMURA, T. Cruise report of the second phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) in 2009 (part I) - offshore component.: 34pp.
5. YASUNAGA, G., KATO, H., KISHIRO, T., YOSHIDA, H., ISHIKAWA, H., GOTO, M., TABATA, S., MAEDA, H., NAKAMURA, G., INOUE, S., MIYAKAWA, N., TAMURA, T., KUMAGAI, S., IWASAKI, T., KANAJI, Y., WATANABE, H., HIRUTA, H., YAMAZAKI, K., YONEHARA, Y., OIKAWA, H. AND ONODERA, K. Cruise report of the second phase of the Japanese Whale Research Program under Special Permit in the Western North Pacific (JARPN II) in 2009 - (Part II) - coastal component off Sanriku. 20pp.
6. KISHIRO, T., KATO, H., YOSHIDA, H., YASUNAGA, G., TABATA, S., NAKAMURA, G., MAEDA, H., INOUE, S., MIYAGAWA, N., OKAMOTO, R., OIKAWA, H., WATANABE, H., IWASAKI, T., KANAJI, Y., MINAMIKAWA, S., OTANI, S., ISHIKAWA, H., KANDA, N., GOKITA, A., YAMAZAKI, K. AND YONEHARA, Y. Cruise report of the second phase of the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN II) in 2009 (part II) - coastal component off Kushiro. 13pp.
7. KATO, H., MIYASHITA, T., KANDA, N., ISHIKAWA, H., FURUKAWA, H. AND UOYA, T. Status report of conservation and researches on the western gray whales in Japan, May 2009-April 2010. 6pp.
8. CHILDERHOUSE, S. Report of the Seattle SORP workshop 2009, National Marine Mammal lab conference room, Alaska Fisheries Science Centre at Sand Point, Seattle, 1-3 December 2009. 5pp.
9. CHILDERHOUSE, S. Annual report of the Southern Ocean Research Partnership 2009/10. 5pp.
10. CHILDERHOUSE, S. Project outlines for the Southern Ocean Research Partnership. 28pp.
11. [NO PAPER].
12. GALES, N. Antarctic Whale Expedition. Preliminary science field report and summary. 14pp.
13. PIKE, D.G., GUNNLAUGSSON, T., VÍKINGSSON, G.A., DESPORTES, G. AND MIKKELSEN, B. Estimates of the abundance of humpback whales (*Megaptera novaeangliae*) from the T-NASS Icelandic and Faroese ship surveys conducted in 2007. 15pp.
14. PIKE, D.G., GUNNLAUGSSON, T. AND VÍKINGSSON, G. Distribution and abundance of humpback whales in Icelandic coastal waters in summer 2007. 17pp.
15. KOCK, K.-H., HERR, H., SCHEIDAT, M., BRÄGER, S., LEHNERT, K., LEHNERT, L.S., VERDAAT, H., WILLIAMS, R., SIBERT, U. AND BOEBEL, O. Sighting surveys from a ship and a helicopter in the Weddell Sea in 2006/07 and 2008/09. 32pp.
16. MATSUOKA, K., KIWADA, H., MURASE, H., NISHIWAKI, S. AND MIYASHITA, T. Plan for the cetacean sighting survey in the North Pacific in 2010. 5pp.
17. MATSUOKA, K., KIWADA, H., MURASE, H., NISHIWAKI, S. AND MIYASHITA, T. Plan for cetacean sighting surveys in the Antarctic in the 2010/11 season. 5pp.
18. MIKHALEV, Y.A. Depth of sperm whales' dive according to the acoustic device 'fin whale'. 3pp.
19. BAKER, C.S. AND BROWNELL, R.L., JR. The traceability/trackability of illegal trade in whale products: a proposal to evaluate the technical functionality of DNA register. 4pp.

SC/62/Progress Reports

Argentina. 18pp.
Australia. 28pp.
Belgium. 6pp.
Brazil. 22pp.
Chile. 8pp.
Denmark. 6pp.
France. 18pp.
Germany. 17pp.
Iceland. 9pp.
Ireland. 9pp.
Italy. 31pp.
Japan. 32pp.
Republic of Korea 16pp.
Mexico. 13pp.
Netherlands. 6pp.
New Zealand. 19pp.
Norway. 6pp.
Spain. 13pp.
Sweden. 4pp.
UK. 14pp.
USA. 39pp.

SUBMITTED REPORTS

SC/62/Rep

1. Report of the Southern Right Whale Die-Off Workshop, Puerto Madryn, Argentina, 15-18 March 2010. 46pp.
2. Report of the Third Intersessional Workshop on the Review of MSYR for Baleen Whales, Seattle, 20-24 April 2010. 15pp.
3. Report of the Intersessional meeting on the North Pacific Survey Programme, Tokyo, 25-26 September 2009. 9pp.
4. Report of the POLLUTION 2000+ Phase II Workshop,The Marine Mammal Center, Sausalito, CA, USA, 22-24 February 2010. 25pp.
5. Report of the Third AWMP Workshop of Greenlandic hunts, DTU-Riso, Roskilde, Denmark, 14-17 December 2009. 17pp.
6. Report of the planning meeting for the 2009/10 IWC/SOWER cruise, Tokyo, 24-25 September 2009. 14pp.

COMMISSION DOCUMENTS

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4. Cooperation with other organisations. 15pp.

7rev Proposed Consensus Decision to Improve the Conservation of Whales from the Chair and Vice-Chair of the Commission. 43pp.

9. DONOVAN, G., PALKA, D., GEORGE, C., LEVERMANN, N., HAMMOND, P. AND WITTING, L. Report of the Small Working Group on Conversion Factors (from Whales to Edible Products) for the Greenlandic Large Whale Hunt. 54pp.

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8. Report of the Working Group on Whalewatching. 4pp.

Annex D

Report of the Sub-Committee on the Revised Management Procedure (RMP)

Members: Bannister (Convenor), Acquarone, Allison, An, Baba, Baker, Bjørge, Borodin, Brandão, Brandon, Breiwick, Brownell, Butterworth, Campbell, Castellote, Childerhouse, Chilvers, Choi, Cipriano, Collins, Cooke, de Moor, Donoghue, Donovan, Edwards, Elvarsson, Ensor, Fujise, Funahashi, Gallego, Goodman, Gunnlaugsson, Hakamada, Hammond, Hatanaka, Holloway, Iñíguez, Jaramillo Legorreta, Kanda, Kelly, Kitakado, Koski, Leaper, Lens, Lockyer, Luna, Lusseau, Lyrholm, Matsuoka, Miyashita, Morishita, Muller, Murase, Øien, Okada, Okamura, Palka, Pampoulie, Panigada, Pastene, Punt, Robbins, Roel, Rojas-Bracho, Skaug, Uoya, Uozumi, Vazquez, Víkingsson, Wade, Walløe, Witting, Yamakage, Yasokawa, Yoshida, Zerbini.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks
As Convenor, Bannister welcomed the participants.

1.2 Election of Chair and appointment of rapporteurs
Bannister was elected Chair. Punt acted as rapporteur.

1.3 Adoption of Agenda
The adopted Agenda is shown in Appendix 1. Víkingsson proposed to add an agenda item on North Atlantic sei whales to discuss the proposal detailed in SC/62/RMP2. The Chair ruled that this item be deferred, given the length of the agenda and because North Atlantic sei whales were not referred to in IWC/62/7rev.

1.4 Available documents
The documents considered by the sub-committee were SC/62/RMP1, SC/62/RMP3-8, SC/62/RMP10, SC/62/Rep2, SC/62/O1 and relevant extracts from past reports of the Committee.

2. REVISED MANAGEMENT PROCEDURE (RMP) – GENERAL ISSUES

2.1 Review MSY rates
2.1.1 Report of the Intersessional Workshop
The Third Intersessional Workshop on the Review of MSYR for Baleen Whales was held at the School of Aquatic and Fishery Sciences, University of Washington, Seattle (20–24 April 2010). Donovan summarised its report which is given as SC/62/Rep2.

The Committee has been discussing the maximum sustainable yield rate (MSYR) issue for some time in the context of a general reconsideration of the plausible range to be used in population models used for testing the *Catch Limit Algorithm* (*CLA*) of the RMP. At present this range is 1% to 7% when expressed in terms of the mature component of the population. As part of the review process, information on observed population growth rates at low population sizes is being considered; Cooke (2007) noted that in circumstances where variability and/or temporal autocorrelation in the effects of environmental variability on population growth rates is high, simple use of such observed population growth rates could lead to incorrect inferences being drawn concerning the lower end of the range of plausible values for MSYR. The aim of the Third Workshop was to examine whether the observed levels of variation in baleen whale reproduction and annual survival rate parameters were sufficiently large that biases of the nature identified from population models incorporating environmentally-induced variability might be of concern.

The Chair expressed thanks to the scientists who had generously provided the data for consideration, many of whom attended the Workshop. A summary of the data received can be found in SC/62/Rep2, table 1. Detailed descriptions of the datasets can also be found in SC/62/Rep2. It is important to note that few data were available to inform on survival rate variation and this requires further consideration. After inspection of the datasets, a subset ('calving proportion indices' and 'calving interval estimates') was selected for further analysis (and see table 2 of SC/62/Rep2).

As a first step in the analytical work required to assist in addressing the objective of the Workshop, an approach was developed and followed to estimate the coefficient of variation (CV) and temporal autocorrelation for the time series of calving proportion index and calving interval data discussed above, recognising that this ignores observation error and thus results in positively biased estimates. This information (modified appropriately – see SC/62/Rep2) provides input for a method (see Annex D of SC/62/Rep2) developed to relate variability in calving proportion to variability in the annual growth rate of a population using a population dynamics model. The Annex D model is tuned by adjusting the input CV and temporal autocorrelation estimates in table 4 of SC/62/Rep2 upwards until the corresponding model outputs for these quantities match those in the table, i.e. until the variability simulated by the model matches that observed in the field. The model then outputs the CV and temporal autocorrelation to be expected in the growth of the population from year to year.

The Workshop identified two further steps needed before such results can be used to draw inferences about the plausible ranges for the CV and temporal autocorrelation parameters describing the effects of environmental variability on population dynamics in the model of Cooke (2007). These were incorporated into the work plan and are discussed under Item 2.1.2 of this report.

As noted above, although few data are available, environmentally-induced variability in population abundance can arise also from variation in the annual survival rate, and the Annex D model can also take this into account. The Workshop deferred decisions on the specific form of representations of this effect to the 2010 Annual Meeting (see Item 2.1.2 of this report).

The Workshop also addressed progress made on three other issues listed in the Work Plan for Completion of the MSYR Review (IWC, 2010d).

(1) Examination of information from other taxa via the GPDD (Global Population Dynamics Database – *http://www.cpb.bio.ic.ac.uk*), which is said to be one of the largest collections of animal and plant population data in the world, unfortunately revealed that this was very unlikely to contain information that would assist in the present Review. Although some other data series *might* provide useful information, these series were not generally readily available and the Workshop had agreed that further discussion on whether this issue should be followed up should be deferred to the 2010 Annual Meeting.
(2) For a variety of reasons, the expected genetic experts were unable to attend the Workshop and further consideration of this aspect was deferred to the 2010 Annual Meeting.
(3) Pressure of time to complete other computations meant that it had not been possible to complete the simulation study based on the environmental variability population model (Cooke, 2007) to determine the predicted relationship between the length of series and estimated level of variability for the standard scenarios (table 2 in IWC, 2010a). The Workshop had requested the Secretariat to complete this work for consideration at the 2010 Annual Meeting.

Turning to the issue of a meta-analysis of population growth rates previously discussed (IWC, 2010a); the Workshop was pleased to receive a revised approach (Punt, 2010) to that discussed at the 2009 Annual Meeting. The Workshop suggested some additional work to be completed before the 2010 Annual Meeting, recognising that this would represent an improvement on that used last year to construct a probability distribution for the rate of increase for an 'unknown' stock in the limit of zero population size, r_0.

The sub-committee expressed its appreciation to the Workshop participants and particularly to Donovan for his chairmanship.

2.1.2 Issues arising

SC/62/RMP3 responded to the recommendations of the Workshop to apply the age-structured Annex D model of SC/62/Rep2 to all of the data sets assembled during the Workshop to estimate the resultant CV and temporal auto-correlation in growth rate, and to conduct further tests of the Bayesian meta-analysis approach of Punt (2010) using scenarios which better reflect the data sets on which a posterior distribution for the rate of increase for an 'unknown' stock in the limit of zero population size, r_0, would be based. The inputs to age-structured model were selected so that the model-predictions of the variation and temporal autocorrelation in the calving rate matched those specified during the Workshop. The CV and temporal autocorrelation in the annual rate of increase was found to differ markedly among stocks, with the CV being largest for North Atlantic right and Gulf of California blue whales, and lowest for southeast Atlantic right whales. The estimates of lower percentiles for the posterior distribution for r_0 were shown to be somewhat positively biased, with estimation performance a function of the extent of measurement error, the number of stocks for which rates of increase were available, and the range of years over which the stock was monitored.

The sub-committee **agreed** that the Bayesian approach of Punt (2010) was acceptable as the basis to compute a posterior distribution for r_0, once the inputs needed to apply it (rates of increase and associated sampling CVs, and values for the extent and temporal-auto-correlation in environmentally-driven factors on the growth rate) become available. It also **agreed** that account would need to be taken, when making recommendations regarding appropriate values for MSYR for use in trials, that the estimates of lower posterior percentiles from this method are positively biased.

The sub-committee noted that the results in SC/62/RMP3 will need to be revised once the Committee agrees values for the extent of variation and temporal autocorrelation in demographic parameters.

SC/62/RMP2 and SC/62/RMP4 responded to the recommendations to use the environmental variability model of Cooke (2007) to provide CVs and temporal autocorrelation estimates for the growth of the population from one year to the next for the standard set of scenarios and to use this model to determine the predicted relationship between the length of series and the estimated level of variability in the population rate of increase. The CVs for the rate of population growth were negatively correlated with the MSY rate and positively correlated with the amount of process variation. This CV declined with increasing length of the series for all scenarios.

The Workshop thanked Allison and Punt, noting that it now had a basis to link variability in demographic processes with the inputs of the Cooke (2007) model.

Brandon, Kitakado and Cooke reported on efforts to fit models which account for both process and observation error to the data on calving rates and calving intervals. Numerical problems had been encountered during the intersessional period in implementing these models. A small group (Brandon, Cooke, Kitakado and Punt) was established to develop a work plan for completing this work. The sub-committee **endorsed** the work plan (Appendix 2), and looked forward to seeing the results of this work at the 2011 Annual Meeting. The approach in Appendix 2 ignores possible environmental covariates which determine annual changes in reproductive indices. Such covariates should be considered in future analyses.

The sub-committee noted that for many stocks, the available data are such that variation in reproductive rates can be estimated, but variation in survival rates cannot be estimated with useful precision. An important issue is how to relate variation in net recruitment rate, which depends on variation in both survival and reproduction, to variation in reproductive rates alone. The sub-committee considered Appendix 3 which showed that if variation in reproduction is due to variation in available energy (food), then for some parameter values, and under certain assumptions concerning the optimal allocation of energy between maintenance and reproduction, one would expect variation in survival to be positively correlated with variation in reproduction. In such cases, variation in net recruitment rate would be underestimated, if the survival rate is assumed to remain constant while reproductive rates vary.

Witting noted that empirical data sets for other species often show negative correlation between reproduction and survival rates. For example, experimental manipulation of reproductive rates in birds through removal of eggs has been shown to result in increased survival of adults. If baleen whale reproduction varies due to factors other than food availability (such as predation), a negative correlation between reproductive and survival rates might be expected, because reduced reproduction reduces the energy burden on mothers and could enhance their survival. Even if the variation in reproduction is due to variation in food availability, the specific timing of food limitation relative to reproduction could yield correlations of either sign. For example, if reproduction is suppressed one year due to low food availability at a point in the cycle critical for reproduction, but feeding conditions substantially improve thereafter, the reduced reproduction could enhance subsequent survival.

The sub-committee considered the question of correlations between survival and reproductive rates to be potentially important for the question of estimating typical levels of variation in net recruitment rate for baleen whales, but **agreed** that more analysis is required before any general inference can be drawn. The sub-committee **requested** in particular:

(1) a literature review with regard to the question of the circumstances under which correlations between survival and reproductive rates would be negative or positive;
(2) more extensive modelling to cover the full range of parameter values deemed to be plausible for baleen whales, in order to determine whether general inferences can be drawn, or at least to identify the circumstances where substantial correlations of a specific sign would be expected; and
(3) direct estimation of variability in survival rates to the extent this is possible.

The sub-committee **agreed** that if results from this work are available at its next meeting, then they should be taken into account in the sub-committee's deliberations with respect to the level of variability in baleen whale demography, but that lack of results will not preclude the sub-committee from completing its review of MSY rates.

The sub-committee considered the extent to which genetic data could place bounds on fluctuations in population size (see fig. 1 of IWC (2010c) for some examples of trajectories arising for the environmental variation model of Cooke (2007)). It was noted that, in principle, measures of genetic diversity and the ratio of effective to census population size could be used to impose such bounds. However, doing so is not straightforward and, for example, inferences regarding the size of a local population or stock based on measures of genetic diversity could be markedly in error if there is migration among local populations (Appendix 4). The sub-committee recognised the potential of genetic methods to inform its deliberations on the plausible range of MSYR values, but **agreed** that these methods could not be used during the current review. It **recommended** that the number of haplotypes in whale populations, along with other population and demographic measures, should be assembled. This might inform the current review. Brownell noted that he had started such a compilation and the sub-committee **encouraged** completion of this compilation. Members also noted that there are prospects for collating information on the ratio of effective to census population for whale species.

The sub-committee **agreed** that the use of time-series of abundance estimates for species other than whales to make inferences regarding the extent of variation and the temporal auto-correlation of the rate of growth remained a good idea. However, the lack of such time-series at present means that this source of information cannot be pursued during the current review of MSY rates.

2.1.3 Conclusions and recommendations

Although considerable progress was made during the current meeting, the sub-committee was once again not in position to complete the review. It established a work plan which addresses the final issues which need to be examined for the sub-committee to complete the review at next year's meeting.

2.2 Finalise the approach for evaluating proposed amendments to the *CLA*

The sub-committee was once again pleased to see the progress made at the MSYR Intersessional Workshop and during the current meeting, but again recognised that it could not complete discussions on amendments to the *CLA* until the range for MSYR values in the RMP was finalised.

2.2.1 Norwegian proposal

Walløe noted that all of the relevant trials results related to the Norwegian proposal were presented in Aldrin and Huseby (2007), but that evaluation of this proposal could not occur until the review of MSY rates was complete.

2.3 Version of *CLA* to be used in trials

SC/62/RMP10 examined the sensitivity of catch limits to the level of accuracy when computing posterior distributions using the *CLA*. SC/62/RMP10 found that the catch limits for some combinations of species, region and variant are very sensitive to the choice of the step sizes when applying the *CLA*. Furthermore, the choice of step sizes can have an impact on the selection among variants of the RMP. Four versions of programs used to implement the *CLA* were discussed.

The sub-committee **endorsed** the recommendations in SC/62/RMP10 that: (a) only the Norwegian version of the *CLA* should be used when conducting future trials; (b) any Second Intersessional Workshops (IWC, 2005a) will need to be carefully scheduled to ensure that all trials can be run before it takes place; (c) if special circumstances arise when it becomes necessary to run additional trials during a meeting (e.g. during a Second Intersessional Workshop), that the 'intermediate' version of the Cooke implementation that is more accurate than the 'trials' version (but less accurate than the 'accurate' or Norwegian version) be used for this purpose and the results confirmed using the Norwegian 'CatchLimit' program after the meeting; and (d) a full set of revised results for North Atlantic fin whales, Western North Pacific Bryde's whales, and North Atlantic minke whales should be run using the Norwegian 'CatchLimit' program and the results placed on the IWC website.

2.4 Updates to RMP specification and annotations

In the context of applying the RMP pursuant to Item 4 of this report, the sub-committee identified some issues where updating and clarification of the specifications of the RMP and the accompanying annotations and guidelines were warranted.

(1) The provision for the adjustment for sources of human-caused mortality other than commercial catches, as recommended by the Scientific Committee in 2000 (IWC, 2001b), should be included in the RMP with the qualification specified by the Commission (IWC, 2001a) that the provision be limited to mortality due to bycatches, ship strikes, non-IWC whaling, scientific permit catches and indigenous subsistence whaling. A new annotation should be added to provide the Committee with operational guidelines to implement this provision.
(2) The maximum period of validity of catch limit calculations should be extended from five to six years to be consistent with the six-year cycle of surveying specified in section 3.2.2 of the RMP, as

currently implemented for minke whales in the North Atlantic.
(3) The rule for rounding of catch limits to a whole number of whales should be clarified.
(4) The guidelines for conducting surveys under the RMP and those for *Implementing* the RMP (IWC, 2005a; 2005b) should be modified to clarify that changes to the guidelines are not retroactive. That is, results from surveys conducted in accordance with the earlier version of the guidelines would not become inadmissible for use in the RMP when the guidelines are changed.

Proposed amendments to the RMP and annotations to address the above issues are given in Appendix 5, along with some background information. The sub-committee **recommended** adoption of these amendments to the RMP specification and annotations. The sub-committee further **requested** the Editor to prepare a proposal to next year's meeting to update the guidelines to accommodate point (4) above.

The sub-committee noted that several amendments to the RMP specifications and annotations had been adopted since the most recent published version (IWC, 1999). These are listed in Appendix 5. The sub-committee **recommended** that a consolidated revised version be published in full in the next Supplement to *J. Cetacean Res. Manage*.

2.5 Work plan

The sub-committee **agreed** that its work plan for the 2011 Annual Meeting would be as follows.

(1) Brandon, Cooke, Kitakado and Punt to finalise the analyses of the calving rate and calving interval data (see Appendix 2 for details).
(2) Conduct analyses to examine variability in survival rates and the correlation between survival and reproductive rates.
(3) Complete the compilation of the number of haplotypes and other demographic parameters for whale populations.
(4) Complete the review of the range of MSYR values for use in the RMP.
(5) Finalise the approach for evaluating proposed amendments to the *CLA*.
(6) Evaluate the Norwegian proposal for amending the *CLA*.
(7) Consider the implications that the phase-out rule in the RMP is applied by *Small Area* when catch cascading is applied and the abundance estimates are based on multi-year surveys.
(8) The full set of revised results for North Atlantic fin whales, Western North Pacific Bryde's whales and North Atlantic minke whales run using the Norwegian 'CatchLimit' program should be conducted and placed on the IWC website.
(9) The Secretariat to modify the Norwegian 'CatchLimit' program to allow variance-covariance matrices to be specified for the abundance estimates. The results from the modified program should be compared with those from the 'accurate' version of the Cooke program for some cases.

3. RMP – SPECIFIC IMPLEMENTATIONS

3.1 Western North Pacific Bryde's whales

3.1.1 Survey data validation

Allison reported that Burt and Hughes had successfully completed an audit of the survey data.

3.1.2 Research proposal for the 'variant with research'

The Committee had agreed in 2007 (IWC, 2008) that three of the four RMP variants (1, 3 and 4) considered during the *Implementation* for the western North Pacific Bryde's whales, performed acceptably from a conservation perspective and recommended that those variants could be implemented without a research programme. It had also agreed that variant 2 (i.e. sub-area 2 is taken to be a *Small Area* and the complete sub-area 1 is treated as a *Small Area*) was not 'acceptable without research' because conservation performance was 'unacceptable' on three 'medium' plausibility trials in which there were two stocks of Bryde's whales in the western North Pacific, one of which consists of two sub-stocks (stock structure hypothesis 4).

The Committee reviewed a research proposal (Pastene *et al.*, 2008) at the 2008 Annual Meeting which aimed to determine whether or not sub-stocks occur in sub-area 1. Based on this review, the Committee recommended that the *Implementation Simulation Trials* for western North Pacific Bryde's whales be used to determine whether differences in age-compositions between sub-areas 1W and 1E could be used to resolve if there are sub-stocks in these sub-areas, and that results from previous (and any new) power analyses that assess the use of genetic methods to evaluate stock structure hypothesis 4 be included in the revised proposal.

Appendix 6 outlines a revised research plan. The sub-committee welcomed the work that has been done on the proposal and the fact that several of its earlier recommendations had been implemented. The results of the *Implementation Simulation Trials* showed that recent age structure data would not be able to distinguish between scenarios in which there is or is not age-structuring in sub-areas 1W and 1E. The sub-committee **recommended** that the proposal be revised further and, in particular, that the power analysis focus more clearly on the specific hypotheses for the Western North Pacific Bryde's whales. Pastene advised the sub-committee that a revised proposal will be presented next year which will focus to a greater extent on the use of genetic data.

3.1.3 Recommendations and work plan

The sub-committee **agreed** that its work plan for the 2011 Annual Meeting would be as follows.

(1) Review the research proposal for the 'variant with research' to be submitted to the 2011 meeting.

3.2 North Atlantic fin whales

Last year, the Committee completed the review of the *Implementation Simulation Trials* for North Atlantic fin whales. It agreed that if the RMP is implemented for these whales, variants 1, 3, 4, 5 and 6 (see table 4 of IWC, 2010c) can be implemented without an associated research programme. The Committee further agreed that variant 2 (sub-area WI+EG is a *Small Area*) cannot be implemented except in conjunction with a research programme that the Committee agrees could feasibly show that the trials on which variant 2 performs 'unacceptably' should have been assigned 'low' plausibility. The trials were based on stock structure hypothesis IV (four breeding stocks, but without dispersal between the C sub-stocks).

The comparison of results from different versions of the *CLA* (see Item 2.3) revealed that variant 3 (sub-areas WI+WG+EI/F are a *Small Area*) does not have 'acceptable' performance for some of the trials and can no longer be considered to be 'acceptable without research'.

3.2.1 Review estimates for use in the CLA

No abundance estimates were provided for adoption this year and the sub-committee was advised that no new abundance estimates were being prepared.

3.2.2 Research proposal for the 'variant with research'

Last year, Víkingsson, on behalf of Iceland, advised the Committee that a research proposal would be developed for this year's meeting. Last year, the Committee confirmed that use of variant 2 for ten years followed by variant 1 (sub-area WI is a *Small Area*) led to performance which was 'acceptable' for all trials and consequently that the requirements for stage 1 of the process for implementing a 'variant with research' had been met. The second stage of the process for implementing a 'variant with research' was for Iceland to demonstrate to the satisfaction of the Committee that a research programme has a good chance (within a 10-year period) of being able to clarify the situation with respect to stock structure, and in particular to confirm or deny that stock structure hypothesis IV is implausible.

SC/62/RMP1 presented the research proposal following the pro-forma agreed by the Committee in 2007. Hypothesis IV differs from the other hypotheses in that it assumes that there is no interchange among the three sub-stocks in the central North Atlantic in the breeding areas and that these whales have no memory next year of where they were this year and do not change their foraging behaviour in response to changes in density in any one feeding area but will go back to their native feeding area 95% of the time each year. Neither of these assumptions is based on any data. Genetic studies have found a lack of genetic structure in the North Atlantic. There has been no explanation of how such behaviour could have evolved and this behaviour would have grave consequences for the species in the event of anticipated environmental changes. Hypotheses where there is gradual dispersal over time do predict a trend with time in external recoveries. The existing Discovery mark data were tested and the availability of marks from *Small Area* EG was found to increase while it decreases in the *Small Area* WI and this is significant. These results are already sufficient to reject hypothesis IV. The proposed 100 biopsy samples from *Small Area* EG should double this dataset through direct matches and strengthen these results. A power analysis shows that comparison of relative relatedness of animals in *Small Areas* WI and EG also has a good chance of rejecting hypothesis IV. Comparison of relatedness with existing samples from the area and any samples from other areas could strengthen these. SC/62/RMP1 proposed satellite tagging early in the season to reveal animals moving across area boundaries within the season, which will add to the information from the genetic data. Satellite tags placed late during the season on the feeding grounds may survive long enough for detection of the breeding grounds. If the animals from the feeding areas breed in overlapping areas they would be expected to interbreed, which would show that the assumption of an isolated breeding stock is implausible. Models with biologically more plausible hypotheses are proposed to be developed that might provide a superior fit to the data, and methods to integrate different pieces of information, such as results from satellite tagging, that cannot be fitted in the *Implementation Simulations Trial* model will be identified.

The sub-committee welcomed the proposal, noting that it was not final and that Iceland was inviting suggestions for how it can be improved. In discussion, the sub-committee noted that the aim of the proposal should be to assess the probability of hypothesis IV relative to the probabilities for the other stock structure hypotheses. It noted that the *Implementation Simulation Trials* could be used to assess the effect sizes on which power analyses should be based. In particular, the sub-committee **recommended** that the lowest rate at which the C sub-stocks mix in sub-areas EC, WG, EG, WI, EI+F and N and where the performance of variant 2 is 'acceptable' for all trials, should be calculated and used when conducting power analyses.

The authors of SC/62/RMP1 argued that data on time-trends in recoveries of Discovery marks from the WI and EG *Small Areas* are already sufficient to reject stock structure hypothesis IV. The sub-committee noted that these mark-recapture data had been considered during the *Implementation Simulation Trials* and the fits to those data had been examined qualitatively at the 2008 and 2009 Annual Meetings. It **recommended** that quantitative analyses along the lines of appendix 3 of SC/62/RMP1 be conducted for each of the stock structure hypotheses.

Cooke noted that the proposed genetic mark-recapture studies could be partially confounded by male-mediated genetic exchange between breeding stocks, as is known to occur, for example, in humpback whales. Such male-mediated exchange would have no demographic consequences and, to the extent that it involves transference between breeding grounds rather than feeding grounds, would not affect the dynamics of feeding ground abundance as modelled in the trials. The presence or absence of such exchange therefore has no implications for any of the *Implementation Simulation Trials* conducted to date, and does not require development of any new hypotheses. It does, however, potentially reduce the power of genetic mark-recapture data to distinguish among the existing hypotheses. The proposed method should be modified so as not to be potentially confounded by male-mediated relatedness (such as paternal half-siblings), and its power re-calculated, for the purpose of evaluating the adequacy of the proposed research programme to distinguish between hypotheses within the 10-year time frame.

The authors of SC/62/RMP1 responded that the assumption under Hypothesis IV of a constant, but limited, mixing between the feeding grounds could not be explained if there were significant genetic interchange between the breeding stocks. However, these matters could be addressed in a revised proposal to be submitted to next year's meeting.

3.2.3 Work plan

The sub-committee **agreed** that its work plan for the 2011 Annual Meeting would be as follows.

(1) Review a revised research proposal for the 'variant with research' to be submitted to the 2011 meeting.
(2) Review any abundance estimates for use in the *CLA*.

3.3 North Atlantic minke whales

3.3.1 Stock boundaries

The sub-committee noted that some of the boundaries among the *Small Areas* for the North Atlantic minke whales had been changed during the 2003 *Implementation Review*. However, some of the boundaries among the *Small Areas* remain unspecified. The sub-committee **recommended** that a point at 63°N, 12°W be introduced to fill the 'hole' between the CM and CIP *Small Areas*, and that boundaries around the southern tip of Greenland be defined as shown in Fig. 1. The sub-committee **recommended** that the *Small Areas* in Fig. 1 be adopted for use when the applying the RMP for North Atlantic minke whales.

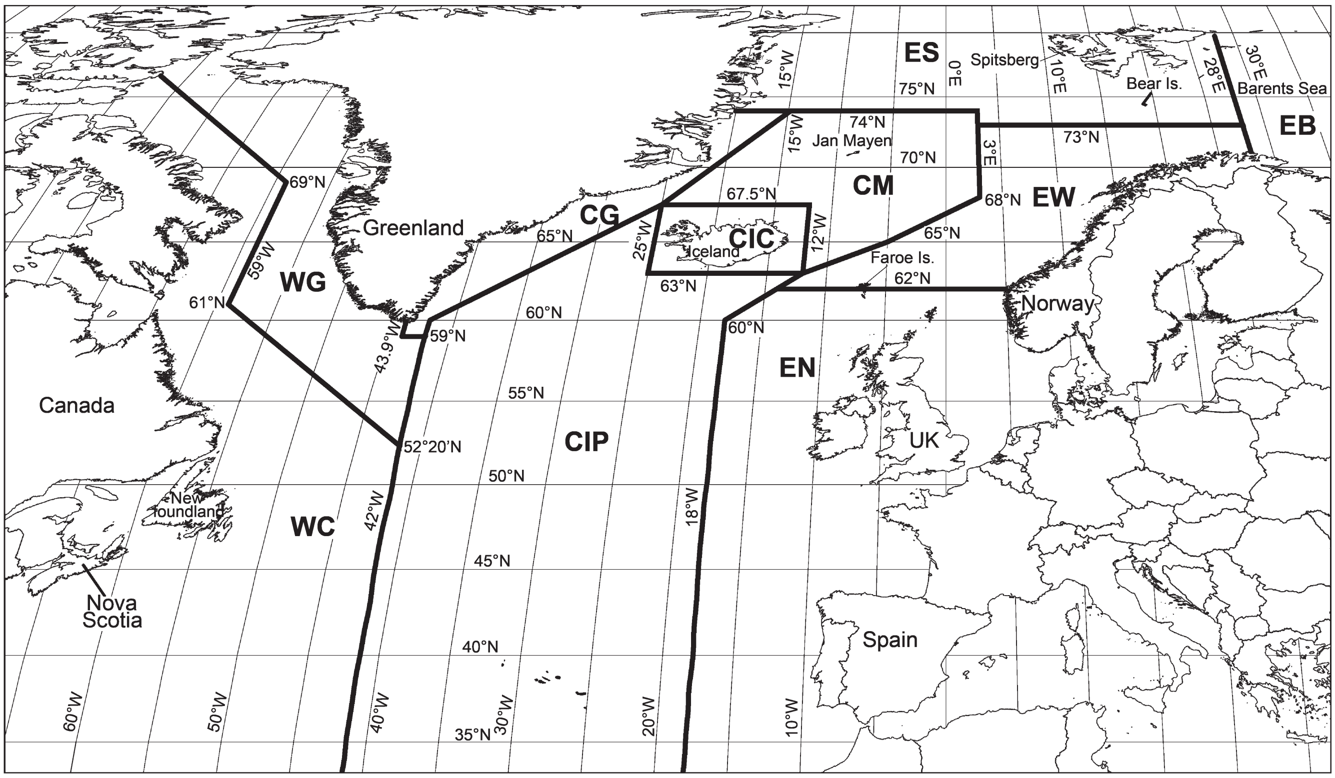


Fig. 1. The specifications for the *Small Areas* for the North Atlantic minke whales.

The boundary between the EB and EW *Small Areas* was based on genetic differences about the 28°E line of longitude for a small number of animals. Walløe informed the sub-committee that Norwegian scientists had checked the data for these animals and that no errors had been found.

3.3.2 Abundance estimates

SC/62/RMP6 presented a method for estimating *g*(0) from single platform line transect data in which both the forward and perpendicular distances have been recorded. The method was applied to double platform northeastern Atlantic minke whale sightings surveys in which one of the platforms had been masked in different proportions of the time. It was found that the estimate of *g*(0) did not break down in the limit where data only from a single platform were used. The context of this study was that Norway is conducting ecosystem surveys with (single platform) whale observers onboard. These data are currently not used for abundance estimation in the context of the RMP. There are several difficulties that must be overcome for this to be done: *g*(0) estimation is one of them, but probably more important is the fact that the ecosystem surveys take place during another period of the year than the ordinary sighting surveys.

The sub-committee noted that attempts had been made in the past (Hiby and Thompson, 1985) to estimate *g*(0) using data from a single platform. It is clearly desirable to be able to estimate *g*(0) using the locations of the sightings from a single platform in two dimensions, and the sub-committee **encouraged** efforts to develop methods to achieve this. However, the sub-committee was concerned that the estimates of *g*(0) would not be robust to model structure uncertainty, measurement error and diving pattern. The sub-committee **recommended** that the robustness of the method proposed in SC/62/RMP6 to these factors be examined.

SC/62/RMP7 summarised a sighting survey conducted in the North Sea area within *Small Area EN* during summer 2009. This was the second year in the six-year survey programme 2008–13 for minke whales in the northeast Atlantic. One vessel covered the area during the period 21 June to 31 July: in the periods 25 June to 12 July and 22 to 31 July as dedicated whale surveys and in the intervening period as a herring survey with whale counting as an opportunistic activity. The total survey area was divided into three ordinary blocks and one herring survey block which was contained within parts of two of the ordinary survey blocks. The survey procedures and sighting protocol as used in previous surveys were followed both in the dedicated and opportunistic parts of the survey and a double platform configuration was used exclusively. The vessel was able to survey about 1,500 n.miles with primary search effort during the dedicated parts and 700 n.miles during the herring survey. The most frequently observed species was the minke whale, of which 29 groups were observed from the primary platform during the dedicated parts and 11 groups during the herring survey. The North Sea area was last surveyed in the Norwegian survey programme in 2004. The most striking feature when comparing the 2009 survey with the 2004 survey is the nearly complete absence of harbour porpoise observations during 2009. Also, very few sightings of *Lagenorhynchus* species were made in 2009.

The sub-committee welcomed this information and noted that these data would be included in a future abundance estimate for the North Atlantic minke whales.

SC/62/RMP5 presented estimates of abundance for minke whales in the Central Atlantic from the North Atlantic Sightings Survey conducted by Icelandic and Faroese vessels during June/July 2007. Stratified line transect methods were used and the half-normal model provided the best fit to the data. No covariates improved the fit. Attempts to estimate *g*(0) using these data based on only five duplicate sightings (Paxton *et al.*, 2009) were not accepted by the Committee in 2009 and estimation of *g*(0) was not attempted in

SC/62/RMP5. The estimate using all sightings identified as minke whales and the original strata was 11,193 (CV 0.33; 95% CI 5,007 to 18,815) and is most comparable to earlier estimates from these surveys, but the poor coverage realised in the western part of the area near the East Greenland ice edge, that had high density in the earlier surveys, probably means that this estimate is substantially negatively biased compared with the earlier estimates for this area. All of these estimates should be considered to be substantially negatively biased due to uncorrected perception and availability biases.

The sub-committee **agreed** that the methods in SC/62/RMP5 followed the Guidelines for how survey results should be analysed if the estimates are to be used for the RMP. Table 1 lists the estimates of abundance for the CG and CIP *Small Area* obtained using the estimates by survey block in SC/62/RMP5. The sub-committee **agreed** to adopt the estimates of abundance for 2007 presented in Table 1 for use in the RMP.

Table 1

Abundance estimates for minke whales in the CG and CIP *Small Areas*. The survey block estimates were split on *Small Areas* in relation to the number of sightings and area overlap but inverse to effort. Similarly, the variance was split (SC/62/RMP1, Appendix 2).

Small Area	Estimate	CV
CG	1,048	0.60
CIP	1,350	0.38

The sub-committee noted that estimates for the component of the CG *Small Area* which was not covered during 2007, but was covered during previous surveys of the Central *Medium Area*, could be obtained using, for example, GLM models. The sub-committee noted that any estimates obtained using models would need further review before being adopted for use in the RMP.

Appendix 7 summarises how the Norwegian survey data for the northeast Atlantic were allocated to the *Small Areas* agreed during the 2003 *Implementation Review*. The proration method used resulted in differences from two estimates approved previously: that for 1989 E *Medium Area* and the 1989 CM *Small Area*. The argument for keeping the earlier approved estimates of respectively 64,730 and 2,650 animals (Schweder *et al.*, 1997) was that the intended coverage for the 1989 block causing the problem was within the area boundary of the northeastern stock of minke whales which corresponds exactly to the E *Medium Area* in the RMP *Implementation*. The sub-committee **endorsed** these abundance estimates for use in the RMP (see Table 2).

3.3.3 Recommendations and work plan

The sub-committee **recommended** that the boundaries in Fig. 1 be adopted for use when applying the RMP for the North Atlantic minke whales. It also **recommended** that abundance estimates in Tables 1 and 2 be adopted for use in the RMP.

The sub-committee **agreed** that its work plan for the 2011 Annual Meeting would be as follows:

(1) Review any new abundance estimates.

4. CONSIDERATION OF REQUESTS FOR ADVICE FROM THE COMMISSION

4.1 Review of Annex {SI} to IWC/62/7rev – scientific information requirements

The sub-committee **recommended** that the reference to bulla be removed from point 2(b) because the Committee has agreed that bullae do not provide a reliable means for estimating age (Olsen and Øien, 2002). The sub-committee also noted that earplugs do not provide reliable age estimates for North Atlantic minke whales. Walløe and Víkingsson noted that lengths could not always be recorded for minke whales in the North Atlantic in the manner specified, although estimates of length are reported to the Secretariat. The sub-committee **recommended** that the following footnote be added to point (a): '*Onboard small coastal whaling vessels such as those participating in Norwegian and Icelandic operations, it may be difficult to obtain accurate length measurements because whales are handled on a limited space. It is recognised that measurements in these cases may not be as accurate as those taken in ideal situations.*'

4.2 Review of Annex {OI} to IWC/62/7rev – operational information requirements

The sub-committee **endorsed** the operational information requirements in Annex {OI} of IWC/62/7rev.

4.3 Review of proposed timetable for future *Implementations and Implementation Reviews* (IWC/62/7rev, Appendix B)

At the outset, the sub-committee **agreed** with the Scientific Assessment Group (SAG) that the schedule in Section 5 of IWC/62/7rev is ambitious. It noted that *Implementations* and *Implementation Reviews* can (and do) involve considerable time and resources from national scientists and, especially in cases when *Implementation Simulation Trials* are required, the Secretariat. Moreover, delays can occur when conducting *Implementations* given that the same members of the Committee are involved in many of the *Implementations* and *Implementation Reviews*. The Committee has previously

Table 2

Estimates of abundance for CM *Small Area* and for the eastern *Medium Area* by *Small Areas*.

Survey period	Mid-year	EB Year	EB N	EB SD	EN Year	EN N	EN SD	ES Year	ES N	ES SD	EW Year	EW N	EW SD	E total Year	E total N	E total CV	CM Year	CM N	CM SD
1988–89	1989	1989	21,868	4,503	1989	8,318	2,113	1989	13,070	1,699	1989	20,991	3,552	1989	64,730[1]	0.192	1988	2,650[1]	1,283
1995	1995	1995	29,712	5,378	1995	22,536	5,263	1995	24,891	2,389	1995	34,986	4,033	1995	112,125	0.104	1995	6,174	2,203
1996–2001	1999	2000	25,885	6,219	1998	13,673	3,482	1999	17,406	2,454	1996	23,522	3,013	1999	80,487	0.15	1997	26,718	3,973
2002–07	2005	2007	28,625	6,709	2004	6,246	2,912	2003	19,377	5,335	2002, 2006	27,152	5,917	2005	81,401	0.23	2005	26,739	10,428

[1]These estimates are taken from Schweder *et al.* (1997) and are different from the results from direct application of area proration. The differences are caused by a very small part of the 1989 survey block (SN) falling within the CM *Small Area* in the area projection used here.

agreed that it can only conduct one *Implementation* at a time. The schedules for Western North Pacific Bryde's whales, and for North Atlantic common and fin whales, match the schedules expected from the *Implementations* for these species. The Committee has previously been able to complete an *Implementation Review* during a single meeting, provided that no *Implementation Simulation Trials* are required.

The sub-committee cannot conduct *Implementations* for the Western North Pacific sei and Antarctic minke whales at the same time. The SAG considered it more important to conduct an *Implementation* for the Western North Pacific sei whales first given the size of current catches and the estimates of abundance for this stock. However, the sub-committee noted that there are also reasons to conduct an *Implementation* for Antarctic minke whales starting in 2012. The issue of the relative merits of when to conduct these two *Implementations* will be discussed in Plenary, taking into account discussions in Annex G. The recommended order will thus be decided upon by the full Committee.

In relation to the Table, the sub-committee **recommended** that two years should be allowed for the *pre-Implementation assessment* for Antarctic minke whales irrespective of when the *Implementation* for these whales starts (under the current schedule, the first year of the *pre-Implementation assessment* would be 2014). It was also recognised that the current *Implementation* for these whales is sufficiently dated (1993) that it is unreasonable to expect that this 1993 *Implementation* can simply be reviewed after almost 20 years of developments in how to *Implement* the RMP. It therefore **recommended** that '/IR' be deleted from the box for 2015 for Antarctic minke whales.

4.4 Review of the Scientific Assessment Report

4.4.1 General issues

4.4.1.1 CATCH LIMIT CALCULATIONS (ACTIVATION, YEARS, INPUTS AND OUTPUTS)

As part of the SAG process, the RMP was applied to three species-Region combinations (western North Pacific Bryde's whales, North Atlantic minke whales, and North Atlantic fin whales). The calculations reported are therefore the results of applying the RMP, although results are also shown for tunings other than the Commission-agreed 0.72 tuning (the 0.6 tuning). When applying the *CLA*, the phase-out rule was applied for each *Small Area* after the catch limit was cascaded to the *Small Areas* from the *Medium Area* rather than applying the phase-out rule before cascading the *Medium Area* catch limit to the *Small Areas*.

4.4.1.2 TUNING LEVELS

The SAG report (and Appendix 8) provides results for the 0.72 and 0.6 tunings of the RMP because the whaling countries in the Commission's support group had requested the latter tunings. This issue is discussed more fully in the SAG report (IWC, 2010b). The sub-committee noted that although the 0.6, 0.66 and 0.72 tunings of the *CLA* were recommended to the Commission by the Committee, having been subjected to testing during the development of the RMP, the *Implementation Simulation Trials* have only been conducted by the Committee for the 0.72 tuning of the RMP. Norwegian scientists have run the *Implementation Simulation Trials* for minke whales in the northeast Atlantic for the 0.6 tuning of the RMP, but these calculations were not undertaken nor reviewed in detail by the Committee. It is also known that which RMP variants are 'acceptable' may change if the tuning level is changed.

The sub-committee **agreed** that the tuning level which was used when calculating catch limits using the *CLA* should be that which is tested in *Implementation Simulation Trials*; in this case only the 0.72 tuning. In principle, the *Implementation Simulation Trials* could be repeated for a new tuning if requested by the Commission. However, the criterion used to evaluate whether performance of an RMP variant is 'acceptable', 'borderline' or 'unacceptable' is linked to the 0.6 and 0.72 tunings of the RMP. The present criterion may need to be investigated if the Commission requested that a different tuning of the RMP should be considered.

4.4.2 Application of Stocks/Regions

The sub-committee requested that the Secretariat provide the specifications of how the RMP was applied during the SAG meeting to western North Pacific Bryde's whales, North Atlantic minke whales, and North Atlantic fin whales. The sub-committee reviewed the specifications. It **recommended** changes to the format (see Appendix 8 for the final format) to make the calculations clearer and to emphasise the results calculated using the Commission-agreed 0.72 tuning. The following sections summarise the modifications to the initial applications by the Secretariat by the sub-committee in reaching its **agreed** applications. Table 3 lists the resulting catch limits from the 0.72 and 0.6 tunings of the *CLA*.

4.4.2.1 WESTERN NORTH PACIFIC BRYDE'S WHALES

The application of the RMP to Western North Pacific Bryde's whales was based on a single abundance estimate

Table 3

Summary of the application of the RMP (full details of the inputs to the RMP as well as relevant intermediate calculations are given in Appendix 8). Phaseout has been applied where applicable.

Year	WNP Bryde's whales	N Atlantic fin whales		N Atlantic minke whales					
Sub-area	1W+1E	WI (variant 6)	WI (variant 2)	CIC	CM	ES	EB	EW	EN
(a) Catches limits based on the 72% tuning (Commission's agreed value)									
2010	5	46	87	224	135	58	92	152	70
2011	3	46	87	224	135	58	92	152	70
2012	1	46	87	224	135	46	92	152	70
2013	0	46	87	224	135	35	92	152	56
2014	0	46	87	224	108	14	92	152	42
(b) Catches limits based on the 60% tuning									
2010	33	90	155	345	208	122	195	322	148
2011	19	90	155	345	208	122	195	322	148
2012	4	90	155	345	208	97	195	322	148
2013	0	90	155	345	208	73	195	322	118
2014	0	90	155	345	166	29	195	322	89

for the *Region* (time-stamped at 2000). The sub-committee requested that the time-stamps for the *Small Areas* when applying catch cascading be set to the effort-weighted years. It was noted that survey data were available for 1988–96 and that these data were used when computing the additional variance for the 1998–2002 surveys (Shimada *et al.*, 2008). An abundance estimate can be computed for 1988–96, but the Committee has only accepted the estimate from the 1998–2002 surveys (IWC, 2009). The earlier surveys were not conducted under the new Guidelines for Conducting Surveys under the RMP (IWC, 2005b), although they did follow the protocols used during the IDCR surveys. Although abundance estimates could be computed for using the 1988–96 data, account would need to be taken of the correlation of these estimates with those for 1998–2002 if they were included in RMP calculations of catch limits. However, the presently-coded version of the RMP does not allow input of a variance-covariance matrix for the abundance estimates. The sub-committee therefore **recommended** that the program for the *CLA* be modified to allow variance-covariance matrices to be input (see Item 2.4). It also **recommended** that the data and resulting abundance estimates from the 1994–96 surveys should be reviewed for possible use in the RMP during the next *Implementation Review*. The final specifications for how the RMP was applied to these whales are listed in Appendix 8A.

4.4.2.2 NORTH ATLANTIC COMMON MINKE WHALES

The sub-committee **recommended** the following changes to the abundance estimates for minke whales in the Central North Atlantic.

(1) Use the estimates in Table 1 to construct an abundance estimate for *Small Areas* CG+CIP and include this abundance estimate in that for the C *Medium Area* for 2006.
(2) Use the estimate for the CM *Small Area* in 2005 of 12,043 (CV 0.28) in place of the estimate of 6,174 (CV 0.36) because the former estimate is based on surveys which covered more of the CM *Small Area*.
(3) Use the revised version of the estimate of abundance for 2005 of 26,739 (CV 0.39) in place of the estimate of 24,890 (CV 0.45).

Allison reported that she had recalculated the CVs for the abundance estimates for the C *Medium Area*.

The sub-committee **recommended** that the catch limits for the minke whales in the eastern North Atlantic be based on sex ratios for 2005–09 rather than 2004–08, reflecting the data for the most recent five years.

The final specifications for how the RMP was applied to these whales are listed in Appendix 8B.

4.4.2.3 NORTH ATLANTIC FIN WHALES

The sub-committee had no changes to the application of the RMP by the Secretariat. The specifications for how the RMP was applied to these whales are listed in Appendix 8C.

5. WORK PLAN

(1) RMP – general matters

(1) Brandon, Cooke, Kitakado and Punt to finalise the analyses of the calving rate and calving interval data (see Appendix 9).
(2) Conduct analyses to examine variability in survival rates and the correlation between survival and reproductive rates.
(3) Complete the compilation of the number of haplotypes and other demographic parameters for whale populations.
(4) Complete the review of the range of MSYR values for use in the RMP.
(5) Finalise the approach for evaluating proposed amendments to the *CLA*.
(6) Evaluate the Norwegian proposal for amending the *CLA*.
(7) Consider the implications that the phase-out rule in the RMP is applied by *Small Area* when catch cascading is applied and the abundance estimates are based on multi-year surveys.
(8) The full set of revised results for North Atlantic fin whales, Western North Pacific Bryde's whales, and North Atlantic minke whales run using the Norwegian 'CatchLimit' program should be conducted and placed on the IWC website.
(9) The Secretariat to modify the Norwegian 'CatchLimit' program to allow variance-covariance matrices to be specified for the abundance estimates. The results from the modified program should be compared with those from the 'accurate' version of the Cooke program for some cases.

Task (1) has funding implications. The sub-committee **endorsed** the funding request as in Appendix 9.

(2) *Implementation* for the western North Pacific Bryde's whales

(1) Review the research proposal for the 'variant with research' to be submitted to the 2011 meeting.

(3) *Implementation* for the North Atlantic fin whales

(1) Review a revised research proposal for the 'variant with research' to be submitted to the 2011 meeting.
(2) Review the abundance estimates for use in the *CLA*.

(4) *Implementation* for the North Atlantic minke whales

(1) Review any new abundance estimates.

6. ADOPTION OF REPORT

The report was adopted at 14:56 on 7 June 2010. The sub-committee thanked Bannister (and Hammond) for their excellent chairmanship, the rapporteur for his work, and Allison for conducting the applications of the RMP with her normal considerable care. The sub-committee wished Bannister a rapid recovery.

REFERENCES

Aldrin, M. and Huseby, R.B. 2007. Simulation trials 2007 for a re-tuned *Catch Limit Algorithm*. Paper SC/59/RMP4 presented to the IWC Scientific Committee, May 2007, Anchorage, USA (unpublished). 143pp. [Paper available from the Office of this Journal].
Cooke, J.G. 2007. The influence of environmental variability on baleen whale sustainable yield curves. Paper SC/N07/MSYR1 presented to the MSYR Workshop, Seattle, USA, 16–19 November 2007 (unpublished). 19pp. [Paper available from the Office of this Journal].
Hiby, A.R. and Thompson, D. 1985. An analysis of sightings data from the 1983/84 IDCR minke whale assessment cruise: estimating the hazard rate and the effective strip width. *Rep. int. Whal. Commn* 35: 315–18.
International Whaling Commission. 1999. Report of the Scientific Committee. Annex N. The Revised Management Procedure (RMP) for Baleen Whales. *J. Cetacean Res. Manage. (Suppl.)* 1:251–58.
International Whaling Commission. 2001a. Chairman's Report of the 52nd Annual Meeting. *Ann. Rep. Int. Whaling Comm.* 2000:11–63.
International Whaling Commission. 2001b. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 3:1–76.
International Whaling Commission. 2005a. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised

Management Procedure. Appendix 2. Requirements and Guidelines for *Implementation*. *J. Cetacean Res. Manage. (Suppl.)* 7:84–92.
International Whaling Commission. 2005b. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised Management Procedure. Appendix 3. Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme. *J. Cetacean Res. Manage. (Suppl.)* 7:92–101.
International Whaling Commission. 2008. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 10:90–120.
International Whaling Commission. 2009. 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. 2010a. Report of the Intersessional Workshop on MSYR for Baleen Whales, 6–8 February 2009, Seattle. *J. Cetacean Res. Manage. (Suppl.)* 11(2):493–508.
International Whaling Commission. 2010b. Report of the Scientific Assessment Group, Honolulu, Hawaii, 23–25 January 2010. Paper IWC/M10/SWG6 presented to the SWG on the Future of the International Whaling Commission, 2–4 March 2010, St Pete Beach, Florida, USA (unpublished). 14pp. [Paper available from the Office of this Journal].
International Whaling Commission. 2010c. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised Management Procedure (RMP). *J. Cetacean Res. Manage (Suppl.)* 11(2):114–34.
International Whaling Commission. 2010d. Report of the Scientific Committee. Annex P. Work Plan for Completion of the MSYR Review. *J. Cetacean Res. Manage (Suppl.)* 11(2):399–400.
Olsen, E. and Øien, N. 2002. A comparison of age determination methods when applied to North Atlantic minke whales. Paper SC/54/RMP7 presented to the IWC Scientific Committee, April 2002, Shimonoseki, Japan (unpublished). 17pp. [Paper available from the Office of this Journal].
Pastene, L.A., Kitakado, T. and Hatanaka, H. 2008. Research proposal accompanying management variant 2 of the RMP *Implementation* for western North Pacific Bryde's whale. Paper SC/60/PFI9 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 10pp. [Paper available from the Office of this Journal].
Paxton, C.G.M., Gunnlaugsson, T. and Mikkelsen, B. 2009. Mark-recapture distance sampling estimate of minke whales from the Icelandic, Faroese and Russian components of T-NASS. Paper SC/61/RMP12 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 16pp. [Paper available from the Office of this Journal].
Punt, A.E. 2010. A revised Bayesian meta-analysis for estimating a posterior distribution for the rate of increase for an 'unknown' stock. Paper SC/A10/MSYR2 presented to the IWC Scientific Committee Maximum Sustainable Yield Rate (MSYR) review Workshop, April 2010, Seattle, USA (unpublished). 9pp. [Paper available from the Office of this Journal].
Schweder, T., Skaug, H.J., Dimakos, X.K., Langaas, M. and Øien, N. 1997. Abundance of northeastern Atlantic minke whales, estimates for 1989 and 1995. *Rep. int. Whal. Commn* 47: 453–84.
Shimada, H., Okamura, H., Kitakado, T. and Miyashita, T. 2008. Abundance estimate of western North Pacific Bryde's whales for the estimation of additional variance and *CLA* application. Paper SC/60/PFI2 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 34pp. [Paper available from the Office of this Journal].

Appendix 1

AGENDA

1. Introductory items
    - 1.1 Convenor's opening remarks
    - 1.2 Election of Chair, appointment of rapporteurs
    - 1.3 Adoption of agenda
    - 1.4 Available documents
2. Revised Management Procedure (RMP) – general issues
    - 2.1 Review MSY rates
        - 2.1.1 Report of intersessional workshop
        - 2.1.2 Issues arising
        - 2.1.3 Conclusions and recommendations
    - 2.2 Finalise the approach for evaluating proposed amendments to the *CLA*
        - 2.2.1 Norwegian proposal
    - 2.3 Version of *CLA* to be used in trials
    - 2.4 Modifications to RMP and its annotations
    - 2.5 Work plan
3. RMP – specific implementations
    - 3.1 Western North Pacific Bryde's whales
        - 3.1.1 Survey data validation
        - 3.1.2 Research proposal for the 'variant with research'
        - 3.1.3 Recommendations and work plan
    - 3.2 North Atlantic fin whales
        - 3.2.1 Review estimates for use in the *CLA*
        - 3.2.2 Research proposal for the 'variant with research'
        - 3.2.3 Work plan
    - 3.3 North Atlantic minke whales
        - 3.3.1 Stock boundaries
        - 3.3.2 Abundance estimates
        - 3.3.3 Recommendations and work plan
4. Consideration of requests for advice from the Commission
    - 4.1 Review of Annex {SI} to IWC/62/7rev – scientific information requirements
    - 4.2 Review of Annex {OI} to IWC/62/7rev – operational information requirements
    - 4.3 Review of proposed timetable for future *Implementations* and *Implementation Reviews* (IWC/62/7rev Appendix B)
    - 4.4 Review of the Scientific Assessment Report
        - 4.4.1 General issues
            - 4.4.1.1 Catch limit calculations (activation, years, inputs and outputs)
            - 4.4.1.2 Tuning levels
        - 4.4.2 Application of Stocks/Regions
            - 4.4.2.1 Western North Pacific Bryde's whales
            - 4.4.2.2 North Atlantic common minke whales
            - 4.4.2.3 North Atlantic fin whales
5. Work plan
6. Adoption of Report

Appendix 2

STEPS TO MOVE FORWARD REGARDING ESTIMATING VARIABILITY IN REPRODUCTION RATES

J. Brandon, J. Cooke, T. Kitakado and A. Punt

One potential structure:

(1) If known (annual) standard deviations are available, treat the data[1] as normally distributed, i.e.:

$$I_{i,y} \sim N(\mu_{i,y},\sigma^2_{i,y})$$

where $I_{i,y}$ is the observed datum for stock i and year y, $\sigma_{i,y}$ is the (known) standard deviation for $I_{i,y}$.

(2) Model the process according to an AR1 formulation:

$$\mu_{i,y} \sim N(\rho_i\mu_{i,y-1}, \tilde{\sigma}^2_i)$$

where ρ_i is the extent of temporal auto-correlation in reproductive rate, and $\tilde{\sigma}^2_i$ is the variability in reproductive rate.

(3) Assume the following priors: $\mu_{i,1}$ (uninformative) normal for each i, arctan(ρ_i) normally distributed from a normal hyper-prior, and $\ell n\tilde{\sigma}_i$ normally distributed from a normal hyper-prior.

(4) Impose uninformative priors on the hyper-parameters of the hyper-priors.

The above model is a multivariable AR model (a simple example of a VAR model?). Example code exists to implement WinBUGS models for AR(1) models.

The aim of the analyses during the intersessional period should be to:

- Fit the above model to: (a) the real data; and (b) some simulated data sets.
- Represent the results from the model in the form of inputs to the age-structured model of Annex D of SC/62/Rep2 and use this model to compute the standard deviation and temporal auto-correlation in the annual rate of increase.
- Identify the values for the environmental model of Cooke (2007) which match the outputs from the age-structured model.
- Investigate improvements in modelling approaches for proportion data for which the sampling error variances are not known.

[1]Some of the proportion data are zeros and will need to be transformed (e.g. using the arctan function) prior to modelling.

Appendix 3

A NOTE ON THE EXPECTED RELATIONSHIP BETWEEN VARIABILITY IN REPRODUCTIVE RATE AND VARIATION IN NET RECRUITMENT RATE BASED ON LIFE HISTORY TRADE-OFF MODELS

Justin G. Cooke

Introduction

The recent Workshop on the review of MSYR for baleen whales (SC/62/Rep2) examined a number of time series of different demographic parameters (mainly calving rates and/or calving intervals) from baleen whale populations (table 1 in SC/62/Rep2) with a view to estimating typical levels of variability in baleen whale net recruitment rates. An issue arising from the Workshop is the estimation of variance in net recruitment rate for the common case where an estimate of variance is known only for one or some of the life history parameters (typically calving rate) but not for others (typically survival). The assumption that all parameters remain constant, except those for which the variance has been estimated, may result in underestimation of the variability in net recruitment rate, unless the variation in the different life history parameters is mutually compensatory.

There is a substantial body of literature on both empirical and theoretical results relating to trade-offs in life history parameters and especially trade-offs in energy investment between reproduction and survival (see, e.g. the review by Perrin and Sibly, 1993). These approaches might provide some insight into how reproductive and survival rates may be expected to co-vary. In this appendix a simple example of such a model is used to generate predictions of what co-variation might be expected between reproductive and survival rates in baleen whale populations. This could be used as a first-order approach for estimation of inferred variation in net recruitment rate from the observed variation in one or more demographic parameters.

Methods

For simplicity we consider species with a 1-year reproductive cycle such as minke whales. For species with multi-year breeding cycles, issues of energy storage over the cycle may need to be taken into account explicitly.

Suppose that in each year there is a ration y of energy available to the individual of which an amount x (where $0 \leq x < y$) can be invested in reproduction. For female adults, the survival rate of the calf depends on the invested energy x, and the survival rate of the mother depends on the remaining energy y–x. The total energy ration y is assumed given by environmental factors, but the part of this invested in reproduction can be optimised by the individual.

The factors of interest are S, the adult survival probability, and R, the effective reproductive rate. R is expressed in terms of the probability of raising a female calf that survives to maturity, so that the expected net recruitment rate is $S + R - 1$.

One would expect the relationship between available energy and survival to be roughly of the shape of the curves shown in Fig. 1, with diminishing returns at higher energy levels, but with survival rates of adults and calves possibly declining rapidly when the available energy drops below critical levels.

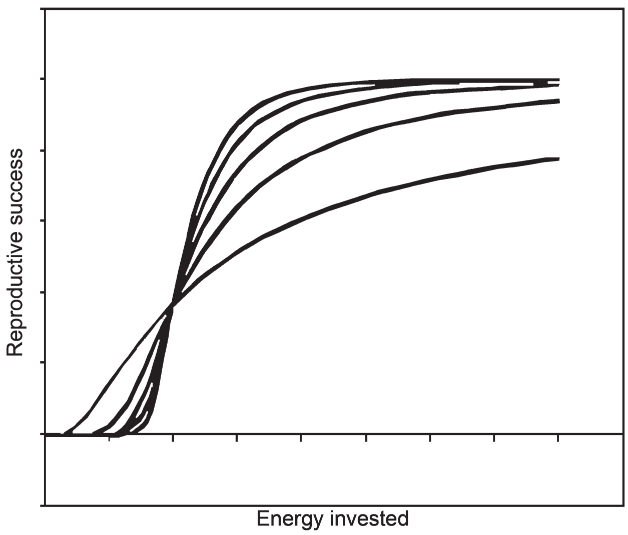


Fig. 1. Curves of potential relationships between effective reproductive success and energy invested in reproduction (analogous curves for the energy/survival relationship).

Curves of this shape can be modelled by:

$$S(x) = S_{\max} \exp\left(-\left(\frac{\alpha_S}{y-x}\right)^z\right) \qquad (1)$$

$$R(x) = R_{\max} \exp\left(-\left(\frac{\alpha_R}{x}\right)^z\right) \qquad (2)$$

where α_S and α_R are population-specific parameters and z is an exponent parameter introduced to allow flexibility in the shape of the relationships. The values $S_{\max}$ and $R_{\max}$ denote the maximum survival rates of adults and offspring in times of plenty.

If the individual 'chooses' x optimally then two outcomes are possible, depending on the total available energy y. For low values of y, the optimal choice is to set $x = 0$ and not to attempt reproduction ($R = 0$). For higher values of y, the optimal choice is at a local maximum that satisfies:

$$dR/dx + dS/dx = 0 \qquad (3)$$

The globally optimum value of x can be determined for given values of y and the parameters as follows:

(i) solve equation (3) for x in $0 < x < y$, if possible, to obtain a local maximum of $S + R$;
(ii) calculate S for $x = 0$ (implying $R = 0$); and
(iii) choose either the local maximum or $x = 0$ depending which yields the higher value of $S + R$.

Example results and discussion

Figs 2–4 show some example results for the parameter values: $S_{max} = 0.99$, $R_{max} = 0.1$, $\alpha_S = \alpha_R = 1$, $z = 2$. Fig. 2 shows the net recruitment rate as a function of available energy for (a) choice of x yielding a local maximum and (b) $x = 0$ (no reproduction). The optimum lies on curve (a) to the right of the crossover and on curve (b) to the left of the crossover. The crossover point is the critical energy level below which reproduction is not worthwhile.

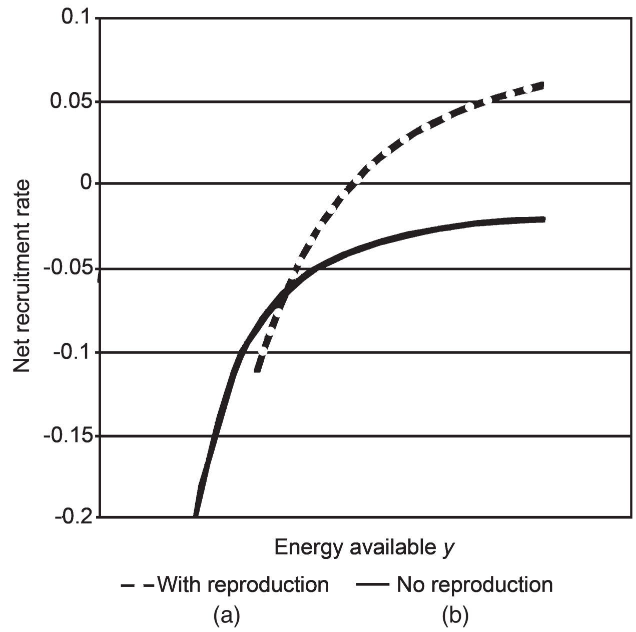


Fig. 2. Net recruitment as a function of available energy for: (a) choice of x yielding a local maximum; and (b) $x = 0$ (no reproduction). The optimum lies on curve (a) to the right of the crossover and on curve (b) to the left of the crossover.

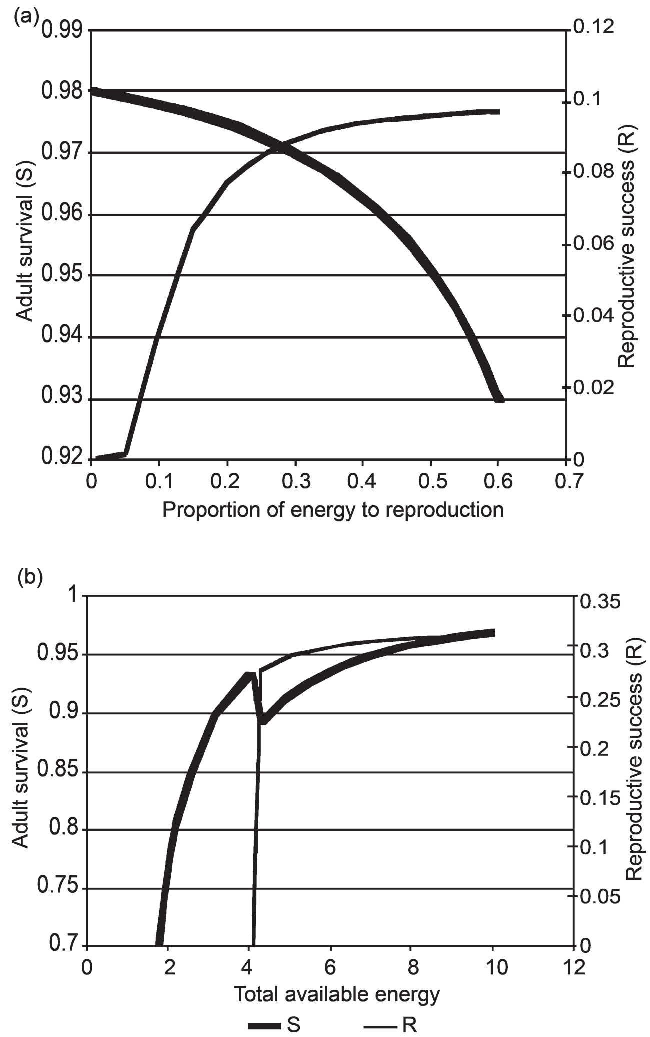


Fig. 3 (a) Survival and reproductive success as a function of proportion of available energy invested in reproduction for fixed total available energy. (b) Survival and reproductive success as a function of total available energy, assuming optimal allocation to reproduction.

Fig. 3a shows the relationship between S and R as a function of x for fixed y. The relationship between survival and reproduction is negative, because of the trade-off involved in investing energy into reproduction. Fig. 3b shows the relationship between S and R as a function of y, the total energy available, when x is chosen optimally. The correlation is positive, except for energy levels near the critical level where reproduction is abandoned. Environmentally driven variation in the available energy is thus predicted to generate positive covariance between survival and reproduction except over a limited range of energies.

Fig. 4 shows the fraction x/y of available energy invested in reproduction for the globally optimal choice of x as a function of y, along with the values of S and R (where S has been expressed in terms of $M = 1 - S$ to make it more comparable with R). Fig. 4 shows that the optimal proportion of energy invested in reproduction remains fairly constant above the critical energy level at which reproduction is abandoned, except when very close to the critical level.

Fig. 4 also shows that the adult survival rate S declines (M increases) substantially with decreasing energy levels even well above the critical level. The absolute variation in S (or M) over energy levels above the critical level is similar in magnitude to the absolute variation in R. For the net recruitment rate, $R - M$, the absolute (not relative) variation in S and R is decisive. If only the variation in R were measured, then the assumption that S is constant would in this model lead to substantial underestimation of the variability in the net recruitment rate.

If exploration of a wider range of models and parameter values confirms this finding, then it will be necessary to take account of potential variation in survival, even in cases where it is hard to measure empirically. Where data are lacking, the assumption that variation in adult survival rates and reproduction are equally important may be a preferable null hypothesis to the assumption that adult survival rates do not vary.

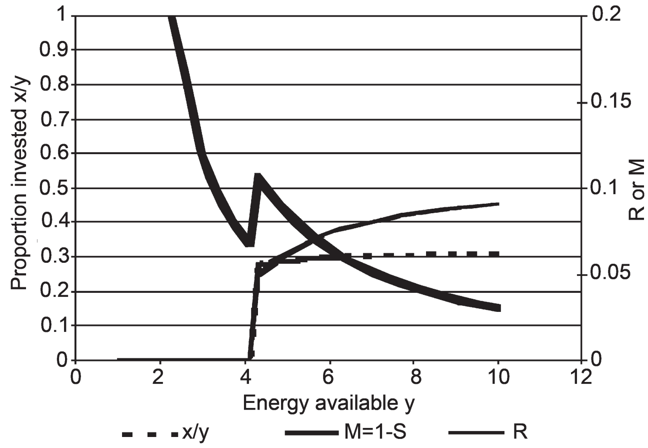


Fig. 4. Reproductive success (R), mortality (M = 1 – S) and proportion (x/y) of energy invested in reproduction as a function of total energy available (y).

REFERENCE

Perrin, N. and Sibley, R.M. 1993. Dynamic models of energy allocation and investment. *Annual Rev. Ecol. Systematics* 24:379–410.

Appendix 4

GENETIC DIVERSITY, MIGRATION, AND POPULATION SIZE

Robin Waples

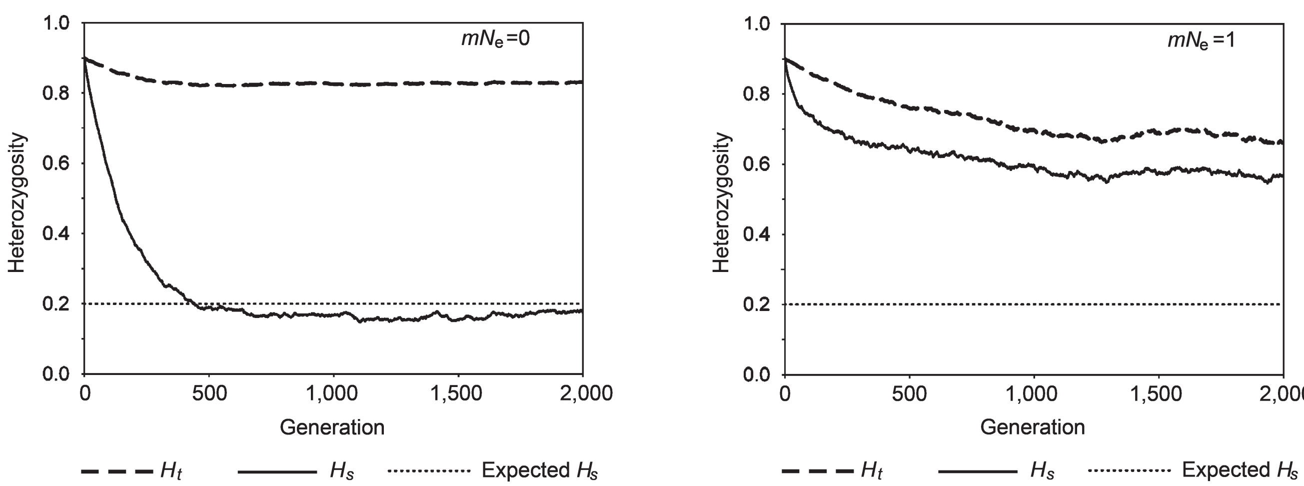


Fig. 1. Relationship between mean within-population expected heterozygosity (H_s) and expected heterozygosity for a metapopulation as a whole (H_t) as a function of level of gene flow (mN_e) and time since initialisation (Waples, 2010). Black dotted lines show expected value of H_s for a local subpopulation; solid and dashed lines show data for simulated Wright-Fisher populations (EasyPop; Balloux, 2001). Simulations used 4 subpopulations of 100 ideal individuals each in an island model; each of 20 neutral gene loci had a maximum of 10 allelic states and a mutation rate of 5×10^{-4}, and the first generation was initiated with the maximal diversity option.

REFERENCES

Balloux, F. 2010. Easypop (version 1.7): a computer program for population genetics simulations. *J. Heredity* 90: 301–302.

Waples, R.S. 2010. Spatial-temporal stratifications in natural populations and how they affect understanding and estimation of effective population size. *Molecular Ecology Resources* (doi: 10.1111/j.1755–0998.2010.02876.x; published online early May 2010).

Appendix 5

UPDATES TO THE RMP SPECIFICATIONS AND ANNOTATIONS

Background

The last full published version of the RMP was included in IWC (1999). Subsequently there have been a number of revisions to the annotations:

(1) IWC (2002, p.5): inserting of the correct percentile in paragraph 4.4 and annotation 31;
(2) Allison *et al.* (2002): addition of footnotes on additional variance when combining estimates from different years (21); time stamp (20a); phase-out (23a); unsurveyed areas (21a) and order of adjustments (26a); and
(3) IWC (2006); revision to RMP annotation 2 regarding *Small Areas*.

Additional text related to catches over time had been developed in an RMS context in IWC (2001, p.5), as follows:

Catch limits calculated under the Revised Management Procedure shall be adjusted downwards to account for human-induced mortalities due to sources other than commercial catches. Each such adjustment shall be based on an estimate provided by the Scientific Committee of the size of adjustment required to ensure that total removals over time from each population and area do not exceed the limits set by the Revised Management Procedure. Total removals include commercial catches and other human-induced mortalities, to the extent that these are known or can reasonably be estimated.

An amendment to limit the provision to specific types of human-induced mortality was proposed by the RMS working group and accepted by the Commission (IWC, 2000, pp.32–33):

Catch limits calculated under the Revised Management Procedure shall be adjusted downwards to account for human-induced mortalities due to sources other than commercial catches. Each such adjustment shall be based on an estimate provided by the Scientific Committee of the size of adjustment required to ensure that total removals over time from each population and area do not exceed the limits set by the Revised Management Procedure. Total removals include commercial catches and other human-induced mortalities **caused by indigenous subsistence whaling, whaling under Special Permit for scientific research, whaling outside the IWC, bycatches and ship strikes** to the extent that these are known or can be reasonably estimated.

Proposed new amendments

1. Human-induced mortalities

The sub-committee agreed that the Commission's amendment was best included in the RMP specification as a new paragraph 3.6 and that the following new annotation should be added to provide the Committee with operational guidelines for implementing this provision:

3.6. Adjustment for other sources of human-caused mortality

(26aa). For the purpose of this provision, 'known or can be reasonably estimated' shall be interpreted as follows:

(a) if the recorded mortalities of the specified types are considered by the Scientific Committee to be reasonably complete, the adjustment shall be based on these;
(b) if the recorded mortalities of a given type are considered to be incomplete, but an estimate is available that is acceptable to the Scientific Committee, the estimate shall be used; and
(c) if the recorded mortalities of a given type are considered to be incomplete, but there is insufficient information to make an acceptable estimate, the recorded mortalities shall be used as a fall-back, but the Committee shall note the problem in its report.

In the case of bycatch, ship strikes, and non-IWC whaling, the 'size of adjustment required to ensure that total removals over time from each population and area do not exceed the limits set by the Revised Management Procedure' should normally be calculated as follows, unless specific circumstances indicate otherwise: the catch limit for each *Year* of the *Catch Limit Calculation* shall be reduced by 20% of the total (over the most recent five-year period for which data or estimates are available) of the recorded or reasonably estimated mortalities for the *Management Area* to which the catch limit applies. The adjustment shall be calculated at the time of the *Catch Limit Calculation*.

In the case of Scientific Permit catches, the adjustment to the catch limit for each *Year* shall be based on the maximum proposed scientific take for the given *Management Area* in the given *Year* as specified in a research whaling proposal submitted to the Scientific Committee. The adjustment can be made whenever a research proposal is submitted, without performing a new *Catch Limit Calculation*. In the case of indigenous subsistence whaling regulated by the IWC, the adjustment to the catch limit for each *Year* shall be based on the maximum allowed strike permitted for that *Year*, or, in the case of a multi-year strike limit, on the average annual strike limit.

If the unadjusted catch limit for a *Management Area* is less than the adjustment, the resulting catch limit is zero. In the cases of uncertainty with respect to location, mortalities shall be allocated to *Management Areas* as specified in section 3.2.1. In cases where a carry-over provision under section 3.1 is operative, the carry-over is applied to the catch limits after the adjustment under section 3.6. For example, suppose that there is a catch limit of 850 in a given year, but a scientific catch of 350 whales is proposed: the commercial catch limit for the year is reduced to 500. If the commercial limit is fully taken, but only 200 whales are taken under the scientific permit, the shortfall of 150 whales will be carried over and added to the catch limit for the following year.

To the extent known, the sex ratio of the human-caused mortalities that are taken into account in section 3.6 should be taken into account in the calculation of the sex ratio of the recent total catch as specified in section 3.5.

Annotation 26b is amended to clarify that the adjustment under the new paragraph 3.6 is made after all other calculations and adjustments have been effected except for catch-capping (amendment in ***bold***).

(26b) The order in which catch limits are calculated is as follows:

(i) the *Catch Limit Algorithm* is applied to compute catch limits for *Small Areas* and/or *Medium/Large Areas* and *Combination Areas* as required, with the associated abundance estimates utilised having the time stamps specified in annotation 20a;
(ii) when *Catch-cascading* is involved the associated catch limit for a *Combination Area* is distributed amongst the constituent *Small Areas* (see annotation 9);
(iii) the *Phaseout Rule* (Section 3.4) is applied to catch limits for *Small Areas*;
(iv) the adjustment for recent sex ratios in the catch (see Section 3.5) is applied to catch limits for *Small Areas*;
(v) ***the adjustment for other sources of human-caused mortality (Section 3.6) is applied to the catch limits for each Management Area (Small, Medium, Large);***

(vi) *Catch-capping* limitations, if relevant, relate to *Small Area* limits as evaluated at stage (v).

Note:

~~(1) Any subtraction of incidental catches from the catch limits output from the RMP as above would take place at the end of this process at the *Small Area* level, and separately at the *Medium/Large Area* level if *Catch-capping* was applied. However, as this is an RMS rather than an RMP feature, no wording to cover this is proposed here.~~

(2) *Catch-capping* has effect only when the catch limit for a *Medium/Large Area* is less than the sum of the limits for the constituent *Areas*. The RMP does not specify how limits are then reduced in these *Areas* – that is left to the operators – though RMP trials assume pro rata reductions. Sections 3.4 and 3.5 of the RMP indicate that phaseout and sex ratio adjustments apply only to *Small Areas*, so that steps (iii) and (iv) above do not affect *Medium/Large Area* limits computed in step (i) if *Catch-capping* applies.

2. Period of catch limit calculations

This should be extended from five to six years for the reasons given in the sub-committee report. The recommended interval between *Implementation Reviews* should also be changed from five to six years. The references to the five-year period that are to be changed occur in section 3.1 of the specifications and in annotations 9, 11, 11A, 25 and 26. There is no need to change the period specified for calculating adjustments for sex ratios and other sources of mortality (the past five years for which data are available), but the adjustments will apply to the full set of six catch limits. Simulation trials conducted during the development of the *CLA* confirmed that the performance of the *CLA* is robust even if the catch limit is set for 10-year periods.

3. Rounding of catch limits

Section 4.5 (computation) is augmented to clarify that the rounding of each catch limit to the nearest integer should be performed after all other apportionments and adjustments have been effected (amendment in ***bold***).

4.5 Computation

All steps in the above algorithm for the calculation of the nominal catch limit shall be performed using a computer program validated by the IWC Secretariat and with sufficient numerical accuracy that the calculated nominal catch limit is numerically accurate to within one whale. ***Catch limits shall be rounded to the nearest integer number of whales after the apportionment of limits to Small Areas (when catch-cascading is applied) and after performing each of the adjustments specified in sections 3.4, 3.5 and 3.6.***

REFERENCES

Allison, C., Butterworth, D., Cooke, J. and Skaug, H. 2002. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 4. Modifications to the annotations to the RMP. *J. Cetacean Res. Manage. (Suppl.)* 4: 114–15.

International Whaling Commission. 1999. Report of the Scientific Committee. Annex N. The Revised Management Procedure (RMP) for Baleen Whales. *J. Cetacean Res. Manage. (Suppl.)* 1:251–58.

International Whaling Commission. 2000. Chairman's Report of the Fifty-First Annual Meeting. *Ann. Rep. Int. Whaling Comm.* 1999:7–50.

International Whaling Commission. 2001. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 3:1–76.

International Whaling Commission. 2002. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 4:1–78.

International Whaling Commission. 2006. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure (RMP). Appendix 2. Revision to RMP Annotation 2. *J. Cetacean Res. Manage. (Suppl.)* 8:84.

Appendix 6

ON THE PENDING ISSUES RELATED TO RESEARCH PROPOSAL ACCOMPANYING MANAGEMENT VARIANT 2 FOR WESTERN NORTH PACIFIC BRYDE'S WHALE

Luis A. Pastene, Naohisa Kanda, Tsutomu Tamura and Hiroshi Hatanaka

Institute of Cetacean Research

Introduction

Management variant 2 of the RMP *Implementation* for western North Pacific Bryde's whale had acceptable performance for all 'high' weight trials. However, the conservation performance was 'unacceptable' for the 'medium' weight trials BR13, BR15 and BR17. All these trials are related to the hypothesis of two sub-stocks in sub-area 1, which mix across to each other across the boundary of the 1W and 1E sub-areas (stock structure hypothesis 4, Fig. 1). This means that variant 2 could be implemented with a research program accepted by the IWC Scientific Committee ('variant with research option').

A research proposal written following the pro-forma agreed by the Scientific Committee in 2007 was presented to the Scientific Committee in 2008 (Pastene *et al.*, 2008). The ultimate objective of the research programme was to be able to provide information to the Committee so that it could modify (or confirm) its decisions regarding the appropriate plausibility level for the trials on which variant 2 performed 'unacceptably'.

The research proposal was discussed at the Scientific Committee meeting in 2008 and some comments and suggestions were provided. At the 2009 Scientific Committee meeting no discussion on this matter was conducted but the proponents informed that a revised research proposal would be presented once the analyses/pending issues are completed/elucidated.

The objective of this Appendix is to summarise the results of some analyses and the view of the proponents regarding the following pending issues: age composition data, power analyses of the genetic work and utility of the satellite tags for elucidating problems of stock structure.

Age composition data

Analyses of age distribution data indicated some differences in age distribution between whales in sub-areas 1W and 1E+2 (IWC, 2007). Explanations given for such differences were: (a) differences are real and reflect stock structure; (b) differences are real and reflect age-segregated distribution within a population; and (c) differences are related to age reading and/or sampling issues in the commercial data.

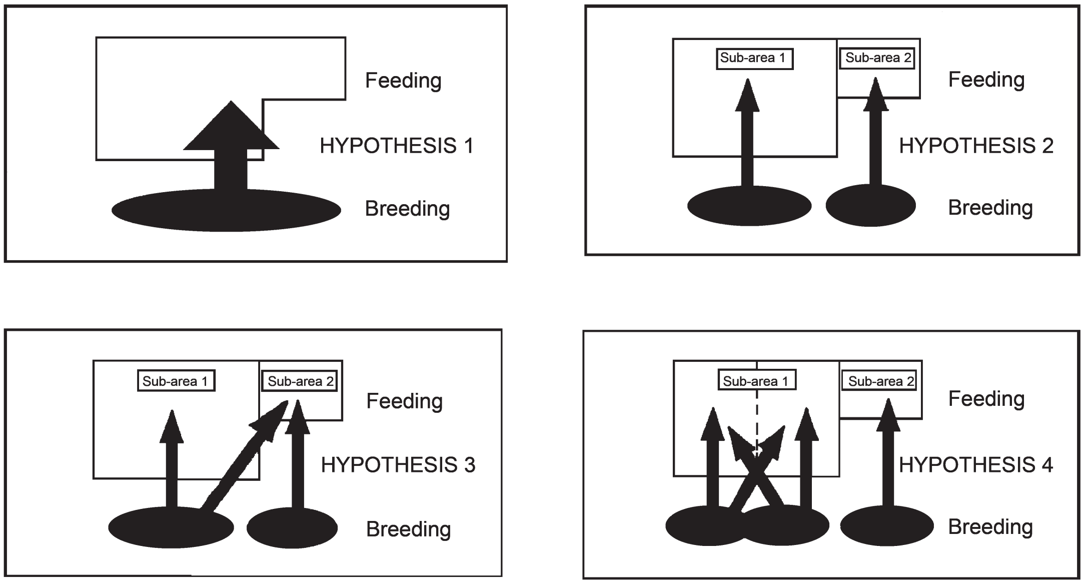


Fig. 1. Hypotheses on stock structure in the western North Pacific Bryde's whale.

Arguing that the old commercial data included some bias, and therefore re-reading of old earplugs might not resolve whether the differences in age composition between sub-areas 1W and 1E reflect sub-stocks or not, the research proposal was aimed to examine earplug data for future whaling operations in sub-areas 1W and 1E. In 2008 the Scientific Committee noted however, that it was not clear whether the effect would be as large today as during the period of commercial whaling. The Scientific Committee noted that this could be examined using the *IST*s based on the stock structure hypothesis 4 and it recommended that this work be done (IWC, 2009).

Analysis conducted

Just after completion of the 2009 Scientific Committee meeting Allison conducted some analyses related to this work. The rational for this analysis under stock structure hypothesis 4 is as follows. As most of the past catches were in sub-area 1W, differences in historical age data between sub-areas 1W and 1E could be ascribed to low mixing between these sub-areas. So if we look at two different trials (one that does have age sub-structure and the other which does not) and age composition data at two different times (one just after commercial whaling ended and the other in recent years), the extent of the effect in recent samples can be evaluated.

Table 1 looks at trials 9 which does have age sub-structure and 3 which does not, and age composition data for two years 1987 and 2006. Differences can be observed in the age composition of the population in 1987 depending on whether or not there is this substructure. For 2006 differences between trials 3 and 9 are virtually zero.

An explanation for this result is that the original difference evident in 1987 came from the different levels of exploitation on the two assumed sub-stocks at that time (if one accepts hypothesis 4). However by 2006, following a period of minimal catches, the total mortality has been the same (just the natural mortality) for a long time.

Results of this analysis suggest that the effect of age composition differences might not be detected using recent or future age samples.

However these results are not inconsistent with explanation (c) above that attributed the differences in age composition to age reading and/or sampling issues in the commercial data. Recent samples have been collected under a scientific research programme, which is less biased than samples obtained by commercial whaling operations in the past. Furthermore in recent years earplugs have been read by a single researcher. In other words the fact that no differences in age composition are found in recent years could just reflect the fact that reading and sampling bias have been resolved under scientific surveys.

We still consider that re-reading of old earplugs might not resolve whether the differences in age composition between sub-areas 1W and 1E reflect sub-stocks or not. Even if we re-read ages of old samples a considerable difference might be found because the body size limit regulation was different between coastal (10.7m) and pelagic (12.2m) whaling. Thus, re-reading might not help at all to resolve the matter. Therefore sub-structure in sub-area 1 should be better elucidated by using genetic analysis as the main analytical tool.

Power analysis of the genetic work

Some members of the Scientific Committee have argued that in absence of power analyses results it would be difficult to assess whether the genetic data, in themselves, would be sufficient to be able to show that stock structure hypothesis 4 was implausible. The Scientific Committee recommended that the results from previous (and any new) power analyses be presented and discussed at the SC meeting (IWC, 2009).

Review of previous work

Earlier work to estimate the power of the genetic analyses for the western North Pacific Bryde's whale was conducted by Kitakado *et al*. (2005) who evaluated power under an island model. Results of this work were presented to the Workshop on the *pre-Implementation assessment* of western North Pacific Bryde's whales (IWC, 2006). The Workshop agreed that the analyses presented had shown that for the sample sizes available, the power to detect genetic differences is high unless the value of F_{st} is very small. The Workshop offered several recommendations to improve this work.

More recently Kanda *et al*. (2009a) presented a power analysis for their hypothesis testing study on stock structure of the O stock common minke whale (based on microsatellite

Table 1

Results of the simulation study to investigate the effect of age composition difference through *IST*s.
The columns show the estimated proportion by age and sex of the population under various trials for 1987 and 2006.

	Br09	Br09	Br09	Br09	Br03	Br03	Br03	Br03	Difference between Br09 and Br03			
	m87	F87	M06	F06	m87	F87	M06	F06	m87	F87	M06	F06
1	0.0884	0.0827	0.0835	0.0824	0.0887	0.0828	0.0836	0.0825	-0.0003	-0.0001	-0.0001	-0.0001
2	0.0817	0.0764	0.0769	0.0759	0.0819	0.0765	0.0770	0.0760	-0.0003	-0.0001	-0.0001	-0.0001
3	0.0761	0.0712	0.0708	0.0699	0.0763	0.0713	0.0710	0.0700	-0.0003	-0.0001	-0.0001	-0.0001
4	0.0703	0.0658	0.0652	0.0644	0.0706	0.0659	0.0653	0.0645	-0.0003	-0.0001	-0.0001	-0.0001
5	0.0654	0.0612	0.0601	0.0594	0.0656	0.0613	0.0602	0.0594	-0.0003	-0.0001	-0.0001	-0.0001
6	0.0582	0.0559	0.0551	0.0544	0.0587	0.0561	0.0553	0.0545	-0.0005	-0.0002	-0.0001	-0.0001
7	0.0524	0.0519	0.0505	0.0497	0.0532	0.0522	0.0506	0.0498	-0.0008	-0.0003	-0.0001	-0.0001
8	0.0475	0.0487	0.0462	0.0454	0.0486	0.0493	0.0463	0.0455	-0.0011	-0.0006	-0.0001	-0.0001
9	0.0417	0.0449	0.0422	0.0414	0.0429	0.0455	0.0423	0.0416	-0.0013	-0.0006	-0.0001	-0.0001
10	0.0380	0.0413	0.0386	0.0378	0.0392	0.0420	0.0387	0.0379	-0.0013	-0.0007	-0.0001	-0.0001
11	0.0358	0.0389	0.0353	0.0346	0.0371	0.0398	0.0354	0.0347	-0.0013	-0.0009	-0.0001	-0.0001
12	0.0323	0.0353	0.0324	0.0318	0.0336	0.0363	0.0325	0.0318	-0.0013	-0.0010	-0.0001	-0.0001
13	0.0283	0.0314	0.0298	0.0292	0.0298	0.0325	0.0298	0.0292	-0.0014	-0.0012	-0.0001	-0.0001
14	0.0261	0.0290	0.0273	0.0268	0.0274	0.0301	0.0274	0.0268	-0.0013	-0.0011	0.0000	0.0000
15	0.0229	0.0254	0.0251	0.0245	0.0240	0.0264	0.0251	0.0246	-0.0011	-0.0010	0.0000	0.0000
16	0.0208	0.0228	0.0229	0.0225	0.0218	0.0238	0.0230	0.0225	-0.0010	-0.0010	0.0000	0.0000
17	0.0184	0.0201	0.0210	0.0206	0.0193	0.0210	0.0210	0.0205	-0.0008	-0.0008	0.0000	0.0000
18	0.0161	0.0173	0.0192	0.0188	0.0167	0.0180	0.0192	0.0188	-0.0006	-0.0007	0.0000	0.0000
19	0.0145	0.0152	0.0177	0.0173	0.0149	0.0157	0.0177	0.0173	-0.0004	-0.0005	0.0000	0.0000
20	0.0127	0.0135	0.0164	0.0160	0.0128	0.0138	0.0164	0.0160	-0.0001	-0.0003	0.0000	0.0000
21	0.0115	0.0120	0.0151	0.0148	0.0114	0.0121	0.0151	0.0148	0.0000	-0.0001	0.0000	0.0000
22	0.0104	0.0108	0.0141	0.0138	0.0102	0.0108	0.0141	0.0138	0.0001	0.0000	0.0000	0.0000
23	0.0096	0.0099	0.0130	0.0128	0.0094	0.0098	0.0130	0.0128	0.0002	0.0001	0.0000	0.0000
24	0.0089	0.0091	0.0115	0.0117	0.0086	0.0089	0.0115	0.0117	0.0003	0.0001	-0.0001	0.0000
25	0.0082	0.0083	0.0102	0.0107	0.0079	0.0080	0.0103	0.0108	0.0003	0.0002	-0.0001	0.0000
26	0.0076	0.0076	0.0092	0.0100	0.0072	0.0074	0.0094	0.0100	0.0004	0.0003	-0.0001	0.0000
27	0.0072	0.0072	0.0084	0.0094	0.0068	0.0069	0.0086	0.0094	0.0004	0.0003	-0.0002	-0.0001
28	0.0067	0.0067	0.0074	0.0086	0.0063	0.0064	0.0076	0.0087	0.0004	0.0003	-0.0002	-0.0001
29	0.0062	0.0062	0.0067	0.0079	0.0058	0.0059	0.0069	0.0080	0.0005	0.0003	-0.0002	-0.0001
30	0.0057	0.0055	0.0063	0.0075	0.0052	0.0053	0.0065	0.0076	0.0004	0.0003	-0.0002	-0.0001
31	0.0052	0.0051	0.0057	0.0068	0.0048	0.0048	0.0059	0.0070	0.0004	0.0003	-0.0002	-0.0002
32	0.0047	0.0046	0.0050	0.0060	0.0043	0.0043	0.0052	0.0062	0.0004	0.0003	-0.0002	-0.0002
33	0.0043	0.0042	0.0046	0.0056	0.0039	0.0039	0.0048	0.0058	0.0004	0.0003	-0.0002	-0.0002
34	0.0040	0.0039	0.0041	0.0049	0.0036	0.0036	0.0042	0.0051	0.0004	0.0003	-0.0002	-0.0002
35	0.0038	0.0036	0.0037	0.0044	0.0033	0.0033	0.0038	0.0046	0.0004	0.0003	-0.0001	-0.0002
36	0.0035	0.0034	0.0033	0.0039	0.0031	0.0031	0.0034	0.0040	0.0004	0.0003	-0.0001	-0.0001
37	0.0033	0.0032	0.0029	0.0034	0.0029	0.0029	0.0029	0.0034	0.0004	0.0003	-0.0001	-0.0001
38	0.0031	0.0030	0.0026	0.0029	0.0026	0.0026	0.0026	0.0030	0.0004	0.0003	0.0000	-0.0001
39	0.0029	0.0028	0.0023	0.0026	0.0024	0.0024	0.0023	0.0026	0.0004	0.0003	0.0000	0.0000
40	0.0026	0.0025	0.0020	0.0023	0.0022	0.0022	0.0020	0.0023	0.0004	0.0003	0.0000	0.0000
41	0.0024	0.0023	0.0019	0.0021	0.0020	0.0020	0.0018	0.0021	0.0004	0.0003	0.0001	0.0000
42	0.0022	0.0021	0.0017	0.0019	0.0018	0.0018	0.0017	0.0019	0.0004	0.0003	0.0001	0.0000
43	0.0020	0.0020	0.0016	0.0018	0.0017	0.0017	0.0015	0.0017	0.0004	0.0003	0.0001	0.0000
44	0.0019	0.0018	0.0015	0.0016	0.0015	0.0015	0.0014	0.0015	0.0004	0.0003	0.0001	0.0001
45	0.0017	0.0017	0.0014	0.0015	0.0014	0.0014	0.0013	0.0014	0.0003	0.0003	0.0001	0.0001
46	0.0016	0.0016	0.0013	0.0014	0.0013	0.0013	0.0012	0.0013	0.0003	0.0003	0.0001	0.0001
47	0.0015	0.0014	0.0012	0.0013	0.0012	0.0012	0.0011	0.0012	0.0003	0.0003	0.0001	0.0001
48	0.0014	0.0014	0.0011	0.0012	0.0011	0.0011	0.0010	0.0011	0.0003	0.0002	0.0001	0.0001
49	0.0013	0.0013	0.0010	0.0011	0.0010	0.0010	0.0009	0.0010	0.0003	0.0002	0.0001	0.0001
50	0.0169	0.0159	0.0128	0.0132	0.0118	0.0118	0.0102	0.0111	0.0051	0.0041	0.0026	0.0021

data). Genotypic data were generated using the computer software EASYPOP and heterogeneity tests were conducted with the generated data. The number of populations was determined depending on the stock structure scenario tested. The same method was employed to evaluate the power of the genetic analysis on Bryde's whale stock structure conducted by Kanda *et al*. (2009b).

Results suggested that from a genetics perspective, it was reasonable to conclude that the data set had adequate statistical power to study genetic differentiation in the Bryde's whale samples. This simulation analysis supported the conclusion of a single stock of Bryde's whales in sub-area 1 (see Adjunct 1 for details of this analysis).

Utility of the satellite tags for elucidating problems of stock structure

The research proposal presented in 2008 included experiments on satellite tagging. Some Scientific Committee members highlighted the value of tag-based techniques to evaluate stock structure hypothesis. The Scientific Committee noted the necessity to evaluate the trade-off between the cost of finding Bryde's whales and successfully attaching satellite tags and the value of this information to address questions of stock structure.

Experiments on satellite tags under JARPN II

Evaluation of satellite tagging for stock structure studies can be done by examining the experiments on satellite tagging in Bryde's whales conducted under JARPN II. Experiments were conducted in 2004, 2006 and 2008. The number of trials in each of these years was 3, 3 and 13 involving 59, 85 and 488 minutes of experimental effort, respectively.

Two satellite tags were successfully attached to Bryde's whales, one in 2006 and the other in 2008, providing information on movement of the animals for periods of 15 and 21 days, respectively (Nishiwaki *et al.*, 2009).

A large number of marks will be required if the aim is to investigate mixing across the boundary line separating sub-areas 1W and 1E. If the same experimental effort is maintained during future commercial operations (during which the research plan will be implemented) we cannot expect a large number of marks successfully attached. However as the original research plan noted, the aim of the satellite tagging experiment is to obtain information on the pattern of migration and location of breeding grounds. For this aim experiments should be conducted at the end of the feeding season and large sample numbers might not be required. Biopsy sampling would be conducted on the same animals.

Conclusions

As noted in the original plan, the research will start once the RMP is implemented for the western North Pacific Bryde's whale. Based on the results of the power analyses conducted we consider that genetics should be the main analytical tool to investigate sub-stock structure in sub-area 1. Age data are not required as a tool to investigate stock structure. Experiments on satellite tagging could be valuable to investigate patterns of migration and location of breeding grounds, and a large number of samples might not be required. This information will facilitate the interpretation of the results of the genetic analyses. It is unlikely that the collection of age data from new samples will provide information on age composition differences between sub-areas. However these data will be collected as they are essential for the estimation of biological parameters, which can be examined to further interpret results of the main analytical tool: genetics.

REFERENCES

International Whaling Commission. 2006. Report of the Workshop on the *pre-Implementation assessment* of western North Pacific Bryde's whales. *J. Cetacean Res. Manage. (Suppl.)* 8:337–55.

International Whaling Commission. 2007. Western North Pacific Bryde's *Implementation*: Report of the First Intersessional Workshop, 25–29 October 2005, Shizuoka, Japan. *J. Cetacean Res. Manage. (Suppl.)* 9:407–27.

International Whaling Commission. 2009. 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.

Kanda, N., Goto, M., Kishiro, T., Yoshida, H., Kato, H. and Pastene, L. 2009a. Further microsatellite analysis of common minke whales in the western North Pacific. Paper SC/61/JR8 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 14pp. [Paper available from the Office of this Journal].

Kanda, N., Goto, M. and Pastene, L.A. 2009b. Stock structure of Bryde's whales in the western North Pacific as revealed by microsatellite and mitochondrial DNA analyses. Paper SC/J09/JR31 presented to the Expert Workshop to Review Results of JARPN II, 26–30 January 2009, Tokyo, Japan (unpublished). 8pp. [Paper available from the Office of this Journal].

Kitakado, T., Kanda, N. and Pastene, L.A. 2005. A prospective evaluation of statistical power for population identification under island models. Paper SC/M05/Br3 presented to the Workshop on the *pre-Implementation assessment* of western North Pacific Bryde's whales, Tokyo, Japan, March 21–24 2005 (unpublished). 14pp. [Paper available from the Office of this Journal].

Nishiwaki, S., Otani, S. and Tamura, T. 2009. Movements of Bryde's whales in the western North Pacific as revealed by satellite tracking experiments conducted under JARPN II. Paper SC/61/O7 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 7pp. [Paper available from the Office of this Journal].

Pastene, L.A., Kitakado, T. and Hatanaka, H. 2008. Research proposal accompanying management variant 2 of the RMP *Implementation* for western North Pacific Bryde's whale. Paper SC/60/PFI9 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 10pp. [Paper available from the Office of this Journal].

Adjunct 1

Assessment of statistical power for the tests of homogeneity on Bryde's whales in Kanda *et al*. (2009)

In order to assess statistical power for tests of homogeneity (e.g. Waples and Gaggiotti, 2006), we generated genotypic data using computer software EASYPOP (Balloux, 2001) and conducted heterogeneity tests with these generated data Table 1). We conducted the simulation analysis for assessing the statistical power for the tests between the samples from sub-areas 1W and 1E for Bryde's whales (Kanda *et al.*, 2009).

We assumed two populations, each of which consists of diploid individuals with a constant size and equal sex ratio with random mating. We assumed the ratio of effective population size to census population size to be 1/3 to 1/4 (Roman and Palumbi, 2003). We used a census population size of 15,000. These numbers were set on the basis of the IWC's accepted population abundance estimates for this species in the North Pacific.

Each generation, simulation produces a genotypic data set for 17 independent nuclear gene loci (microsatellites) for each individual. The number of the loci simulated and maximum number of the allelic states (18) was set based on the observed data in this study. Bidirectional migration was assumed with equal migration rates (m). Different levels of the migration rates were selected, some of which were quite high for the genetic method to detect. We specified a range of genetic divergence using F_{ST} values estimated assuming an island model between the two populations by changing migration rate. A mutation rate of 5×10^{-4} was chosen to represent microsatellite loci. For each simulation parameter set, we made 100 replicates. We ran 5,000 generations for each replicate before collecting data. In the final generation of each replicate, a sample of 140 individuals was taken from each population for genetic analysis. This sample size was set to reflect the observed data, although the program was only able to have equal sample size over the populations. The sample size for Bryde's whales equalled the sum of the sample size from the sub-area 1E.We conducted homogeneity tests for the generated data set using pairwise tests of differentiation option in the FSTAT 2.9.3 (Goudet, 1995). In this option, for each pair of samples, multi-loci genotypes are randomised between the two samples. The overall loci G-statistic is given and statistical significance was decided with a table wide level of significance at 5%.

The simulation analysis was carried out to see if our genetic data set was adequate to test genetic heterogeneity between the samples from sub-areas 1W and 1E. Percent of rejecting panmixia with our data set (sample size of 140 and genetic variation at 17 microsatellite loci) was close to 100% at the mutation rate of 0.02 (estimated F_{ST} less than 0.0050). From a genetics perspectives, it is therefore reasonable to say that our data set has adequate statistical power to study genetic differentiation in our Bryde's whale samples. This simulation analysis supported our conclusion of a single stock of Bryde's whales in the sub-area 1.

Table 1

Input parameter sets used for generating simulated data set using EASYPOP to assess statistical power in our samples and results of the homogeneity tests with the simulated data. The following were fixed in all sets other than shown in the table: diploid, random mating, equal sex ratio, subpopulations of constant Ne, mutation rate of 0.0005, and 100 replicates each with 5,000 generations.

n	N	Ne	m	Nem	F_{ST}	S	L	A	% rejecting panmixia
N=3Ne									
2	15,000	5,000	0.01	50	0.0050	140	17	18	100
2	15,000	5,000	0.02	100	0.0025	140	17	18	85
2	15,000	5,000	0.05	250	0.0010	140	17	18	27
2	15,000	5,000	0.1	500	0.0005	140	17	18	5
2	15,000	5,000	0.2	1,000	0.0002	140	17	18	9
N=4Ne									
2	15,000	3,750	0.01	38	0.0066	140	17	18	100
2	15,000	3,750	0.02	75	0.0033	140	17	18	95
2	15,000	3,750	0.05	188	0.0013	140	17	18	46
2	15,000	3,750	0.1	375	0.0007	140	17	18	14
2	15,000	3,750	0.2	750	0.0003	140	17	18	15

N=census population size; Ne=effective population size; m=mutation rate; Nem=number of migrants per generation; S=number of sample size; L=number of loci analysed; A=possible number of alleli.

REFERENCES

Balloux, F. 2001. Easypop (version 1.7): a computer program for population genetics simulations. *J. Hered.* 92: 301–02.

Goudet, J. 1995. FSTAT, version 1.2: a computer program to calculate F-statistics. *J. Heredity* 86: 485–86.

Kanda, N., Goto, M. and Pastene, L.A. 2009. Stock structure of Bryde's whales in the western North Pacific as revealed by microsatellite and mitochondrial DNA analyses. Paper SC/J09/JR31 presented to the Expert Workshop to Review Results of JARPN II, 26–30 January 2009, Tokyo, Japan (unpublished). 8pp. [Paper available from the Office of this Journal].

Roman, J. and Palumbi, S.R. 2003. Whales before whaling in the North Atlantic. *Science* 301: 508–10.

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.

Appendix 7

ESTIMATES USED FOR CATCH LIMIT CALCULATIONS IN NORTHEAST ATLANTIC MINKE WHALES

Gjermund Bøthun and Nils Øien

A series of four surveys were conducted by Norway to estimate the abundance of minke whales in the northeastern Atlantic: 1988/89 and 1995 (Schweder *et al.*, 1997), 1996–2001 (Skaug *et al.*, 2004) and 2002–07 (Bøthun *et al.*, 2009).

The surveys in 1988 and 1989 were conducted before the RMP *Implementation* of North Atlantic minke whales and thus the block structure of those surveys was not fitted to the *Small Management Areas* (SMA) later implemented (IWC, 1993, p.115). For the surveys following in 1995 and onwards the SMAs were taken into consideration when establishing the block structure. However, during the *Implementation Review* in Berlin in 2003, some changes were made to the original SMA definitions. In the last survey period from 2002–07 the necessary adjustments of the underlying survey block structure to the new SMA definitions were made, so estimates for that survey period were directly calculated with respect to the 2003 SMA structure based on the survey block structure. However, for the earlier surveys, the new SMA boundaries divide some of the survey blocks used, and estimates have to be recalculated to fit the present SMAs. The method chosen here is to assign estimates from divided blocks proportionally to SMAs by area as follows:

A_{ij} = area of survey block i within SMA_j

A_i = total area of survey block i

Let **F** be a matrix with element $\{F\}_{ij} = A_{ij} / A_i$

Let **N** be a vector with element $\{N\}_i$ = abundance in survey block i

The elements of matrix **F** are given in Tables 2, 5, 8 and 11.

The elements of vector **N** are given in Tables 3, 6, 9 and 12.

Abundances by new small areas ($\mathbf{N}_{SMA}$) are given in Table 13 and are found by:

$\mathbf{N}_{SMA} = \mathbf{N}*\mathbf{F}$ (assuming the same order of survey blocks in N and F).

Let $\sum$ be the covariance matrix corresponding to N with element $\sum_{ii}$ corresponding to the standard deviation given in Tables 3, 6, 9, and 12 and assume $\sum_{i\neq j} = 0$. Then the standard deviations in Table 13 are given by diagonals in $(\mathbf{F'}\sum\mathbf{F})^{½}$.

The areas listed in Tables 1, 4, 7 and 10 have been calculated using GIS with an Albers equal area projection. Maps are shown in Figs 1–4.

REFERENCES

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/RMP2 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished) 13pp. [Paper available from the Office of this Journal].

International Whaling Commission. 1993. Report of the Scientific Committee, Annex F. Report of the sub-committee on North Atlantic baleen whales. *Rep. int. Whal. Commn* 43:115–29.

Schweder, T., Skaug, H.J., Dimakos, X.K., Langaas, M. and Øien, N. 1997. Abundance of northeastern Atlantic minke whales, estimates for 1989 and 1995. *Rep. int. Whal. Commn* 47: 453–84.

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.

Table 1

Areas in km² for 1988/89 survey blocks divided by 2004 small areas.

Small Area	Survey block	Area km²
CM	SN	8,004.0
EB	BA	292,633.0
EB	FI	14,633.6
EB	GA	158,937.0
EB	KO	85,021.0
EN	NS	247,229.0
EN	SN	113,775.0
ES	BA	67,136.4
ES	BJ	75,370.0
ES	NO	90,192.5
ES	SV	79,351.7
ES	VSN	13,104.5
ES	VSS	26,838.8
EW	FI	75,040.3
EW	LO	121,875.0
EW	NO	255,970.0
EW	SN	346,852.0

Table 2

Fraction of 1988/1989 survey blocks belonging to given SMAs.

Survey block	CM	EB	EN	ES	EW
BA	0	0.81	0	0.19	0
BJ	0	0	0	1	0
FI	0	0.16	0	0	0.84
GA	0	1	0	0	0
JM	1	0	0	0	0
KO	0	1	0	0	0
LO	0	0	0	0	1
NO	0	0	0	0.26	0.74
NS	0	0	1	0	0
NV	1	0	0	0	0
SN	0.04	0	0.24	0	0.72
SV	0	0	0	1	0
VSN	0	0	0	1	0
VSS	0	0	0	1	0

Table 3

Combined 1988/89 abundance estimates with standard errors by block.

Survey block	Abundance	SD
BA	5,364	2,241
BJ	2,549	541
FI	2,626	926
GA	2,522	1,108
JM	847	298
KO	14,554	3,963
LO	3,192	901
NO	9,519	2,266
NS	5,429	1,873
NV	1,803	1,214
SN	11,935	4,039
SV	4,052	1,260
VS	2,988	694

Table 4

Areas in km² for 1995 survey blocks divided by 2004 small areas.

Small Area	Survey block	Area km²
ES	VSI	–
ES	VSN	17,133.0
ES	VSS	27,228.0
ES	SV	88,250.0
ES	SVI	142,424.0
ES	NON	88,970.0
ES	BJ	74,607.0
ES	BAW	79,602.0
EB	BAW	28,745.0
EB	FI	14,343.0
EB	BAE	457,068.0
EB	KO	85,586.0
EB	GA	160,666.0
EW	NOS	396,650.0
EW	LOC	95,109.0
EW	FI	75,280.0
EW	NSC	208,335.0
EN	NSC	96,725.0
EN	NS	248,689.0
CM	JMC	67,858.0
CM	NVN	356,290.0
CM	NVS	238,237.0

Table 5

Fraction of 1995 survey blocks belonging to given SMAs.

Survey block	CM	EB	EN	ES	EW
BAE	0	1	0	0	0
BAW	0	0.27	0	0.73	0
BJ	0	0	0	1	0
FI	0	0.16	0	0	0.84
GA	0	1	0	0	0
JMC	1	0	0	0	0
KO	0	1	0	0	0
LOC	0	0	0	0	1
NON	0	0	0	1	0
NOS	0	0	0	0	1
NS	0	0	1	0	0
NSC	0	0	0.32	0	0.68
NVN	1	0	0	0	0
NVS	1	0	0	0	0
SV	0	0	0	1	0
SVI	0	0	0	1	0
VSI	0	0	0	1	0
VSN	0	0	0	1	0
VSS	0	0	0	1	0

Table 6

Combined 1995 abundance estimates with standard errors by block.

Survey block	Abundance	SD
BAE	16,101	4,819
BAW	4,062	1,075
BJ	7,164	1,677
FI	5,974	1,771
GA	10,615	2,291
JMC	1,339	750
KO	962	544
LOC	2,462	562
NON	3,357	873
NOS	22,678	3,527
NS	20,294	5,237
NSC	7,070	1,670
NVN	4,835	2,072
SV	4,719	767
SVI	2,691	768
VSI	345	140
VSN	1,672	326
VSS	1,959	456
NVS	0	0

Table 7

Areas in km² for 1996–2001 survey blocks divided by 2004 SMAs.

Small Area	Survey block	Area km²
ES	VSI	22,130.0
ES	VSN	17,133.0
ES	VSS	27,228.0
ES	SV	88,609.0
ES	SVI	177,972.0
ES	NON	88,970.0
ES	BJ	74,607.0
ES	BAW	101,946.0
EB	BAW	33,045.0
EB	FI	14,343.0
EB	BAE	525,391.0
EB	KO	85,586.0
EB	GA	160,666.0
EW	NOS	396,650.0
EW	LOC	95,109.0
EW	FI	75,280.0
EW	NSC	208,335.0
EN	NSC	96,725.0
EN	NS	248,689.0
CM	JMC	67,858.0
CM	NVN	329,467.0
CM	NVS	298,076.0

Table 8

Fraction of 1996–2001 survey blocks belonging to given SMAs.

Survey block	CM	EB	EN	ES	EW
BAE	0	1	0	0	0
BAW	0	0.24	0	0.76	0
BJ	0	0	0	1	0
FI	0	0.16	0	0	0.84
GA	0	1	0	0	0
JMC	1	0	0	0	0
KO	0	1	0	0	0
LOC	0	0	0	0	1
NON	0	0	0	1	0
NOS	0	0	0	0	1
NS	0	0	1	0	0
NSC	0	0	0.32	0	0.68
NVN	1	0	0	0	0
NVS	1	0	0	0	0
SV	0	0	0	1	0
SVI	0	0	0	1	0
VSI	0	0	0	1	0
VSN	0	0	0	1	0
VSS	0	0	0	1	0

Table 9

Combined 1996–2001 abundance estimates with standard errors by block.

Survey block	Abundance	SD
JMC	4,432	921
NVN	9,554	1,789
NVS	12,732	3,426
BAE	11,605	4,888
FI	6,762	1,563
GA	9,971	3,730
KO	2,461	819
NOS	13,037	2,478
LOC	584	818
NS	11,713	3,455
NSC	6,182	1,368
BAW	3,128	1,516
BJ	1,909	403
NON	2,579	704
SV	4,699	1,214
SVI	1,932	1,315
VSI	226	140
VSN	1,540	304
VSS	2,159	860

Table 10

Areas in km² for 2002–2007 survey blocks divided by 2004 SMAs.

Small Area	Survey block	Area km²
ES	VSI	0.0
ES	VSN	17,133.0
ES	VSS	27,228.0
ES	SV	85,278.0
ES	SVI	138,000.0
ES	NON	88,970.0
ES	BJ	74,607.0
ES	BAW1	100,726.0
EB	BAW2	24,536.0
EB	FI2	14,343.0
EB	BAE	392,666.0
EB	KO	85,586.0
EB	GA	160,666.0
EW	NOS	396,650.0
EW	LOC	95,109.0
EW	FI1	75,280.0
EW	NSC1	208,335.0
EN	NSC2	96,725.0
EN	NS	248,689.0
CM	JMC	67,858.0
CM	NVN	355,563.0
CM	NVS	319,571.0

Table 11

Fraction of 2002–07 survey blocks belonging to given SMAs.

Survey block	CM	EB	EN	ES	EW
BAE	**0**	**1**	**0**	**0**	**0**
BAW1	**0**	**0**	**0**	**1**	**0**
BAW2	0	1	0	0	0
BJ	0	0	0	1	0
FI1	0	0	0	0	1
FI2	0	1	0	0	0
GA	0	1	0	0	0
JMC	1	0	0	0	0
KO	0	1	0	0	0
LOC	0	0	0	0	1
NON	0	0	0	1	0
NOS	0	0	0	0	1
NS	0	0	1	0	0
NSC1	0	0	0	0	1
NSC2	0	0	1	0	0
NVN	1	0	0	0	0
NVS	1	0	0	0	0
SV	0	0	0	1	0
SVI	0	0	0	1	0
VSI	0	0	0	1	0
VSN	0	0	0	1	0
VSS	0	0	0	1	0

Table 12

Combined 2002–07 abundance estimates with standard errors by block.

Survey block	Abundance	SD
JMC	9,904.9	3,680
NVN	13,445.5	9,316
NVS	3,388.3	1,979
BAE	13,264.7	5,077
BAW2	31.5	61
FI2	204.6	243
GA	8,114.6	3,388
KO	7,009.8	2,778
NSC2	3,382.0	2,550
NS	2,864.4	1,406
BAW1	3,401.9	1,819
BJ	4,630.8	1,564
NON	3,123.2	1,230
SV	7,060.4	4,570
VSN	314.4	226
VSS	846.6	505
VSI	–	0
SVI	–	0
FI1	2,201.0	1,208
LOC	3,456.6	1,718
NSC1	4,321.2	1,760
NOS	17,173.0	4,953

Table 13

Summary of estimates by 2004 SMAs.

Survey period	Mid-year	EB			EN			ES			EW			E total			CM		
		Year	N	SD	*Year*	N	SD	*Year*	N	SD	*Year*	N	SD	*Year*	N	CV	*Year*	N	SD
1988–89	1989	*1989*	21,868	4,503	*1989*	8,318	2,113	*1989*	13,070	1,699	*1989*	20,991	3,552	*1989*	64,730[1]	0.192	*1988*	2,650[1]	1,283
1995	1995	*1995*	29,712	5,378	*1995*	22,536	5,263	*1995*	24,891	2,389	*1995*	34,986	4,033	*1995*	112,125	0.104	*1995*	6,174	2,203
1996–2001	1999	*2000*	25,885	6,219	*1998*	13,673	3,482	*1999*	17,406	2,454	*1996*	23,522	3,013	*1999*	80,487	0.15	*1997*	26,718	3,973
2002–07	2005	*2007*	28,625	6,709	*2004*	6,246	2,912	*2003*	19,377	5,335	*2002, 2006*	27,152	5,917	*2005*	81,401	0.23	*2005*	26,739	10,428

[1]These estimates are taken from Schweder *et al.* (1997) and are different from the results from direct application of area proration. The differences are caused by a very small part of the 1989 survey block (SN) falling within the CM *Small Area* in the area projection used here.

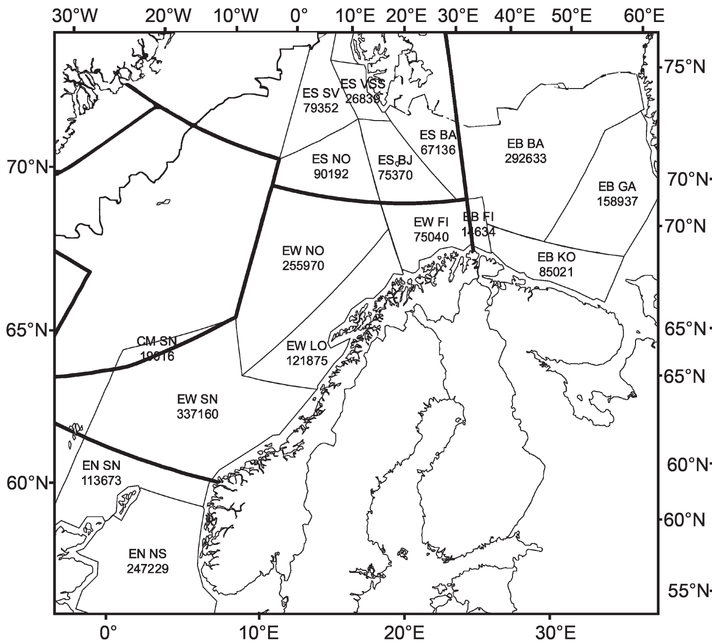


Fig. 1. 1989 survey blocks divided by 2004 SMAs.

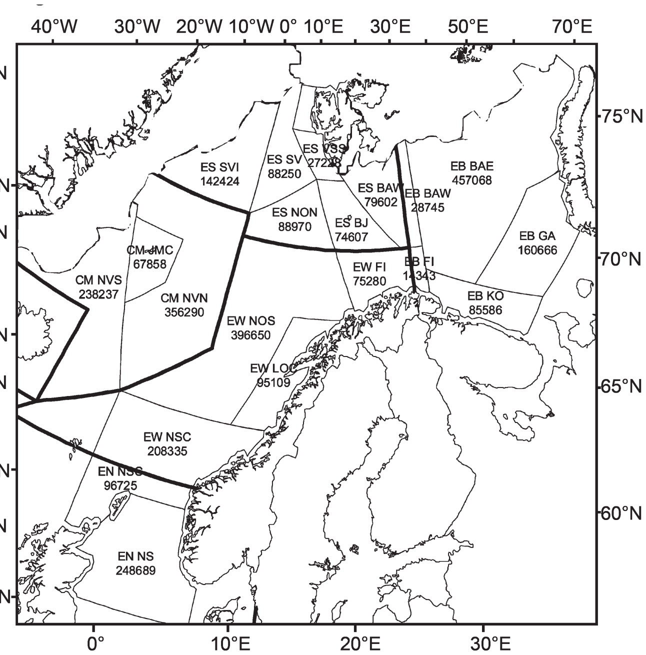


Fig. 2. 1995 survey blocks divided by 2004 SMAs.

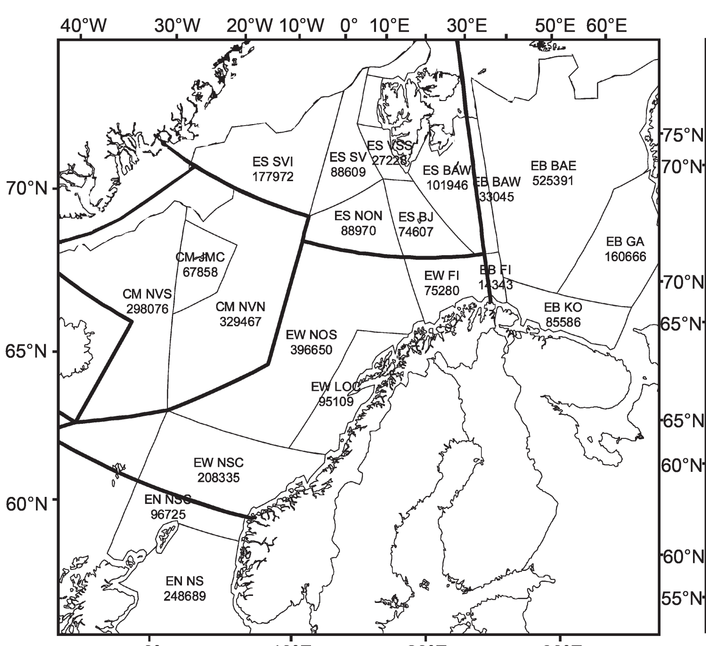


Fig. 3. 1996–2001 survey blocks divided by 2004 SMAs.

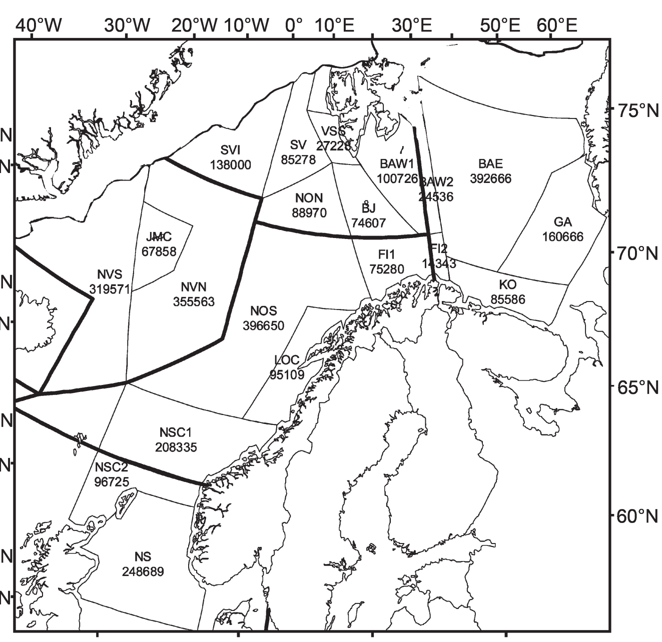


Fig. 4. 2002–07 survey blocks divided by 2004 SMAs.

Appendix 8

DATA USED IN CALCULATION OF CATCH LIMITS

C. Allison

A. Western North Pacific Bryde's whales

Catch data (sub-areas 1W+1E+2 combined)

Year	Catch	Year	Catch	Year	Catch	Year	Catch	Year	Catch
1906	13	1927	118	1948	134	1969	89	1990	0
1907	34	1928	80	1949	199	1970	139	1991	0
1908	82	1929	63	1950	288	1971	919	1992	0
1909	47	1930	62	1951	307	1972	160	1993	0
1910	51	1931	135	1952	491	1973	699	1994	0
1911	156	1932	104	1953	61	1974	1,323	1995	0
1912	81	1933	84	1954	75	1975	1,432	1996	0
1913	125	1934	93	1955	94	1976	1,459	1997	0
1914	56	1935	92	1956	24	1977	946	1998	1
1915	169	1936	87	1957	39	1978	796	1999	0
1916	105	1937	122	1958	254	1979	1,281	2000	43
1917	181	1938	160	1959	263	1980	755	2001	50
1918	148	1939	193	1960	404	1981	485	2002	50
1919	161	1940	110	1961	167	1982	482	2003	50
1920	92	1941	144	1962	504	1983	545	2004	51
1921	89	1942	21	1963	210	1984	528	2005	50
1922	81	1943	29	1964	68	1985	357	2006	51
1923	75	1944	74	1965	8	1986	317	2007	50
1924	111	1945	12	1966	55	1987	317	2008	50
1925	118	1946	126	1967	45	1988	0	2009	50
1926	134	1947	106	1968	171	1989	0		

Incidental catches. Extract from the *Implementation* trial specifications (IWC, 2008b, p.463):

Only four incidental catches have been recorded since 1975 (of which one (in October 2003) from a trap net in Shizuoka) was identified as an offshore type Bryde's whale. The remaining three (in August 1978 from Oita, April 1988 from Hyogo and March 1995 from Kochi (released) are all thought to have been inshore forms although no DNA data is available to confirm this. In addition three Bryde's whales have been stranded.

Recent progress reports (covering the period 2004–09) list two incidental catches of Bryde's whales by Japan in 2004 (one from Chiba and one from Nagasaki in trap nets) and one by Korea in 2007 (a female in the Korea Strait).

Abundance estimate:

Year	Estimate	CV	Reference
2000	20,501	0.3366	IWC (2009a, pp.6–7)

The Catch Limit is calculated using Management Variant 4. Sub-areas 1 and 2 (combined) are taken to be a *Combination area*, and sub-areas 1W, 1E and 2 are *Small Areas*, with *catch-cascading* applied – see IWC (2008a, p.95).

The ‘raw’[1] Catch Limits set for *Combination area* 1+2 are 15.5 and 91.9 whales for the 72% and 60% tunings respectively.

The ‘raw’ Catch Limits are split between *Small Areas* 1E, 1W and 2 using abundance estimates of 4,957, 11,213 and 4,331 respectively (IWC, 2009a, pp.6–7) and the phaseout reduction applied (the Area 2 limit is not used).

						Catch limits (after applying phaseout)				
Area	Abundance	CV	Abundance date stamp	Tuning level	Catch limit split to area	2010	2011	2012	2013	2014
1W	4,957	0.398	2000	72%	3.7	2	1	1	0	0
1E	11,213	0.498	1999	72%	8.5	3	2	0	0	0
2	4,331	0.553	2002	72%	(3.3)					
1W	4,957	0.398	2000	60%	22.2	13	9	4	0	0
1E	11,213	0.498	1999	60%	50.3	20	10	0	0	0
2	4,331	0.553	2002	60%	(19.4)					

[1]The ‘raw’ catch limit is the catch limit set by the ‘CatchLimit program’, before catch cascading, sex ratio correction and phaseout is applied.

The Final catch limits for Western North Pacific Bryde's whales in Areas 1W+1E. No adjustment for sex imbalance is necessary.

Area	Year	Catch limit 72% tuning	Catch limit 60% tuning
1W+1E	**2010**	**5**	33
1W+1E	**2011**	**3**	19
1W+1E	**2012**	**1**	4
1W+1E	**2013**	**0**	0
1W+1E	**2014**	**0**	0

B. North Atlantic minke whales
Historic catches:

Year	C	E	Year	C	E	Year	C	E	Year	C	E	Year	C	E
1914	1		1934	6	700	1954	38	3,499	1974	252	1,420	1994	46	239
1915	10		1935	6	878	1955	58	4,309	1975	422	1,430	1995	51	176
1916	6		1936	1	1,053	1956	47	3,656	1976	286	1,889	1996	52	348
1917	6		1937	1	1,231	1957	46	3,634	1977	195	1,699	1997	34	483
1918	6		1938	1	1,353	1958	44	4,341	1978	332	1,383	1998	67	568
1919	6		1939	1	918	1959	61	3,076	1979	319	1,786	1999	73	533
1920	6		1940	1	552	1960	69	3,273	1980	320	1,807	2000	67	430
1921	20		1941	14	2,110	1961	181	3,107	1981	246	1,771	2001	48	521
1922	20		1942	14	2,134	1962	289	3,062	1982	321	1,782	2002	45	599
1923	20		1943	14	1,613	1963	218	3,067	1983	317	1,688	2003	72	626
1924	20		1944	14	1,349	1964	322	2,469	1984	293	630	2004	53	527
1925	20		1945	14	1,786	1965	400	2,122	1985	244	634	2005	48	634
1926	9	4	1946	33	1,883	1966	354	1,923	1986	52	329	2006	64	545
1927	9	4	1947	45	2,556	1967	475	1,827	1987	54	323	2007	47	597
1928	9	0	1948	99	3,487	1968	743	2,108	1988	10	29	2008	69	506
1929	9	6	1949	111	3,841	1969	296	2,032	1989	10	17	2009	85	485
1930	9	38	1950	33	1,990	1970	373	1,912	1990	6	5			
1931	6	175	1951	38	2,752	1971	303	1,802	1991	7	1			
1932	6	350	1952	40	3,325	1972	373	2,175	1992	11	95			
1933	6	525	1953	38	2,435	1973	388	1,562	1993	22	213			

Recent catches by sex (excludes lost whales and others of unknown sex). The catch limit calculation for the SAG used the catches by sex for 2004–08 period when applying the sex correction to the catch limit. The figures for 2005–09 are now available and are also shown below.

Subarea		CIC	CIC	CM	CM	EN	EN	EW	EW	ES	ES	EB	EB
Year	Sex:	M	F	M	F	M	F	M	F	M	F	M	F
2005		20	14	4	1	6	1	108	133	5	92	31	249
2006		31	28	0	0	10	20	200	166	9	108	0	22
2007		14	28	0	0	52	44	86	88	12	271	20	8
2008		28	7	5	25	43	48	99	55	9	220	12	10
2009		64	14	0	0	28	21	83	97	13	234	1	3
Female Ratio 2005–09			0.37		0.74		0.49		0.48		0.95		0.82

Incidental catches. Recent progress reports (covering the period 2004–09) list the following minke whales:

Year		Nation	Number
2009	Ship strike	UK	1
2009	Incidental catch	Denmark	1
2009	Incidental catch	Norway	1
2008	Incidental catch	Denmark	1
2008	Incidental catch	Iceland	1
2008	Incidental catch	Spain	2
2008	Incidental catch	UK	2
2007	Incidental catch	UK	1
2006	Incidental catch	Iceland	1
2006	Incidental catch	Portugal	1
2006	Incidental catch	UK	2
2005	Incidental catch	Iceland	1
2005	Incidental catch	Portugal	1
2005	Incidental catch	UK	1
2004	Incidental catch	Belgium	1
2004	Incidental catch	Portugal	1

Central Area Abundance estimates (taken from IWC, 2009b, p.135 unless otherwise noted).

Area	Year	Estimate	CV	Notes
C	1988	39,250	0.210	Combination of estimates (a), (d) and (g) below
C	2000	93,943	0.117	Combination of estimates (b), (e) and (h) below
C	2006	39,817	0.274	Combination of estimates (c), (f), (i) and (j) below
CM	1988	4,732	0.229	(a) Estimate is a combination of 5,609 (CV 0.26) in 1987 and 2,650 (CV 0.48) in 1988–89
CM	1995	(6,174)	(0.36)	Not used: the 12,043 estimate is used instead as it has better coverage of the area
CM	1995	12,043	0.28	
CM	1997	26,718	0.14	(b)
CM	2005	26,739	0.45	(c) See IWC (2010b, p.140) (update to 26,739 estimate in IWC (2009b, p.135))
CIC	1987	24,532	0.324	(d)
CIC	2001	43,633	0.19	(e)
CIC	2007	10,680	0.29	(f)
CG+CIP	1989	9,986	0.22	(g) Minimum estimate
CG+CIP	1995	4,854	0.27	Minimum estimate
CG+CIP	2001	23,592	0.26	(h) Minimum estimate
CG	2007	1,048	0.60	(i)
CIP	2007	1,350	0.38	(j)

The Central Area Catch Limits are calculated taking the C *Medium Area* to be a *Combination area*, and sub-areas CM, CIC and CG+CIP are *Small Areas*, with *catch-cascading* applied. The catch allocated to the CG+CIP area is not used.
The 'raw' Catch Limits set for the C *Combination area* are 491.8 and 756.5 whales for the 72% and 60% tunings respectively. The Catch Limits are split between *Small Areas* (the CG+CIP limit is not used) and the sex ratio correction applied to give the following catch limits.

	Year of most recent abundance estimate	Split to *Small Area* 72% tuning	Sex-ratio	**Catch limit 72% tuning**	Split to *Small Area* 60% tuning	Sex-ratio	**Catch limit 60% tuning**
CIC	2007	224.1	0.37	**224**	344.7	0.37	**345**
CM	2005	200.7	0.74	**135**	308.8	0.74	**208**
CG+CIP	2007	(66.9)			(103.0)		

The Final Catch Limits for North Atlantic minke whales from the Central area (including phaseout):

	Catch limits with 72% tuning		Catch limits with 60% tuning	
Year	CIC	CM	CIC	CM
2010	**224**	**135**	345	208
2011	**224**	**135**	345	208
2012	**224**	**135**	345	208
2013	**224**	**135**	345	208
2014	**224**	**108**	345	166

The Abundance estimates for the E Combination Area – see IWC (2009b, p.135; 2010b) and SC/62/RMP2:

Year	Date stamp	Estimate	CV	Notes
1988–89	1989	64,730	0.192	63,730 CV 0.19 in IWC (2009b, p.135) but 64,730 in original (Schweder, 1997, p.470).
1995	1995	112,125	0.104	
1996–2001	1998	80,487	0.15	
2002–07	2004	81,401	0.23	Approved estimate rounded to 81,000 in IWC (2010b).

Abundance estimates for the individual Eastern Small Areas (see Appendix 7):

ES			EB			EW			EN		
Year	Abundance	CV	Year	Abundance	CV	Year	Abundance	CV	Year	Abundance	CV
1989	13,070	0.1300	1989	21,868	0.2059	1989	20,991	0.1692	1989	8,318	0.2540
1995	24,891	0.0960	1995	29,712	0.1810	1995	34,986	0.1153	1995	22,536	0.2336
1999	17,406	0.1410	2000	25,885	0.2403	1996	23,522	0.1281	1998	13,673	0.2547
2003	19,377	0.2753	2007	28,625	0.2344	2006	27,152	0.2179	2004	6,246	0.4662

The Eastern Area Catch Limits are calculated taking the E *Medium Area* to be a *Combination area*, and sub-areas ES, EB, EW and EN to be *Small Areas*, with *catch-cascading* applied.

The 'raw' Catch Limits set for the E *Combination area* are 483.2 and 1021.5 whales for the 72% and 60% tunings respectively.
The 'raw' Catch Limits are split between *Small Areas* and the sex ratio correction applied where necessary to give the following catch limits:

	Year of most recent abundance	Split to *Small Area* 72% tuning	Sex-ratio	Catch limit 72% tuning	Split to *Small Area* 60% tuning	Sex-ratio	Catch limit 60% tuning
ES	2003	109.4	0.95	58	231.3	0.95	122
EB	2007	151.5	0.82	92	320.3	0.82	195
EW	2006	152.3	0.49	152	321.9	0.49	322
EN	2004	70.0	0.48	70	148.0	0.48	148

The Final Catch Limits for North Atlantic minke whales from the Eastern area (including phaseout):

	Catch limits with 72% tuning				Catch limits with 60% tuning			
Year	ES	EB	EW	EN	ES	EB	EW	EN
2010	**58**	**92**	**152**	**70**	122	195	322	148
2011	**58**	**92**	**152**	**70**	122	195	322	148
2012	**46**	**92**	**152**	**70**	97	195	322	148
2013	**35**	**92**	**152**	**56**	73	195	322	118
2014	**14**	**92**	**152**	**42**	29	195	322	89

C. North Atlantic fin whales
Historic catches for the 2 management variants considered: WI+EG (Variant 2) and WI+EG+EI/F (Variant 6)

Year	WI+EG	WI+EG+EI/F	Year	WI+EG	WI+EG+EI/F	Year	WI+EG	WI+EG+EI/F	Year	WI+EG	WI+EG+EI/F
1865		8	1901	532	736	1938	113	296	1975	245	245
1866		24	1902	485	780	1939	109	262	1976	275	275
1867		19	1903	322	1,157	1940	0	0	1977	144	144
1868		2	1904	255	1,473	1941	0	0	1978	236	243
1869		0	1905	202	1,685	1942	0	0	1979	260	271
1870		0	1906	151	1,116	1943	0	0	1980	237	237
1871		5	1907	131	1,719	1944	0	0	1981	254	257
1872		0	1908	138	1,534	1945	0	30	1982	194	197
1873		0	1909	261	1,928	1946	0	94	1983	144	149
1874		0	1910	198	1,556	1947	0	196	1984	167	169
1875		0	1911	153	1,444	1948	195	418	1985	161	161
1876		0	1912	97	772	1949	249	471	1986	76	76
1877		0	1913	49	701	1950	226	635	1987	80	80
1878		0	1914	26	694	1951	312	481	1988	68	68
1879		0	1915	59	405	1952	224	244	1989	68	68
1880		0	1916	0	208	1953	207	294	1990	0	0
1881		0	1917	0	0	1954	177	194	1991	0	0
1882		0	1918	0	0	1955	236	316	1992	0	0
1883		0	1919	22	22	1956	265	308	1993	0	0
1884	3	3	1920	36	717	1957	348	489	1994	0	0
1885	18	18	1921	0	174	1958	289	305	1995	0	0
1886	14	14	1922	0	437	1959	178	178	1996	0	0
1887	28	28	1923	0	505	1960	160	160	1997	0	0
1888	47	47	1924	0	746	1961	142	142	1998	0	0
1889	86	86	1925	0	540	1962	303	309	1999	0	0
1890	105	105	1926	0	556	1963	283	286	2000	0	0
1891	119	119	1927	0	434	1964	217	230	2001	0	0
1892	164	169	1928	0	419	1965	288	298	2002	0	0
1893	403	407	1929	0	233	1966	310	314	2003	0	0
1894	273	291	1930	167	405	1967	239	239	2004	0	0
1895	372	382	1931	8	8	1968	202	208	2005	0	0
1896	235	261	1932	194	194	1969	251	251	2006	8	0
1897	329	362	1933	347	442	1970	291	291	2007	0	0
1898	249	298	1934	98	172	1971	208	208	2008	0	0
1899	389	450	1935	25	100	1972	238	238	2009	125	125
1900	425	511	1936	72	154	1973	267	267			
			1937	353	527	1974	285	285			

Incidental catches. Recent progress reports (covering the period 2004–09) list a fin whale ship strike by the UK in 2004 in the NE Atlantic and an incidental catch (probable entanglement) of a female by the UK on 30 October 2007 from Raffin, Highlands, Scotland.
The Abundance estimates are documented in Wade (2009) and IWC (2010a, p.602).

	Variant 6								Variant 2	
Year	EG+WI+EI/F		WI		EG		EI/F		EG+WI	
1988	14,773	0.1424	4,243	0.229	5,269	0.221	5,261	0.277	9,512	0.1594
1995	21,859	0.1567	6,800	0.218	8,412	0.288	6,647	0.288	15,212	0.1867
2001	25,761	0.1253	6,565	0.194	11,706	0.194	7,490	0.255	18,271	0.1425
2007	21,946	0.1483	8,118	0.260	12,215	0.20	1,613	0.260	20,333	0.1588

(1) The Catch Limit is calculated for Management Variant 6: WI, EG and EI/F are *Small Areas*; WI+EG+EI/F is a *Combination Area*. The 'raw' Catch Limit is split between *Small Areas* WI, EG and EI/F using the above abundance estimates. Only the catch limit set for the WI area is used.
(2) In addition the Catch Limit was calculated for Management Variant 2: WI+EG is a *Small Area*. All of the catch is taken in the WI sub-area.

The 'raw' Catch Limits and the split to *Small Area* are given below (only the catch limit for WI is used):

Area	Year	Catch limit 72% tuning	WI 72% tuning	WG	EI/F	Catch limit 60% tuning	WI 60% tuning	WG	EI/F
V6:WI+EG+EI/F	2010	142.1	46	(74)	(21)	276.8	90	(145)	(42)
V2: WI+EG	2010	87.5	87	–	–	155.0	155	–	–

The Final Catch Limits. No adjustment for sex imbalance or phaseout is necessary.

Area	Year	Variant V6 catch limit 72% tuning	Variant V2 catch limit 72% tuning	Variant V6 catch limit 60% tuning	Variant V2 catch limit 60% tuning
WI	**2010**	**46**	**87**	90	155
WI	**2011**	**46**	**87**	90	155
WI	**2012**	**46**	**87**	90	155
WI	**2013**	**46**	**87**	90	155
WI	**2014**	**46**	**87**	90	155

REFERENCES

International Whaling Commission. 2008a. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 10:90–120.

International Whaling Commission. 2008b. Report of the second Intersessional Workshop on the western North Pacific Bryde's whale *Implementation*, Yokohama, 10–14 December 2006. *J. Cetacean Res. Manage. (Suppl.)* 10:449–510.

International Whaling Commission. 2009a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 11:1–74.

International Whaling Commission. 2009b. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised Management Procedure (RMP). Appendix 7. Report of the working group on the North Atlantic minke whales RMP *Implementation Review*. *J. Cetacean Res. Manage. (Suppl.)* 11:132–40.

International Whaling Commission. 2010a. Report of the 2nd Intersessional Workshop of the North Atlantic Fin Whale *Implementation*, 19–22 March 2009, Greenland Representation, Denmark. *J. Cetacean Res. Manage. (Suppl.)* 11(2):587–627.

International Whaling Commission. 2010b. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised Management Procedure (RMP). *J. Cetacean Res. Manage (Suppl.)* 11(2):114–34.

Schweder, T., Skaug, H.J., Dimakos, X.K., Langaas, M. and Øien, N. 1997. Abundance of northeastern Atlantic minke whales, estimates for 1989 and 1995. *Rep. int. Whal. Commn* 47: 453–84.

Wade, P. 2009. Report of the First Intersessional RMP Workshop on North Atlantic Fin Whales, 31 March to 4 April 2008, Greenland Representation, Copenhagen. Annex H. Compilation and calculation of North Atlantic fin whale abundance by sub-area. *J. Cetacean Res. Manage. (Suppl.)* 11: 448–50.

Appendix 9

PROPOSAL: TO CONTRIBUTE TO THE ANALYSIS AND USE OF TIME-SERIES OF DATA ON CALVING RATES AND CALVING INTERVALS FOR USE IN THE REVIEW OF MSY RATES

(Revised and consolidated)

Relevant agenda item (no. and title)
Annex D, item 2.4.

Brief description of project and why it is necessary to the sub-committee
The Scientific Committee of the International Whaling Commission is conducting a review of the range of MSYR values to include in simulation trials when selecting among variants of the Revised Management Procedure (RMP). As part of the review process, information on observed population growth rates at low population sizes, r_0, is being considered; Cooke (2007) noted that in circumstances where variability and/or temporal autocorrelation in the effects of environmental variability on population growth rates is high, simple use of such observed population growth rates could lead to incorrect inferences being drawn concerning the lower end of the range of plausible values for MSYR. The Third Intersessional Workshop on the Review of MSYR assembled a number of data sets on calving rates and calving intervals for baleen whales. Efforts were made following the Workshop to fit models which account for both process and observation error to the data on calving rates and calving intervals. However, numerical problems had been encountered during the intersessional period implementing these models. The sub-committee therefore developed a work plan (see Appendix 2) based on a method which should overcome these numerical problems and which provides the inputs needed to apply the Bayesian hierarchical method adopted by the sub-committee for computing a posterior distribution for r_0. The work plan (and its relationship to this proposal) is as follows.

(1) Investigate improvements to the model of Appendix 2 to handle proportion data for which the sampling error variances are not known.
(2) Brandon and Kitakado to fit the model of Appendix 2 to (a) the real data, and (b) some simulated data sets.
(3) Represent the results from the model in the form of inputs to the age-structured model of Annex D of SC/62/Rep2 and use this model to compute the standard deviation and temporal auto-correlation in the annual rate of increase
(4) Identify the values for the environmental model of Cooke (2007) which match the outputs from the age-structured model.

Timetable
- Kitakado, Brandon, and Punt to refine the specifications for the analyses of calving rate and calving interval data (July–September 2010).
- Kitakado and Brandon (with assistance from Punt) to implement the refined specifications for the analyses (October 2010–February 2011).
- Progress report to the Secretariat (January 2011).
- Punt to use the results of the analyses to develop the basis for applying the Bayesian hierarchical method adopted by the sub-committee (March–May 2011).
- Final report presented to the 2011 Annual Meeting.

Researchers' names
John Brandon (LGL); Toshihide Kitakado (Tokyo University of Marine Science and Technology); André Punt (University of Washington).

Estimated total cost with breakdown as needed
Total budget: £7,000 (Brandon £2,500; Kitakado: £2,000; Punt: £2,500).

REFERENCE

Cooke, J.G. 2007. The influence of environmental variability on baleen whale sustainable yield curves. Paper SC/N07/MSYR1 presented to the MSYR Workshop, Seattle, USA, 16–19 November 2007 (unpublished). 19pp. [Paper available from the Office of this Journal].

Annex D1

Report of the Working Group on the *Pre-Implementation Assessment* of Western North Pacific Common Minke Whales

Members: Hammond (Convenor), Allison, An, Baba, Baker, Borodin, Bravington, Brockington, Brownell, Butterworth, Campbell, Castellote, Childerhouse, Chilvers, Choi, Cipriano, Clapham, Cooke, de Moor, Deimer-Schuette, Donovan, Fujise, Funahashi, Gaggiotti, Gedamke, Goodman, Gunnlaugsson, Hakamada, Hatanaka, Hoelzel, Iñíguez, Jaramillo Legorreta, Kanda, Kasuya, Kato, Kelly, Kitakado, Leaper, Lyrholm, Matsuoka, Miyashita, Morishita, Murase, Okada, Okamura, Palka, Palsbøll, Pamoulie, Pastene, Perrin, Punt, Sekiguchi, Uoya, Uozumi, Víkingsson, Wade, Walløe, Waples, Yamakage, Yasokawa, Yoshida.

1. CONVENOR'S OPENING COMMENTS

Hammond welcomed participants to the meeting, which had commenced as a two day pre-meeting that continued into the main meeting of the Committee.

In 2009, the Commission had agreed that the Scientific Committee should follow the option in its report (IWC, 2010b) that specifies completing a full *Implementation Review* as soon as possible, ideally by the 2012 meeting. This timeline will be possible if the *pre-Implementation assessment* can be completed this year. The Convenor reminded the Working Group that the Committee was undertaking a *pre-Implementation assessment*, rather than immediately commencing an *Implementation Review*, because the 2003 *Implementation* had been conducted before the existing guidelines for *Implementations* had been developed and had focussed primarily on 'O' stock. He drew the attention of participants to Committee guidelines for *Implementations* relevant to *pre-Implementation assessments* (IWC, 2005a). In particular, he stressed that the main focus is: '…the establishment of plausible stock hypotheses consistent with the data that are inclusive enough that it is deemed unlikely that the collection of new data during the *Implementation* process will suggest a major novel hypothesis (e.g. a different number of stocks) not already specified in the basic *Implementation Simulation Trial* structure'.

Additional foci are examination of available abundance estimates and information on the geographical and temporal nature of 'likely' whaling operations and future levels of anthropogenic removals other than due to commercial whaling.

The aim was to complete the *pre-Implementation assessment* at this meeting so that the *Implementation Review* could be completed at the 2012 meeting. However, the guidelines do not put a limit on the time that should be taken to complete the *pre-Implementation assessment*.

2. ELECTION OF CHAIR AND APPOINTMENT OF RAPPORTEURS

Hammond was elected Chair. Waples and Punt were appointed as rapporteurs.

3. ADOPTION OF AGENDA

The adopted Agenda is given in Appendix 1.

4. REVIEW OF DOCUMENTS

Relevant documents available to the Working Group were: SC/62/NPM1-30 and Hatanaka and Miyashita (1997).

An issue was raised concerning paper SC/62/NPM11, which included the instruction 'Do not cite without written permission from the authors'. Committee guidelines (IWC, 2003, p.87) state that documents submitted to the Committee are considered part of the public domain in line with the Rules of Procedure of the Commission. It is the policy of the *Journal* that if authors specify that the paper should not be cited without permission that must be respected. However, Committee guidelines also state that if a paper is to form the major basis for a recommendation by the Committee, it is not acceptable for such a strong restriction on citation to be placed. The authors of SC/62/NPM11 indicated that the paper could be cited in the context of IWC business. Some members believed that all papers submitted to the Committee should be freely citable. This is a general issue and was referred to the full Committee for further consideration.

5. STOCK STRUCTURE

The Chair clarified that the goals for this meeting were not to assess relative plausibility of alternative hypotheses regarding stock structure, but rather: (1) to agree to a set of inclusive plausible hypotheses consistent with the data; and (2) to assemble the types of information that will be considered when evaluating relative plausibility at the First Annual Meeting. The RMP *Implementation* process explicitly takes uncertainty into account by considering alternative stock structure hypotheses. Some discussion ensued regarding the minimum standard for plausibility. Donovan clarified that the IWC has no firm guidelines on this issue. One suggestion was that a single statistical test indicating heterogeneity in a metric directly related to stock structure should be sufficient to establish 'plausibility.' Others felt that it was also important to establish that the test result was not an artefact related to inadequate sampling or other irregularities and that there is reason to believe that differences detected by the test are biologically meaningful. The latter point implies some consideration of effect size in addition to statistical significance. The Working Group **agreed**, as the Committee has in the past, that the most reasonable approach is to use best professional judgment, laced with common sense, after considering all relevant information.

5.1 Brief overview of past discussions

Donovan briefly reviewed previous work on stock structure for western North Pacific common minke whales. Creation of sub-areas allowed for geographic specificity of the stock structure hypotheses. During the previous *Implementation*, the Committee adopted the following stock structure scenarios (IWC, 2004).

(1) Baseline A: a three-stock scenario (J, O, W) with the W-stock found only in part of sub-area 9 and only sporadically.
(2) Baseline B: a two-stock scenario (J and O) with no W-stock.
(3) Baseline C: a four-stock scenario, with J to the west, and O_W, O_E, and W to the east of Japan. Boundaries are fixed at 147°E and 157°E and there is no mixing between the stocks.
(4) Baseline D: a three-stock scenario (J, O, W), with O dominant in the west and W dominant in the east but mixing across 147°E and 162°E.

All of these hypotheses except C involved stock mixing in some areas, and all assumed a single 'J' stock to the west of Japan.

An additional set of hypotheses dealt with potential heterogeneity in the 'J' stock. As summarised in IWC (2010b), these were (in each case, in addition to one or more 'O'-like stocks to the east of Japan):

(5) One stock, J, that migrates to Yellow Sea, Sea of Japan, and the Pacific coast of Japan.
(6) Two stocks, J and Y; J migrates along both coasts of Japan, and Y migrates along the Korean coast.
(7) Two stocks, J and Y; J migrates through the Sea of Japan and Pacific coast of Japan, and Y migrates up to the Yellow Sea.
(8) Two stocks, J and Y; both stocks migrate through the Yellow Sea and Sea of Japan at different times of year.
(9) Three stocks, J, K, and Y; J migrates along both coasts of Japan, K along the Korean coast, and Y up to Yellow Sea.
(10) Three stocks, JE, JW, and Y; JE migrates along the Pacific coast of Japan, JW through the Sea of Japan, and Y up to Yellow Sea.
(11) Three stocks, JE, JW, and Y; JE migrates along the Pacific coast of Japan, JW along the west coast of Japan, and Y migrates along the Korean coast including Yellow Sea.

Only hypotheses (1)–(4) had been agreed by the Working Group last year.

Stock structure evaluations are particularly challenging for North Pacific minke whales because the breeding grounds (presumably to the south of 35°N) have not been identified, let alone sampled, and the primary feeding grounds (in the Sea of Okhotsk) are in Russian territorial waters and present considerable difficulties for sampling. Therefore, available samples are primarily from migrating individuals. Furthermore, migration routes can vary substantially by sex and age, so a sample of individuals collected at a certain time and place might represent a mixture of two or more stocks and/or a non-representative sample from a portion of a single stock. Most population genetic analyses assume that each sample is drawn randomly from a single population, and those analyses that deal explicitly with population mixtures generally require 'baseline' samples from stocks that potentially contribute to the mixture.

Genetic analyses of North Pacific minke whales generally have dealt with these difficulties in one of two ways, both of which have advantages and disadvantages. One approach is to group individuals into geographic collections representing potential stocks and analyse allele or genotypic frequencies using standard population genetic methods and a hypothesis testing framework. The advantage of this approach is that it allows use of well-developed theory and a wide variety of analytical methods, including statistical tests of heterogeneity. The main disadvantages are that the initial grouping of the samples might require rather arbitrary decisions, and results can be ambiguous or misleading if some samples include individuals from more than one population. The other approach has been to use Bayesian clustering methods (specifically, the program STRUCTURE) to partition the entire collection of samples into component gene pools or stocks. The advantage of this approach (which can be considerable for situations such as that for the North Pacific minke whales) is that it does not require one to make *a priori* assumptions about how to put individuals into groups to be compared. The main disadvantages are that the method for inferring the number of gene pools is *ad hoc* and not statistically rigorous, and it has been demonstrated empirically that the power of the method to resolve mixtures of closely related populations is limited. IWC (2010b) has a more detailed discussion of these issues with respect to previous genetic analyses of North Pacific minke whales. IWC (2007) describes related discussions for North Pacific bowhead whales.

5.2 Summary of available genetic and non-genetic data

The Chair emphasised the importance of creating a document that lists the various datasets and other information that were available for the *pre-Implementation assessment*. This would be a living document, at least until a deadline is established for consideration of data for the *Implementation Review*. Kanda, An, Miyashita and Baker constructed a data table, given in Appendix 2.

5.3 Consideration of new information/analyses

The Working Group first considered papers providing non-genetic information.

SC/62/NMP22 provided results of a biopsy skin-sampling survey of common minke whales conducted from 18 July to 31 August 2009 in the Okhotsk Sea by the research vessel *Shonan-maru No.2.* The research area (north of 46°N, south of 57°N, and west of 152°E) included areas within the Russian 200 n.mile EEZ and involved 11 tracklines totalling 2,219.9 n.miles. Weather conditions were generally good, but dense fog sometimes interfered with survey activities. 1,662.6 n.miles were searched in primary searching mode and 447 cetacean groups were sighted. Common minke whale schools were encountered on 46 occasions (48 total individuals), mainly in shallow coastal waters of around 200m depth. Eighteen schools (19 animals) were approached for biopsy sampling and biopsy samples were collected from five individuals, after 18 darts were launched at 9 animals using two Larsen biopsy guns. Unfortunately, none of the biopsy samples could be removed from Russian waters because of CITES-related restrictions. A high-resolution digital camera was used to record scars of cookie-cutter shark bites on 22 common minke whales, all of which exhibited scars on their dorsal and/or lateral aspects. Other large cetaceans encountered were fin, North Pacific right and sperm whales.

In discussion, Miyashita explained that although some permit issues remained unresolved at the start of the cruise, the crew took five biopsy samples in the hope that the permits would be forthcoming. When they learned that it would be impossible to return the biopsies to Japan, the material was disposed of. For subsequent cruises, Japanese scientists plan to conduct some analyses onboard to ensure that at least some information is obtained from the samples (see discussion of SC/62/NPM23 under Item 7.6). It was suggested that other countries are able to import CITES-restricted material from Russia and that in the future the samples might be left with a Russian colleague who could subsequently arrange transfer through another country. This had been explored, but was also found to be unfeasible. In spite of these disappointments, the Working Group was pleased that this research had been conducted within the Russian EEZ, and had been able to collect biopsy samples from minke whales on the feeding grounds. The Working Group therefore **encouraged** future collaborations. Furthermore, the cruise produced valuable new observations on incidence of cookie-cutter shark marks on minke whales and sighting and photographic information on right whales.

SC/62/NPM10 estimated the mixing proportion of 'O' and 'J' stocks in the Sea of Okhotsk using cookie-cutter shark scars from 22 animals. Based on previous research in sub-area 11 in 1996 and 1999, the maximum likelihood estimate for the proportion of 'J' stock in sub-area 12 was 0.

The Working Group welcomed this valuable new information, but **agreed** that the method used to estimate mixing proportions needed some refinement. The baseline data used for incidence of scars on 'J' and 'O' stock were discussed. A question arose as to how long scars from cookie-cutter shark bites remain visible, which determines the time frame over which the observations provide information related to distribution. Although information on scar duration in common minke whales was not readily available, it was noted that some scars are clearly new, others appear to be healing, and others are completely healed and perhaps beginning to fade. Longitudinal studies of individual killer whales indicate that cookie-cutter shark scars can persist for multiple years. Collectively, these results suggest that some caution is needed in interpreting observations of juveniles, which have not had many years to accumulate scars and thus might be misidentified as belonging to a stock that does not frequently enter waters where cookie-cutter sharks occur.

It was suggested that additional data on cookie-cutter scars might be found associated with the JARPN and JARPN II programmes.

SC/62/NPM13 reviewed non-genetic biological information relevant to the stock structure of minke whales in the Yellow Sea, Sea of Japan (East Sea), and western Pacific Ocean. The review was structured to examine four key comparisons between: (1) the Yellow Sea and the Korean coast of the Sea of Japan; (2) the Korean and Japanese coasts in the Sea of Japan; (3) the Sea of Japan and Pacific coasts of Japan; and (4) coastal and offshore areas of the Pacific Ocean. The authors noted that examining minke whale stock structure was made difficult because there are no data from the breeding grounds and there are few data from mature females on the feeding grounds, as sampling has been limited to the mid-latitudes (mostly between 35° and 45°N). A few types of biological data were found to be particularly informative, including conception dates and flipper colour types. An examination of migration patterns, whale distribution, and historical whaling areas on feeding grounds, in concert with observations of immature/mature ratios and sex ratios also provided information to help fully describe possible stock structure hypotheses. Several lines of evidence point to the existence of a separate stock of minke whales in the Yellow Sea. In particular mature females with newborn calves are there in summer, and whales from the Yellow Sea only have dates of conception in autumn (July–September), in contrast to other areas which have winter conception (February–March) dates or a mix of autumn and winter conception dates. There is less information to determine whether two stocks exist on either side of the Sea of Japan. A small sample from the Sea of Japan shows a mixture of autumn and winter conception dates and of type III and type IV flipper colour types, which could be indicative of a mixture of two stocks, but can also be explained by whales from the Sea of Okhotsk moving into the northeastern Sea of Japan. Comparisons between the west and east coasts of Japan (Sea of Japan versus Pacific coast) are complex due to the possibility of certain areas having a mix of multiple stocks or undescribed distinct stocks. Pacific coastal data from Sanriku and east of Hokkaido have only winter conception dates and the type IV flipper colour pattern, whereas the small sample from Sea of Japan has a mix of fall and winter conception dates and type III and IV flipper patterns. It was noted that comparisons between coastal and offshore Pacific areas are complicated because sub-areas 8 and 9 are dominated by immature males whereas coastal sub-area 7 has a majority of females and a higher proportion of mature animals. Whale densities were also much higher along the coast than offshore, suggesting the possibility of a coastal stock, and differences were found between the amount of body scars from cookie-cutter sharks and in the concentrations of some contaminants. Again, the observation of only winter conception dates and the type IV flipper colour patterns from Sanriku and east of Hokkaido are not consistent with the hypothesis that coastal sub-area 7 has a mixture of two stocks. The authors concluded it was plausible there were stock differences between all four comparisons that were made.

The Working Group welcomed this attempt to synthesise diverse types of non-genetic information that potentially can inform discussions of stock structure. The Working Group found the idea of orienting the analyses around four key questions useful. The authors of SC/62/NPM13 acknowledged that although they had attempted to be exhaustive, they might have missed some relevant biological information, particularly if it was reported outside the IWC context, and requested that any such information be forwarded to them. The Working Group in particular supported the collation of the information in table 3 of SC/62/NPM13 and **encouraged** members to work together to complete this and provide it to the First Intersessional Workshop of the *Implementation Review*.

Information about conception dates presented in SC/62/NPM13 was discussed. It was pointed out that the same data are shown in table 1 (as counts) and fig. 6 (as proportions) in the paper, and the latter can be misleading when they are based on a small amount of data. It was also noted that some recent conceptions might be difficult to detect because the foetus is small, and this could potentially lead to bias in estimated conception dates if samples are taken primarily in certain seasons. Several members questioned the proposal, based on a sample size of only eight animals, that minke whales in the Sea of Japan have a bimodal distribution of conception dates. It was pointed out that these data, apparently based on Kato (1992), should not be considered as a single spatial unit because they were derived from two different surveys – three animals with October conception dates were taken off the east coast of Korea in 1972–73 (*Miwa-maru* operation using a self-factory catcher boat), while the other five were from small, coastal-based commercial whaling operations off the west coast of Hokkaido. Wade noted that the samples had been combined to represent samples from the Sea of Japan, which was still the case after the clarification of the exact location of the samples, so the conclusions of SC/62/NPM13 were still valid. It was pointed out that the data on flipper colouration based on Kato *et al*. (1992) were from the *Miwa-maru* operation, which never operated in the neritic zone; these data were therefore not comparable to those considered in SC/62/NPM1 in evaluating migration scenarios (see below). Wade clarified that those data had been used in SC/62/NPM13 to evaluate stock structure scenarios for the Sea of Japan, not migration scenarios, so samples would not need to be restricted to the neritic zone.

Table 1

List of sighting surveys and sightings of common minke whales.

Season	Period	Sub-area	Research vessel*	Research distance (n.miles)	No. primary sightings	
					Schools	Animals
Japanese surveys						
1989	13/07–25/08	12	KY1	1,263	25	30
1990	01/08–29/09	8	T25	789	2	2
1990	01/08–29/09	9	T25	2,716	10	10
1990	25/07–21/09	11	KY1	202	10	14
1991	26/07–19/09	7	KY1	1,900	10	13
1991	10/08–17/09	7	SHU	1,990	14	16
1992	29/07–23/09	6	T18	2,387	11	14
1992	01/08–20/09	7	SHU	2,786	8	8
1992	29/07–23/09	10	T18	1,094	8	9
1992	03/08–27/09	12	KY1	2,215	29	32
1994	05/07–07/09	9	T18,T25	3,981	20	21
1995	13/06–22/08	9	KY1,T18, T25	9,686	80	81
2002	10/04–09/05	6	KSK	390	5	7
2002	13/05–01/07	6, 10	SM2	2,162	33	34
2002	05/06–08/09	7, 8, 9	KS2	3,535	3	6
2003	11/04–10/05	6	KSK	716	3	3
2003	12/05–30/06	6, 10	SM2	1,878	27	31
2003	22/07–19/09	11, 12	SM2	1,598	60	67
2003	22/07–19/09	12	SM1	902	12	12
2003	14/05–05/09	7, 8, 9	KS2	4,934	66	73
2004	11/05–29/06	6, 10	SM2	1,898	14	14
2004	14/05–23/08	7, 8, 9	KS2	3,852	29	33
2005	12/05–30/06	10	SM2	841	11	12
2005	29/07–20/09	8, 9, 12	SM2	868	4	4
2005	29/07–20/09	9	SM1	996	6	6
2005	15/05–24/08	8, 9	KS2	4,975	14	15
2006	18/05–28/06	10	KKM	1,852	51	55
2006	17/05–26/08	7, 8, 9	KS2	5,413	45	53
2007	18/05–28/06	10, 11	SM2	1,599	39	47
2007	16/05–30/07	7, 8, 9	KS2	3,776	6	6
Korean surveys						
2000	Early May–early Jun.	6	TG3	709	25	28
2001	Mid Apr.–late May	5	TG3	811	28	30
2002	Mid May–early Jun.	6	TG3	1,169	30	32
2003	Mid Apr.–late May	6	TG3	1,082	16	18
2004	Mid Apr.–late May	5	TG3	1,787	18	20
2005	Mid Apr.–late May	6	TG3	1,145	28	32
2006	Mid Apr.–late May	6	TG3	1,070	20	25
2007	Mid Apr.–late May	6	TG3	1,043	21	25
2008	Mid Apr.–late May	5	TG3	1,384	18	18
2009	Mid Apr.–late May	6	TG3	1,144	36	40

*KKM = *Kaikomaru*; KSK = *Kurosaki*; KS2 = *Kyoshinmaru No.2*; KY1 = *Kyomaru No.1*; SHU = *Shunyomaru;* SM1 = *Shonan-maru*; SM2 = *Shonan-maru No.2*; T18 = *Toshimaru No.18*; T25 = *Toshimaru No.25*; TG3 = *Tamgu No.3.*

SC/62/NPM28 provided alternative interpretations of data discussed in SC/62/NPM13 and argued that the usefulness of SC/62/NPM13 is limited by the failure to interpret the biological information in the context of the available genetic data. Other major points in SC/62/NPM28 were: (a) the existence of different feeding grounds (Yellow Sea vs Sea of Japan) is not sufficient to define independent populations; (b) available biological data do not support division into three populations (Korean, west and east coasts of Japan); (c) different conception dates between west and east coasts of Japan (winter only in the Sanriku area) can be explained by assuming that juvenile 'J' stock animals intrude into this area (pregnant females of 'J' stock seldom enter this area); (d) sex-ratio differences between coastal and offshore whales can be explained by noting that juveniles (both male and female) feed in coastal areas, while offshore areas are occupied mainly by adult males (Hatanaka and Miyashita, 1997; Zenitani *et al.*, 2000); (e) differences in cookie-cutter shark scars can be explained by juveniles (fewer scars) being abundant in coastal areas and 'J' stock animals (fewer scars) being sometimes in coastal areas while adult males (more scars) are distributed in offshore areas.

Additional points made in discussion of SC/62/NPM13 and SC/62/NPM28 included that the results are generally consistent with existing O+J hypotheses based on how animals migrate in the vicinity of Hokkaido/Sakhalin Island. Animals bycaught around Japan were reported to be mostly juveniles, although these catches generally were not examined for maturity or pregnancy. Additional data might be found in IWC (1997). In Wada (1991), 'Sea of Japan' samples were taken from only a small section off the west coast of Hokkaido so are not representative of the entire Sea of Japan (Wada, 1991). Some types of information (e.g. sex ratio and percent sexually mature) may simply reflect demographics within a population and are of uncertain use for comparisons among stocks. Regarding the last point, Wade largely agreed but felt that, nevertheless, in some circumstances this type of information can be a useful indicator of migration patterns or mixing rates of components of a population.

SC/62/NPM1 evaluated the recent hypothesis regarding migration of 'J' stock animals (IWC, 2010b) in the context of available information on mixing patterns between 'O' and 'J' stocks, distribution of sightings, sea ice condition, and bycatch by coastal fishing gear. Collectively, this information agreed well with the following aspects of the hypothesised migrations of 'J' stock: (a) northward (feeding) migration begins in January–February; (b) pregnant females migrate into the southern part of Okhotsk Sea in April following the retreat of sea ice; (c) the main feeding season is April–June; (d) southward (breeding) migration starts in July; and (e) segregation by sex and maturity occurs, with pregnant females migrating to the northernmost distribution area, adult animals migrating and distributing in offshore waters in the Sea of Japan, and juveniles staying close to the coasts of Japan and Korea for most of the year, following a migration pattern that is different from adults.

The Working Group welcomed this paper. The caveats noted above for SC/62/NPM10 regarding estimates of mixing proportions in sub-area 12 also apply here. In addition, the small sample sizes for late summer limit the strength of conclusions that can be drawn. The question of whether juvenile 'J' stock animals did not go to the Sea of Okhotsk was raised. This was acknowledged to be a difficult question, with insufficient data. SC/62/NPM5 addressed whether 'J' stock went into sub-area 12 perhaps early in the year but that later in the year the whales were returning to their breeding grounds so fewer 'J' stock individuals were seen. Juveniles are bycaught as they migrate into sub-area 11, but the fraction of the population that this represents is uncertain.

Considering juvenile 'J' stock in sub-area 12, no data are available from the Russian EEZ. It is possible that whales might go into sub-area 12 as water temperature warms and ice recedes (see fig. 4 of SC/62/NPM1). In Japan and Korea, juveniles tend to be more coastal, so they are not likely to spread widely across sub-area 12. Although no data exist on prey availability, this area is one of most productive areas in eastern Asia, so it should be a good feeding ground. So, the hypothesis that the whales leave by mid-summer is not for lack of prey, but rather reflects the necessity of leaving early enough to arrive at the breeding grounds in time for autumn breeding (as indicated by conception date estimates). In response to a question, Hatanaka acknowledged that direct evidence that the southward migration begins as proposed is lacking, but the hypothesis is consistent with available information about sightings of migrating individuals (see fig. 8 of SC/62/NPM1). An unresolved question is whether changes in the fraction of 'J' stock individuals in the Sea of Okhotsk are due to outward migration of 'J' stock or more 'O' stock whales entering the area.

The Working Group reconsidered Hatanaka and Miyashita (1997) that investigated feeding migration based on length data. It was pointed out that these data are consistent with the generic concept of an 'O' stock, and that the length data might be useful for mature/immature determinations to condition different migration patterns for one or more 'O' stocks. The Working Group **agreed** to include these data in Appendix 2.

SC/62/NPM11 had two major objectives: (1) to determine the status of whales that could not be identified reliably to 'O' or 'J' stock based on analyses described in Kanda *et al*. (2009); and (2) to examine stock structure of the 'J' stock in the Sea of Japan and Yellow Sea. Data used included genetic variation at 16 microsatellite DNA markers analysed from samples collected during JARPN and JARPN II from 1994 to 2007. Previous analyses using the program STRUCTURE (Kanda *et al.*, 2009) classified 91% of sampled whales to either of two populations (assumed to be 'J' and 'O' stocks). It was argued in SC/62/NPM11 that the analysis could have overlooked additional, but weakly differentiated, stocks. An alternative explanation is that only two stocks exist and levels of differentiation are too small to provide 100% resolution. Additional STRUCTURE runs that focused on unassigned individuals and putative 'O' stock individuals failed to find any evidence of additional stock structure. Principal Component Analysis showed that unassigned individuals tended to occupy a multidimensional space that is intermediate to the centres of distribution of 'O' and 'J' stock individuals – a result that is consistent with what would be expected if the unassigned individuals actually come from either 'O' or 'J' stock. Regarding the second objective, SC/62/NPM11 analysed Korean genetic data for bycaught minke whales from 1999 to 2007 in combination with the Japanese genetic data used above. Samples from Korea from 2005–07 were not used in the previous papers. Analyses using STRUCTURE did not show evidence of more than a single population, while conventional hypothesis testing detected only very weak genetic differences among some of the Korean samples, as well as between the Korean and Japanese samples. The genetic differences between the Korean and Japanese samples could be due to a sub-stock (Y stock) that mainly occupies the Yellow Sea but sometimes migrates north along the Korean coast. Results of SC/62/NPM11 thus support the previous view that 'J' and 'O' are the main stocks inhabiting Korean and Japanese waters. In addition, a Y sub-stock might occupy the Yellow Sea, but further analyses with more samples from the Yellow Sea will be needed to reach a final conclusion.

The Working Group appreciated the efforts of the authors to respond to some of the suggestions for additional analyses made last year. Some discussion ensued on two data quality issues that were unclear in the paper. Park stated that the Korean laboratory followed the protocols described in the paper. Kanda explained that PCR products of 16 microsatellites amplified from five reference individuals were analysed in each laboratory for standardisation of microsatellite scores between the Korean and Japanese laboratories. Kanda also noted that genotypes at each of the loci were compared to see the differences in allelic sizes caused from using different platforms. For the current project, the Korean dataset was standardised to the Japanese set by deleting/adding base pairs to alleles at each of the loci, based on differences obtained from analysing the reference individuals. Kanda further explained that at the inter-lab coordination step, 6 loci were excluded because they had a wide range of allele sizes and/or many minor alleles that were difficult to score. Other members noted that it is not uncommon for different laboratories to be unable to achieve consistent scoring of a subset of loci. It was pointed out that data in table 5 of SC/62/NPM11 show that the Korean laboratory consistently reported higher numbers of alleles than the Japanese laboratory. At least two factors could explain this result: firstly, inconsistencies in scoring methods between the laboratories; and secondly different mixtures of stocks analysed by the two laboratories. It was suggested that comparison of winter samples only (when intrusion of putative Y-stock individuals is rare or absent) might help distinguish these two hypotheses. Kanda and Park performed a comparison for sub-area 6, which still showed the same pattern; at most loci, a larger number of alleles were found in samples from Korea that were analysed in the Korean laboratory.

Some members disagreed with the conclusion of SC/62/NPM11 that these results supported the view that 'J' and 'O' stock are the main stocks inhabiting Korean and Japanese waters. These members noted that the PCA showed a uniform distribution across the primary axis without obvious clustering, consistent with an effect of isolation by distance rather than discrete breeding stocks. There were also a large number of samples that appeared counter-assigned, i.e. samples assigned by STRUCTURE as 'O' stock were found on both sides of the principle component axis.

A question arose as to which information provided insights into a possible Y-stock. Kanda responded that this was inferred from differences between Korean areas of sub-area 5 (K5) and sub-area 6 (K6) – row 3 of table 7 of SC/62/NPM11. Sub-area K5 presumably includes only Y-stock, while sub-area K6 includes 'J' stock as well as seasonal intrusions of Y-stock. It was also noted that the comparison across both sides of the Sea of Japan (row 4 in table 7 of SC/62/NPM11) was also significant, although the F_{ST} value (0.0004) was very low. In response to a question, Kanda confirmed that the significance levels indicated in this Table reflected the Bonferroni correction for multiple testing. Results therefore suggest significant genetic differences for samples taken east and west of Korea, as well as between the Korean and Japanese coasts. It was suggested that fig. 5 of SC/62/NPM11, which showed that the fraction of individuals that are unassigned by the program STRUCTURE is roughly constant across all sample areas, might be useful for testing alternative stock-structure hypotheses. For example, the hypothesis that unassigned individuals represent a distinct stock would not be expected to produce this pattern. Another suggestion was to plot the third axis for figs 3 and 4 of

SC/62/NPM11. Hatanaka suggested that those proposing more analyses could undertake them by taking advantage of the Data Availability Agreement.

Two papers presented new analyses of mtDNA data. Paper SC/62/NPM21 examined genetic variation at the mtDNA control region to evaluate the plausibility of proposed stock structure scenarios for the 'J' and 'O' stocks. Analyses were based on samples collected during JARPN and JARPN II surveys from 1994 to 2007 in the area from the Japanese coast to offshore waters (to 170°E) on the Pacific side, and from by-catches around Japan and the Korean Peninsula. Analyses were conducted using updated databases (which included corrected versions of the mtDNA data) for both Korean and Japanese common minke whale mtDNA. Scientific Committee quality control guidelines were followed as far as possible. Samples were first separated into 'J' and 'O' stocks according to the results of the microsatellite analysis (SC/62/NPM11), and subsequent mtDNA heterogeneity tests were conducted for different categories of grouping (total samples, 'pure' 'O' or 'J+' unassigned samples and 'pure' 'J' or 'O' only). Heterogeneity tests were based on the randomised chi-square test and the F_{st} values were calculated to obtain an idea of the effect sizes of the groups compared. For comparisons involving 'pure' 'J' stock samples: (a) no seasonal significant differences were found in either the Sea of Japan or the Pacific side of Japan; (b) no significant differences were found between whales to the east and west of Japan; (c) a significant difference was found between Japanese and Korean samples, but the test became insignificant when whales in the Yellow Sea were excluded. F_{st} values in all these comparisons were very small. Tests for examining sub-stock structure in the 'O' stocks followed the four stock structure hypotheses adopted at the final stage of the *Implementation* in 2003. No significant heterogeneity was found when the samples were grouped and tested according to the geographical boundaries of the stock scenarios A, C and D and 'pure' 'O+' unassigned animals were used. The F_{st} values were very small in all comparisons. Therefore the present results provide no support for the occurrence of sub-structure within the 'O' stock. In general, the results of these mtDNA analyses, which were based on a substantial number of samples, supported the previous view of two stocks of common minke whale in the western North Pacific, the 'J' and 'O' stocks. The possibility of a different stock in the Yellow Sea should be further investigated in the future.

Some members expressed a general concern with the approach used to 'filter' 'O' and 'J' stock individuals based on the STRUCTURE assignment prior to use of the mtDNA in hypothesis testing.

SC/62/NPM20 reported on differences in mtDNA sequences and sex ratios in western North Pacific minke whales by combining information from samples collected in Korean market surveys (Korean 'bycatch', *n* = 237) with three datasets made available courtesy of the Institute for Cetacean Research (ICR) through the IWC Data Availability Group on 8 January 2010 (version 1.0): Japanese 'bycatch' (*n* = 832), 'coastal whaling' (*n* = 481) and 'offshore whaling' (*n* = 1,238). Because the initial dataset included a number of sequencing errors and errors in computing distance from shore, these analyses collapsed haplotypes into four haplogroups, previously considered to be informative (although not diagnostic) of the 'J' and 'O' stocks. The 'O' and 'J' types defined by the four mtDNA haplogroups showed a 93% concordance with samples assigned to the 'O' and 'J' clusters in the STRUCTURE analysis of microsatellite loci (Kanda *et al.*, 2009). Using the information on haplogroups and sex, SC/62/NPM20 reported on numerous pairwise differences for various strata, including sub-areas, source (bycatch, coastal whaling, offshore whaling), latitude (1 degree increments) and season (autumn/winter and spring/summer). Significant differences were found for either haplogroup frequencies, sex ratios or both, for almost all comparisons. A notable exception was the Korean bycatch (market individuals) vs. sub-area 6 bycatch (Japanese coast of Sea of Japan), which did not show significant differences in haplogroup frequencies, but did show a difference in sex ratios and in the haplogroups-by-sex effect. Analyses then focused on sub-areas 2 and 7W to investigate the potential for one or more coastal stocks along eastern Japan. Haplogroup frequencies of bycatch showed a pronounced change at 33–34°N, suggesting this might be a more natural division than the current subarea boundary at 35°N. Within sub-area 7W, comparisons showed differences in haplogroup frequencies and/or sex ratios for most strata, including 'bycatch (BC)', 'coastal Sanriku (CS)', 'coastal Kushiro (CK)' and 'offshore' hunting. As a qualitative investigation of 'J' stock distribution in sub-area 7W, the location of the four haplogroups were plotted according to latitude and longitude. At a qualitative level, these plots show no clear demarcation of haplogroups by latitude or distance from coastline within the range of the 'coastal' whaling operations at Sanriku and Kushiro.

Paper SC/62/NPM20 had the following conclusions regarding plausible stock structure hypotheses.

(1) CK and BC (sub-area 6) are similar in haplogroup frequencies, consistent with a primary influence of one stock, presumably the 'core' 'J' stock, present year-round in the Sea of Japan. In BC (Korea), however, the male-biased sex ratio and the haplogroup-by-sex differences could reflect migratory mixing (or mixing in the market) of a second stock, perhaps from the Yellow Sea. Although the majority of Korean bycatch is reported from the Sea of Japan (East Sea), some proportion of the whales killed in the Yellow Sea are probably transported for sale to Busan, Ulsan and Pohang, where the samples used in SC/62/NPM20 were collected. No sex bias or haplogroup-by-sex differences were found for BC (sub-area 6), suggesting a year-round presence of a non-migratory coastal stock.
(2) BC (sub-area 2) differs from BCK and BC (sub-area 6), and from BC (sub-area 7), suggesting the potential for an eastern coastal stock (J_E) with characteristics of the 'core' 'J' stock in the Sea of Japan (J_W).
(3) BC (sub-area 7), CS and CK differ from 'offshore' hunting, particularly in sub-areas 8 and 9, suggesting the potential for a second coastal stock (O_W) along eastern Japan, with some (perhaps seasonal) mixing of J_E and O_E. Stocks characterised by intermediate haplotype frequencies are well described in humpback whales, where stock divisions are supported by multiple lines of evidence (e.g. photo-id records).
(4) Although it is possible that the haplotype frequencies of sub-area 7W could be explained by a complex seasonal, sex- and age-biased mixing of two stocks, e.g. a 'core J' and a 'core O', this is not consistent with much of the available data including the observed absence of a haplogroup-by-sex effect in BC (sub-area 7), CS and CK.

The authors of SC/62/NPM20 would have liked to analyse the Korean bycatch data but did not have time to work through the data sharing agreement. SC/62/NPM21 noted that the Korean dataset as originally submitted included a number of sequencing errors, which have now been corrected.

Paper SC/62/NPM27 commented on the analyses conducted in SC/62/NPM20. Major points included: (a) interpretation of results of market samples is difficult, as the origin of the samples is unknown, and the dynamics of whale products in the market is undocumented; (b) quality control of market DNA samples followed protocols of Morin *et al*. (2009) rather than the guidelines agreed by the Scientific Committee; (c) haplogroup AA (informative of the 'J' stock according to the authors of SC/62/NPM20) occurs in higher frequencies in samples of the 'O' stock in coastal and offshore samples; and (d) several statistical comparisons were made for strata where 'J' and 'O' stock animals mix in different proportions. It is therefore not surprising that significant differences are found when these strata are compared. For example, the mixing fractions of 'J' and 'O' stocks are different among areas BC (sub-area 7), 7W and 7E. Consequently, haplogroup composition changes leading to the significant differences. Similarly, it is not surprising that no significant differences are found in comparisons among strata where only one stock is suspected (e.g. between sub-areas 8 and 9 and between BC (sub-area 6) and Korean market). SC/62/NPM27 provided two explanations for their results for the Pacific side of Japan: (i) complex seasonal mixing of 'O' and 'J' stock animals; and (ii) whales in sub-area 7W represent a third stock (e.g. O_w). They considered explanation (ii) more plausible, but did not provide any evidence for assigning plausibility. Results of statistical testing of strata including both 'J' and 'O' stock in different proportions are misleading.

Baker contested statements in SC/62/NPM27 because: quality control protocols as discussed in Morin *et al*. (2009) include and extend those considered by the Committee, and SC/62/NPM27 concludes that the hypothesis of multiple stocks is 'more parsimonious' (rather than more plausible) than a complex age-sex, latitudinal-longitudinal, migratory mix of two breeding stocks, which have no defined breeding grounds.

In discussion, it was clarified that although SC/62/NPM20 and SC/62/NPM27 largely considered the same group of samples, there were two important differences: (1) SC/62/NPM20 used market samples for Korean samples, while SC/62/NPM21 used bycatch; and (2) SC/62/NPM21 used mtDNA data that had been error-corrected subsequently due to time constraints and the agreed deadlines for *pre-Implementation assessment*, while SC/62/NPM20 used the original data and grouped haplotypes into haplogroups to minimise influence of the sequencing errors. Members noted some differences between results for mtDNA and microsatellites and suggested that it would be useful to combine results for the two marker types into a single analysis. Some argued that any deviations from the standard two stock (O+J) hypothesis could be explained by occasional intrusions of Y- or W-stocks. Others believed that the results supported separate 'J' stocks on either side of Japan, or more complex stock structure hypotheses.

The Working Group discussed standards for establishing/rejecting hypotheses, which the Committee had previously discussed on a number of occasions but has been unable to establish any guidelines or criteria. The Working Group **agreed** that it is important to try to find a balance between two potential errors: (1) interpreting minor differences that might be artefacts or not biologically meaningful as evidence for separate stocks; and (2) failing to recognise true stock structure because power to resolve closely related populations is low. Finding the appropriate balance, however, is challenging. One suggestion was to use a weight-of-evidence approach, combined with the expectation that a clear explanation is required if statistically significant results do not result in a new hypothesis.

Discussion of SC/62/NPM20 and SC/62/NPM27 also highlighted divergent opinions within the Working Group regarding how best to deal with the inability to sample pure populations on their breeding grounds. In one view, the best way to approach this problem is to utilise results of the program STRUCTURE, which is designed to deal with situations in which there are no reliable *a priori* ways of grouping individuals into putative populations. If the program works as intended, selective removal of individuals believed to be from different populations could facilitate more meaningful analyses of the data using traditional methods. Others argued that this approach has elements of circularity and can result in a false sense of confidence in model results. In addition, published papers document the inability of STRUCTURE to produce reliable results when dealing with mixtures of closely related populations or systems that are characterised by isolation-by-distance. In this view, relying on imperfect STRUCTURE classifications to adjust datasets runs too high a risk of masking true signals of subtle population sub-division. These same issues have arisen previously regarding earlier versions of the genetic data analyses for North Pacific minke whales (IWC, 2010a; 2010b). The Working Group **agreed** on the potential value of trying to collect at least some samples in areas where a single stock is believed to occur, but it is harder to agree on where such areas occur. There was little disagreement that only 'O' stock occurs in sub-area 8, as discussed in previous years. However, it was pointed out that it is possible for a sample to be 'pure' (in the sense that it includes only a single stock) but nevertheless not representative. This might occur, for example, if a stock is not completely homogeneous, but rather exhibits isolation by distance (individuals that occur closer together are more closely related). It is also problematic that mature females are largely absent from the whales killed in sub-area 9, and thus the available samples are not representative of a true population.

Paper SC/62/NPM30 was a direct response to a request by the Committee for repeating (using updated datasets) two types of analyses that were instrumental in erecting some of the existing stock-structure hypotheses: Boundary Rank (BR – see Taylor and Martien, 2003) and empirical Bayesian estimates of migration rates that are consistent with the genetic data (Taylor and Martien, 2004). An *ad hoc* e-mail group was assembled to help direct the analyses in the most productive way. Principal component analysis (PCA) was used to visualise geographically contiguous patterns of genetic variation because the initial configuration of samples for the original BR analyses could not be recreated. PCA does not group individuals into discrete populations; it outputs each individual's coordinates along axes of variation. However, it is possible to represent each individual PCA score for each axis of variation on a map, which allows regions that are genetically homogenous to be identified. These patterns, together with geographic boundaries of sub-areas specified in previous stock structure hypotheses, were used to group the >2,000 individual whales into 12 collections for use in the BR analyses. As the focus here was on possible heterogeneity within 'O' stock, the BR analyses considered four scenarios with increasing levels of the removal of individuals suspected of belonging to 'J' stock:

(1) all individuals included; (2) removing only individuals considered 'J' stock based on mtDNA haplotypes; (3) removing only individuals having a high assignment index for 'J' stock based on the program STRUCTURE; and (4) including only individuals having a high assignment index for 'O' stock based on the program STRUCTURE.

Although the PCA was only used for defining the initial configuration for the BR analyses, the results were discussed in some detail. Waples and Gaggiotti summarised the main results of SC/62/NPM30 as follows.

PCA. The analysis of Scenario 1 using the mtDNA data showed that the first three axes were statistically significant. A graphical representation is shown in fig. 1 of SC/62/NPM30. Axis 1 demonstrated heterogeneity within each of sub-areas 7, 8, 9. Axis 2 primarily contrasts southern regions of sub-areas 7, 8W, 9E with the rest of the sub-areas. PCAs under Scenarios 2–4 showed statistical significance of the first two axes, but no maps showing the spatial pattern were produced. A PCA of both mtDNA and microsatellite data show the same two axes, as well as a third significant axis that reflects variation in the microsatellite data. There was generally little heterogeneity for this third axis, except in the far northeast corner of sub-area 9. This persisted even under Scenario 4.

Boundary Rank Analyses. The first step repeated the BR analyses using mtDNA data for the 559 individuals included in the original (2003) analysis and led to a signal roughly consistent with Baseline C. The next step considered all the new mtDNA data and the four scenarios described above. None of these analyses supported Baseline C. Under Scenario 1, two BR steps were significant: Group 1 joining Groups 2–5, and Groups 1–5 joining Groups 6–12. Under Scenarios 2 and 3, no geographically separate clusters were found. These analyses proceeded by gradually adding individual groups to an increasingly large main cluster and the only significant test was the last step of adding Group 1 (animals just to the east of Hokkaido) to the remaining clusters. Under Scenario 4, none of the groupings were statistically significant. In this case, Group 1 is no longer distinctive and clusters with Group 4 early in the process. When the constraint against lumping samples that are not geographically contiguous was relaxed, results changed markedly. BR analyses were also performed using all available microsatellite data. Under Scenario 1, two statistically significant steps were found: Group 1 joining several others, and Group 3 joining Group 1 and the remaining sub-areas. No significant steps were found in Scenarios 2–4 with microsatellite data.

Migration rate simulations. A rigorous evaluation of this topic would have required updated estimates of abundance as well as detailed information about effect size, neither of which was available. Accordingly, a wide range of scenarios were considered, but results were not particularly useful as it appears that a very wide range of migration rates is consistent with the empirical data.

Discussion focused on whether, given results of these analyses, it is necessary to postulate more than one stock to the east of Japan. It was acknowledged that BR might not be designed to deal with situations like this, particularly because of uncertainties about how best to impose geographic constraints on grouping samples. During the discussion it was mentioned that the major results of the analyses could be summarised as follows: (1) BR of mtDNA found that the only genetically distinctive area was off the east coast of Hokkaido in the west part of sub-area 7; this pattern was seen in Scenarios 1–3 but disappeared under Scenario 4; (2) evidence for heterogeneity within O-type individuals depends largely on results of PCA analyses, which show residual heterogeneity in areas well to the east of the coastal areas (where 'J' stock mixing is likely). However, the information on stock structure provided by the PCA analyses is more qualitative than quantitative, and these results are not easily translated into specific stock-structure hypotheses; and (3) the PCA for microsatellite data identified a group of distinctive individuals in the far northeast corner of sub-area 9, which could be interpreted as support for intrusion of a different stock (perhaps the so-called W stock). Gaggiotti clarified that SC/62/NPM30 was completed well before the errors in mtDNA data were discovered. Therefore, the BR analyses were not performed with the error-corrected data. However, a reanalysis of the corrected mtDNA data using PCA produced results that were very similar to those of the uncorrected data set.

5.4 Stock-structure hypotheses

The Working Group reviewed and discussed two independent attempts to generate plausible stock-structure hypotheses that synthesised both genetic and non-genetic information.

SC/62/NPM12 examined recent progress in the development of stock structure hypotheses for western North Pacific common minke whales ('O' and 'J' stocks), and conducted a preliminary evaluation of these hypotheses in the context of the available scientific information, mainly genetics, presented and discussed by the Committee in recent years. The aim was to identify stock structure scenarios that are consistent with the data. The authors of SC/62/NPM12 considered that the best available scientific evidence is consistent with the hypothesis that there is a single 'J' stock distributed in the Yellow Sea, Sea of Japan and Pacific side of Japan and a single 'O' stock in sub-areas 7, 8 and 9. They considered this hypothesis the most plausible. It is consistent with the pattern of mixing between 'J' and 'O' stocks along the Japanese coast as proposed by Kanda *et al*. (2009), the migration patterns of adult and juvenile 'J' stock whales as suggested by SC/62/NPM1, and the migration of 'O' stock whales as suggested by Hatanaka and Miyashita (1997). SC/62/NPM12 postulated three less plausible hypotheses which modify the most plausible scenario as follows: (1) a W-stock sporadically intrudes into sub-area 9; (2) a different stock (Y-stock) resides in the Yellow Sea and overlaps with 'J' stock in the southern part of sub-area 6; and (3) a W-stock sporadically intrudes into sub-area 9 and a Y-stock resides in the Yellow Sea, and overlaps with 'J' stock in the southern part of sub-area 6. These four hypotheses are further described and shown graphically in Appendix 3.

The authors of SC/62/NPM15 reviewed genetic and non-genetic data regarding stock structure and summarised their conclusions in the context of addressing four key questions, as follows.

(1) Are whales in the Yellow Sea part of a population that migrates into the Sea of Japan? SC/62/NPM15 summarised that migration north into the Yellow Sea, the presence of mature whales and cow/calf pairs there, and the fact that Yellow Sea whales have only autumn conception dates (n = 124), provides evidence that a separate stock exists there. The Korean coast of the Sea of Japan showed some evidence for a mixture of two stocks, and microsatellite DNA showed seasonal differences that might be explained by a Yellow Sea stock moving along the Korean coast only in summer. In summary, the available data suggest that Yellow Sea whales may not be a part of the Sea of Japan stock.

(2) Are whales along the Korean coast part of the same population as whales along the western Japanese coast? SC/62/NPM15 summarised that there is no obvious hiatus in distribution between the two coasts, and that genetic analyses showed mixed results (haplogroup and STRUCTURE found no difference, pair-wise mtDNA and microsatellite DNA found differences). A small sample ($n = 8$) from the Sea of Japan showed a bimodal distribution of conception dates and a larger sample ($n = 63$) showed two different flipper colour patterns, but these data could be explained by a mixture of whales coming into the northeast Sea of Japan from the Sea of Okhotsk. No sex bias or haplogroup-by-sex differences were found for Japanese Sea of Japan bycatch, suggesting a possible year-round presence of a non-migratory coastal stock. In summary, it is plausible there are different stocks on either side of the Sea of Japan, but the data are somewhat contradictory or are lacking in sufficient resolution or spatial extent to make definitive conclusions. Some genetic evidence suggesting a second stock could be most simply explained by whales from a Yellow Sea stock appearing along the coast of Korea in summer.

(3) Are so-called 'J' type whales on the east coast of Japan the same population as on the west coast of Japan? The majority of whales bycaught on the southern Pacific coast of Japan (sub-area 2) are assigned to be 'J' type and so are either part of a Sea of Japan stock or are a coastal stock separate from a Pacific Ocean ('O') stock. Whales caught in the Pacific Ocean, even from sub-area 7 coastal areas, only have winter conception dates ($n = 68$) and a single flipper colour type ($n = 77$); if coastal sub-area 7 had a mixture of stocks there should be fall conception dates and a mixture of flipper colour types. There are differences in microsatellite DNA and mtDNA between the two coasts of Japan when all samples are used. Additionally, the southern Pacific coast bycatch (sub-area 2) is genetically different from bycatch along the northern Pacific coast of Japan (sub-area 7), suggesting a Pacific coastal stock might be distributed only in the Kuroshio current, and not further north in the Oyashio current. In summary, it is plausible that there are different coastal stocks on either coast of Japan, and/or longitudinally along the Pacific coast.

(4) Is there a coastal population in sub-area 7 (east of Hokkaido and northern Honshu) that is different from offshore minke whales in the Pacific Ocean, even after accounting for Sea of Japan whales that might migrate into this area? One hypothesis is that there is a 'pure' Sea of Japan stock ('J' type whales) and Pacific Ocean stock (O-type whales). Under that hypothesis, genetic differences between Pacific coastal waters (sub-area 7W) and other areas have been interpreted to be a mixture of these two stocks. An alternate hypothesis is that this area contains a distinct stock characterised by intermediate haplotype frequencies, as seen in humpback whales, for example. Again, the lack of evidence of fall conception dates ($n = 68$) and a mixture of flipper colour types ($n = 77$) in the Pacific Ocean argues against there being a mixture of stocks in coastal Pacific areas. Although it is possible that the haplotype frequencies of sub-area 7W could be explained by a complex seasonal, sex- and age-biased mixing of two stocks, e.g. a 'core J' and a 'core O', it is not as parsimonious as the hypothesis of a distinct stock with intermediate haplogroup frequencies. The absence of a strong haplogroup-by-sex interaction in coastal waters is inconsistent with the prediction of a sex-biased mixing of two stocks. SC/62/NPM30 concluded there was genetic heterogeneity in the Pacific Ocean, with a strong signal in the coastal area east of Hokkaido. In summary, the authors of SC/62/NPM15 thought it was plausible that the unique genetic signals seen in coastal waters of the Pacific coast of Japan are due to the existence of a distinct coastal stock or stocks, rather than a mixture of a 'pure J' and a 'pure O' stock.

Baker and Wade later generated a single additional stock-structure hypothesis from consideration of the four questions posed above. This hypothesis postulates six stocks (Y, J_W, J_E, O_W, O_E and W) and is described and shown graphically in Appendix 4.

In discussion, there was general agreement on two of the key questions posed by SC/62/NPM15: (1) a separate 'J' like stock (denoted Y-stock) occurs in the Yellow Sea and in at least some years some Y-stock whales are found in the Sea of Japan; and (2) minke whales on the east coast of Korea and on the west coast of Japan are generally part of a single stock.

In contrast, substantial disagreements remained about answers to the other two questions. These disagreements centred on how to interpret results of statistical tests showing heterogeneity of allele frequencies. In one view, the results can be explained by overlapping distributions of 'O' and 'J' stock, which leads to different mixing proportions (and hence different allele and haplotypic frequencies) in different geographic areas. Under this hypothesis, it would not be surprising that comparisons of samples from areas having different fractions of the two stocks often produce statistically significant results. An alternative view, as articulated in SC/62/NPM15 and SC/62/NPM20, is that an explanation that requires complex mixing patterns is less parsimonious than the hypothesis that the statistically significant differences reflect a distinct stock with intermediate gene frequencies.

Appendix 5 presented three new lines of evidence to support the mixing hypothesis from data for whales sampled from the coastal portion of sub-area 7W: (1) individuals assigned by STRUCTURE to 'O' stock tend to be larger than those assigned to 'J' stock – this is consistent with mixing but would not be expected if whales in this area represent a distinct stock; (2) as expected under the mixing hypothesis, the proportion of individuals assigned to 'O' stock increases with distance from the coast; and (3) four loci (and all loci overall) show highly significant deficiencies of heterozygotes in whales from this sub-area, which is a well known result when genetically divergent populations mix.

It was suggested that two additional types of information could help resolve whether the Hardy-Weinberg deviations are due to a mixture rather than some other factors that can cause the same result. Hardy-Weinberg departures are expected in a mixture only at loci for which allele frequencies differ substantially between contributing stocks. If it can be shown that the loci with significant departures are ones for which substantial differences are found between 'O' and 'J' stock, the argument would be strengthened. Deficiencies of heterozygotes can be due to a population mixture (as claimed here), but also to certain types of genotyping errors (null alleles or allele dropout). The argument would therefore be stronger if it can be shown that these same loci are in Hardy-Weinberg equilibrium in samples that are believed to come from a single population. It was also noted that none of the loci used in the studies were derived from minke whales, which can result in an increased probability of null alleles, and three of the four loci with deviations were eliminated as problematic in the combined datasets across the Japanese and Korean laboratories. In response, Kanda stated that Hardy-Weinberg deviations are not found for these loci in offshore samples (which presumably include few or no 'J' stock individuals).

Appendix 6 reached a different conclusion from consideration of allozyme data (Wada, 1984; 1991). Wada found deviations from Hardy-Weinberg equilibrium at the allozyme locus ADH-1 and evidence of seasonal mixing in what is now termed sub-area 11 (northeast coast of Hokkaido). However, he found no Hardy-Weinberg deviations in samples from small-type coastal whaling sub-area 7W, despite large samples sizes and various stratifications by year, month, age and sex. In discussion, it was suggested that the lack of Hardy-Weinberg equilibrium in sub-area 7W in Wada's analysis could perhaps be explained by the few commercial catches taken in very coastal waters, where the fraction of 'J' stock animals is high.

Other points raised included the following: (1) some analyses in SC/62/NPM15 (comparing 'J' stock along the east and west coasts of Japan) might have been wrongly extrapolated from bycatch (which includes juveniles) to the entire population; (2) Boundary Rank analyses do not support Baseline C, which is the basis for postulating a coastal stock in sub-area 7W; (3) sex-ratio differences noted by SC/62/NPM15 can be explained by segregation by sex and maturity; and (4) considerable evidence for stock mixing exists and has been presented, while the existence of additional stocks is only an opinion not based on real data.

In conclusion, in spite of disagreements about some specific points, the Working Group **agreed** that the set of stock-structure hypotheses based on the four proposed in SC/62/NPM12 and Appendix 3 and the fifth proposed in Appendix 4 were inclusive and sufficiently plausible to take forward to the next step in the *Implementation* process.

Several members prepared a minority statement, which is given in Appendix 7.

6. CATCHES

6.1 Review of information on any uncertainties in commercial catch reports

The Working Group noted that there was information available on the commercial catches for the countries that have taken the largest catches of western North Pacific minke whales. There are, however, limited data on catches for the People's Republic of China and no catch data for North Korea (if North Korea has taken western North Pacific minke whales).

6.2 Review information regarding incidental catches

Several sources of information regarding incidental catches were available.

SC/62/NPM4 provided information on incidental catches of common minke whales off Japan and Korea. Some suggestions were made on how plausible estimates of future incidental catches can be made, as well as to how past series, now considered erroneous, can be constructed. An annual trend of bycatch-per-unit effort (BPUE) was estimated. The annual incidental catches for 1995 to 2000, years for which incidental catches are believed to be underreported, were estimated using this BPUE trend estimate. It was suggested that these estimates are more plausible than assuming an annual incidental catch of 100 animals during this period.

The methods used in this paper were discussed under item 9.4 of Annex J. The Working Group noted that it would be useful if estimates were presented to the Preparatory Meeting for the First Intersessional Workshop of the *Implementation Review* (see Item 11.2).

SC/62/NPM19 provided information on bycatch of minke whales in Korean waters from 1996 to 2008. The authors collected bycatch data from the 14 local branch offices of the Korea Coast Guard which investigates the bycatch of cetaceans. A total of 1,156 minke whales were bycaught of which 83.7% were bycaught in the East Sea. Animals were entangled or trapped by set nets ($n = 363$), entangled by fish pots ($n = 316$) and gillnets ($n = 303$), respectively. Bycatch peaked in May–June and December–January. The average length of bycaught minke whales was 5.05m (range 2.7 to 9.0m). Minke whales were bycaught in a narrow band on the continental shelf of the East Sea while bycatch was scattered widely all over the shallow basins of the Yellow Sea and the Korea Strait. Bottom topography and oceanic conditions in the Yellow Sea reduces the incidence of bycatch even though there are minke whales there year round. Canonical Correspondence Analysis was applied to explain the characteristics of bycatch based on categorical variables such as area, fishing gear and size. Younger animals appear to be trapped in set nets in the southern part of the East Sea in spring. On the other hand, larger whales were bycaught by various fishing gears in the Yellow Sea from summer to winter and middle-sized animals were entangled year round by fish pots and gillnets in the northern part of the East Sea and the Korea Strait.

In discussion, concerning estimates of bycatches by fishing gear, the Working Group was informed that the large majority of the incidental catch off Japan was taken in set nets. Miyashita reported that 119 common minke whales were bycaught in set nets and one animal in a gillnet during 2009 (SC/62/ProgRep Japan).

The Working Group noted that SC/62/NPM26 provided information on incidental catches off Korea based on DNA profiling of market products. This paper was discussed under Item 9.4 of Annex J.

The Working Group **recommended** that available data on incidental catches and the associated effort should be analysed to develop CPUE series for possible use during the *Implementation Review*.

6.3 Development of a set of hypotheses for alternative removal series for use when conditioning trials

The Working Group **agreed** that sufficient information is available that alternative hypotheses regarding time-series of historical commercial and incidental catches could be developed during the *Implementation Review*.

6.4 Spatial and temporal disaggregation of removals

The Working Group **agreed** that there is sufficient information to disaggregate the historical commercial and incidental catches to sub-areas and periods during the year during the *Implementation Review*.

6.5 Areas and timing for future harvesting

SC/62/NPM3 and SC/62/NPM18 provided information on likely future whaling operations for minke whales in the western North Pacific. Japan aims to conduct land-based and pelagic whaling. Land-based whaling will be restricted to close to Japan while pelagic whaling will occur mainly in offshore areas. Temporal and spatial restrictions will be imposed on both types of whaling to try to reduce catching 'J' type animals. Korea intends to conduct land-based whaling to the east and west of Korea from March to November. These whaling plans will need to be elaborated further during the First Intersessional Workshop of the *Implementation Review*. Paper SC/62/NPM5, which describes sub-areas for use in the *Implementation*, was not discussed here and will be presented to the First Intersessional Workshop.

6.6 Future work

The work that needs to be completed prior to the Preparatory Meeting for the First Intersessional Workshop of the *Implementation Review* related to catches is:

(1) construction and GLM standardisation of CPUE series using the incidental catches and the associated fishing effort (see also Item 8.3);
(2) development of a format for reporting incidental catches by Japanese and Korean scientists and the Secretariat and the provision of these data in the agreed format to the Secretariat; and
(3) development of alternative hypotheses regarding time-series of past and future commercial and incidental catches.

7. ABUNDANCE ESTIMATES

7.1 Summary of available information and past discussions

SC/62/NPM2 provided estimates of abundance for the JARPN II survey area (sub-areas 7, 8 and 9, excluding the Russian EEZ) for the early (May and June) and late (July and August) seasons for 2006 and 2007. The data were stratified taking into account migration patterns suggested from sighting surveys during the 1994–2007 JARPN and JARPN II surveys. The abundance estimate for sub-area 7 was divided by 0.854 to account for incomplete coverage. Total abundance in the JARPN II area was 6,395 (CV = 0.717) and 2,872 (CV = 0.458) in the early and late seasons, respectively, assuming $g(0) = 0.798$ (SE = 0.134). The estimated numbers of common minke whales in the survey area during the late season was less than that during the early season. This can be interpreted by most minke whales migrating further north of the JARPN II survey area to regions such as the Sea of Okhotsk and the waters east of the Kamchatka Peninsula and the Kuril Islands. The estimate of 2,872 for the late season represents a part of the whole population and needs to be added to abundance estimates for the main distribution area of minke whales during the late season for *Implementation Simulation Trials.*

SC/62/NPM7 summarised the sighting surveys for minke whales in the western North Pacific conducted by Japan and Korea since 2000. The survey period for 'J' stock was April–June, and that for 'O' stock July–September. The areas covered were the Korean EEZ in sub-areas 5 and 6, the Japanese EEZ in sub-areas 6 and 10, the Russian EEZ in sub-area 10, the Sea of Okhotsk (sub-areas 11 and 12) and east of the Kuril archipelago and Kamchatka (sub-areas 8, 9 and 12), including the Russian EEZ. A total of 505 minke whale schools (560 animals) were sighted on 27,045 n.miles on primary search effort in 22 cruises.

SC/62/NPM16 analysed sightings data from recent surveys conducted by Korea in the Yellow Sea (sub-area 5) and the East Sea (sub-area 6) to estimate the abundance of minke whales. The covariates 'year', 'area' and 'wind' were considered and $g(0)$ was assumed to be 1. The hazard-rate and half-Normal models were considered as detection functions and the hazard-rate model was chosen using AIC. Two coastal and one offshore block for the Yellow Sea and three coastal and two offshore blocks for the East Sea were selected based on area coverage. The abundance in the Yellow Sea was estimated to be 1,534 (CV = 0.523) for 2001, 799 (CV = 0.321) for 2004 and 680 (CV = 0.372) for 2008. The abundance estimates for the East Sea were 549 (CV = 0.419) for 2000, 391 (CV = 0.614) for 2002, 485 (CV = 0.343) for 2003, 336 (CV = 0.317) for 2005, 459 (CV = 0.516) for 2006, 574 (CV = 0.437) for 2007, and 884 (CV = 0.286) for 2009. These may, however, be underestimates because $g(0)$ is assumed to be 1 and some effort and sightings were omitted to allow estimates to be computed for the same area in each year.

SC/62/NPM24 reported on a sighting survey for minke whales and other cetaceans in the East Sea from 21 April to 30 May 2009. The survey area consisted of one offshore block and four coastal blocks. The sightings were made by naked eye, with optional use of binoculars and performed in closing mode for species identification, school size estimation, and taking photographs and videos. The observers were trained to estimate distance and angle during the survey and tested. The research vessel covered 1,143.9 n.miles, and 40 minke whales in 36 primary sightings were observed. Common dolphins, Risso's dolphins, Dall's porpoises and finless porpoises were also sighted during the survey. An provided oversight on behalf of the Scientific Committee. The plan had been presented to the 2008 Annual Meeting (Choi *et al.*, 2008) and was endorsed by the Committee. The sighting survey was carried out under the guidelines for conducting surveys and completed the predetermined transect lines.

The Working Group expressed its appreciation to the Government of Korea for its continued commitment to surveys for minke whales in Korean waters, and to An for his role of oversight on behalf of the Committee. The Working Group **recommends** that the 2009 survey off Korea be adopted for use in the RMP.

SC/62/NPM8 updated the integrated abundance estimates for common minke whales in sub-areas 5, 6 and 10 using new information on abundance and $g(0)$ (Miyashita *et al.*, 2009; SC/62/NPM7 and SC/62/NPM16). Japan and Korea have conducted a series of sighting surveys during April–June in these sub-areas that are one of main habitats of the 'J' stock of common minke whales. Although parts of sub-areas 5 and 6 were not covered during the surveys because of the inability to cover the territorial waters of other countries, information on abundance from sightings data from Japanese and Korean surveys in the rest of the sub-areas can be integrated to obtain better estimates of the abundance of 'J' stock animals. A log-linear model with fixed year and survey block effects and random effects for the process error was employed. Estimates of $g(0)$ and their uncertainties were also taken into account. The extent of the process error was estimated through an integrated likelihood function, and other fixed effects were estimated using linear predictors. The predicted abundance estimates by block and sub-area, and for all three sub-areas together were produced for a reference year (2009), with and without a year trend in abundance. The results showed that the annual trend was not significant. Under the assumption of no annual trend, a spatially-extrapolated estimate for sub-areas 5, 6 and 10 combined was 16,162 (CV = 0.277). It should be noted that 'J' stock animals are also found in the East China Sea, Pacific coast of Japan and the Sea of Okhotsk, and this fact should be taken account of when estimates of abundance for the 'J' stock are used for management purposes.

The Working Group **endorsed** the method used to combine sightings data over time to estimate the extent of additional variance, but not necessarily the methods proposed for dealing with abundance across spatial areas in this case because of concerns over migration during the survey and extrapolation (see also Item 7.3). The Working Group did not review the abundance estimates in SC/62/NPM8 *inter alia* because it is unclear whether the sub-areas used for reporting abundance estimates in SC/62/NPM8 will be used in the *Implementation Simulation Trials* developed during the First Intersessional Workshop of the *Implementation Review*. It was noted that although models can be used to interpolate abundance for unsurveyed regions, if a region has never been surveyed, the abundance estimate for that region should be set to zero when calculating catch limits under the RMP.

7.2 General issues

The Working Group noted that sufficient information needs to be provided for the surveys to enable final decisions regarding whether the resulting abundance estimates can be used for conditioning and in the *CLA*. Specifically, it was noted that some of the surveys had taken place in the same direction as the expected migration of whales and information on why this does not lead to bias needs to be provided.

7.3 Selection of the years and areas for which abundance estimates will be available for use in conditioning of trials

SC/62/NPM14 reviewed the proposed method in SC/62/NPM8 for integrating surveys for use in the *Implementation Simulation Trials*. SC/62/NPM14 found there was a substantial seasonal trend in timing between the southern surveys and the northern surveys. The surveys in the Yellow Sea and the southern part of the East Sea/Sea of Japan occurred from mid- or late-April until late-May or early-June. The surveys of the northern part of the Sea of Japan occurred from mid- or late-May until mid- or late-June, meaning there is an approximate one month lag in the start of the surveys to the north, in the direction the minke whales are thought to be migrating. Therefore, there is the possibility of double-counting if abundance estimates from these two regions are added together, as has been proposed in SC/62/NPM8. Telemetry data on humpback whale migration shows they can travel 60–100km per day. The only telemetry data from minke whales is consistent with this; two minke whales on feeding grounds off northern Norway moved an average of 53 and 66km between daily positions (Heide-Jørgensen *et al.*, 2001). Using the 60–100km a day range one would expect it to take 16–27 days for a minke whale to travel from the southern tip of Honshu to west of Hokkaido (~1,600km), and 22–38 days from the southern tip of Honshu to the northern part of sub-area 10 (~2,250km). Given there is about a 20–30 day lag between the start of surveys in sub-areas 5 and 6-south, and the start of the surveys in sub-areas 6-north and 10, it is clear there is a strong likelihood of double-counting, so those sets of surveys should not be added together to get abundance for the population. SC/62/NPM14 recommended that the early surveys could be added together (survey areas 5E, 6WS and 6ES) for an abundance for that early period in those areas, and the later surveys could be added together (survey areas 6EN, 10E and 10W) for a later period. If the operating model used in the assessment has sufficient resolution (both temporally and spatially), the model could be fitted to both abundance estimates. However, given the migration of minke whales over the survey period it would be inappropriate to use the sum of the two numbers as an abundance estimate for the number of minke whales in the entire study area. SC/62/NPM14 also recommended against the proposal in SC/62/NPM8 to extrapolate average density from surveyed areas into large un-surveyed areas. This is not permitted under the RMP and the Committee has, in the past, also considered this inappropriate for *Implementation Simulation Trials*. This issue is not trivial; for example, an estimate of 1,029 in sub-area 5E is extrapolated to an abundance of 7,897 for the entire Yellow Sea in SC/62/NPM8.

Miyashita stated that SC/62/NPM14 referred to changes in the peak in the catch as evidence for seasonal northward migration (Omura and Sakiura, 1956), but it was necessary to take into account weather condition differences in the same month for different localities affecting the small-type whaling operation. The weather conditions may affect the putative peaks in the catch, which do not represent the migration of common minke whales. It was also stated that segregation by sex and maturity should be taken into account when considering migration. SC/62/NPM1 concluded that the feeding migration for 'J' stocks starts in January and February, the main feeding season for 'J' stock is April to June, and the southward migration starts in July. This means that 'J' stock animals in the Sea of Japan have already finished their northward feeding migration during the present survey period (April–June), and there are no double counting problems in the integrated abundance estimate in SC/62/NPM8.

The Working Group discussed possible migration patterns of 'J' stock minke whales in the Sea of Japan, as well as whether some component of the 'J' stock may not migrate to a substantial extent, in relation to how abundance estimates are computed and used in *Implementation Simulation Trials* and when applying the *CLA*. The Working Group **agreed** that care needed to be taken to avoid double-counting animals when computing abundance estimates. In relation to animals in the Sea of Japan and the Yellow Sea, the Working Group **agreed** that the *Implementation Simulation Trials* would capture hypotheses regarding the migration patterns of western North Pacific minke whales and that the models underlying these trials would be specified accordingly. The abundance estimates used for conditioning will be allocated to the appropriate time periods to avoid double counting.

The Working Group **agreed** that there are several abundance estimates for possible use when conditioning trials. Table 1 provides a summary of the sightings surveys for the sub-areas used in the last set of *Implementation Simulation Trials* and those conducted since. The Working Group did not discuss the acceptability or otherwise of the use of these surveys for conditioning the *Implementation Simulation Trials*. Table 1 provides an overview of where and for which months abundance estimates can be computed as required.

7.4 Selection of the years and areas for which abundance estimates will be available for use in *CLA* in trials

The Working Group noted that it was not necessary to select the abundance estimates for use in the *CLA* at the present meeting; this selection will take place during the First Intersessional Workshop of the *Implementation Review*. The selection of abundance estimates for use in *CLA* will need to take account of whether the surveys and their analysis followed the Requirements and Guidelines for Conducting Surveys and Analysing Data within the RMP (IWC, 2005b) [see also Item 7.2]. Some of these surveys (e.g. those from JARPN II) have not been reviewed by the Committee for use in the RMP.

7.5 Plausible range for *g*(0)

SC/62/NPM9 provided revised estimates of *g*(0) and abundance for western North Pacific common minke whales. The main changes from the previous analyses were the addition of new data, particularly for the Okhotsk Sea for 2003 and 2005. The model used to estimate *g*(0) is based on that used for Antarctic minke whales, although it is simpler because school size is usually one. The model without weather condition covariates had a lower AIC than the model with weather condition covariates, and the resultant abundance estimates were insensitive to whether the weather condition was included in the analysis or not. Thus, the final analysis did not include the weather condition. The resultant estimates of *g*(0) were 0.716 (SE = 0.16) for the Top barrel, 0.617 (SE = 0.19) for the IO platform, 0.505 (SE = 0.21) for the upper bridge, 0.798 (SE = 0.13) for the Top barrel and upper bridge, and 0.859 (SE = 0.10) for the Top barrel, IO platform, and upper bridge.

The Working Group welcomed SC/62/RMP9 which substantially reduced the previous range for *g*(0). There was insufficient time for an in-depth review of SC/62/NPM9. The Working Group **agreed** to review the method used to estimate *g*(0) and the resultant estimates further at the First Intersessional Workshop.

7.6 Plans for future surveys

SC/62/NPM17 and SC/62/NPM4 outlined the plans for future sighting surveys by Korea and Japan. Japan noted that it was not currently planning to conduct surveys in sub-areas 6 and 10, but may revise that decision in future. It was noted that the results of the *Implementation Simulation Trials* may provide information on which programme of surveys will lead to the best performance of the RMP, and that Japan and Korea may wish to modify their survey plans once the results of initial trials become available.

SC/62/NPM25 described plans for a sighting survey in the Yellow Sea, for April–May 2011, in IO passing mode using the research vessel *Tamgu 3*. The objective of the survey is to obtain information on the distribution and abundance of minke whales. The research area includes coastal and offshore waters in the Yellow Sea bounded by 123°24'E, 126°00'E, 33°00'N and 37°18'N. The survey area is divided into six blocks (three inshore and three offshore). The starting points for each block are set randomly and the total transect length is 1,534.2 n.miles, although several transect lines will be cut by the EEZ between Korea and China. The survey will start in the southern coastal block and move north. Once the coastal blocks are surveyed, the survey will cover the offshore block from north to south. Training and testing of distance and angle measurement will be conducted at the start and end of the survey. Biopsy samples will be attempted using both the Larsen gun and a crossbow. An would be able to provide oversight for the survey on behalf of the Committee. Details of the cruise report and abundance estimation will be presented in 2012.

The Working Group was pleased to see that distance and angle estimation will be tested and **requested** that the results of analyses of these and previous data be presented to future meetings. It was noted that the survey could be conducted to eliminate the possible implications of migration during the survey. The Working Group appointed An to provide oversight on behalf of the Committee.

SC/62/NPM23 described plans for a sighting and biopsy sampling survey for common minke whales in the Okhotsk Sea during summer 2010. The aim of the survey is to collect sightings data and information on stock identification. Biopsy sampling using Larsen guns and observations of cookie-cutter shark scars on whale bodies are planned. The research area is north of 46°N, south of 57°N and west of 152°E in the Okhotsk Sea, including the Russian EEZ and 12 tracklines totalling 2,110.0 n.miles are specified. The research vessel *Shonan-maru No.2* will conduct the survey from 13 July to 26 August 2010, and two Japanese scientists and a Russian observer will be onboard. As noted in SC/62/NPM22, all the biopsy samples taken during the last summer survey in the Okhotsk Sea could not be removed from Russian waters because of discrepancies between Russia and Japan as regards the domestic legal status of the common minke whale related to CITES as well as domestic legal systems related to international trade. To overcome this, genetic analysis using biopsied skin samples will be conducted on the research vessel. The RFLP analysis of mtDNA control region will be attempted. The skin samples will not be retained on board after genetic analysis. Photo-identification for large cetaceans such as North Pacific right whales will be also attempted.

The Working Group noted the importance of estimating the proportion of 'J' and 'O' stock animals in the survey area. It **recommended** that Japan explore ways that are not constrained by CITES to facilitate extracting relevant information from biopsy samples collected from the EEZ of Russia which could be used to explore stock structure and mixing. Specifically, 'portable PCR' methods can be used to extract DNA and amplify standard markers. Amplified fragments for sex identification can be visualised in the field with agarose gells. Biotin labelled primer can be used to amplify both microsatellite and mtDNA markers. The amplified fragments can then be bound to streptavidin-coated beads or plates, prior to washing away the native DNA. The streptavidin-bound synthetic DNA is not subject to CITES regulations (Jones, 1994). The Working Group appointed Miyashita to provide oversight on behalf of the Committee.

8. OTHER ISSUES

8.1 Reviewing the information to estimate dispersal rates and mixing proportions

The Working Group noted that SC/62/O30 outlined an approach for estimating mixing rates between stocks using microsatellite data.

8.2 Specification of biological parameters

8.2.1 Biological parameters

Values for the biological parameters for use in *Implementation Simulation Trials* for the western North Pacific minke whales had been assembled for the previous *Implementation* (IWC, 2004).

8.2.2 MSYR

The previous trials were based on values for MSYR(mat) of 1% and 4%. These values should be used in any new trials unless the current review of MSY rates (Annex D, Item 2) leads to a recommendation for a change to this range.

8.3 Other information

The Working Group noted that CPUE data had been assembled and used to compare alternative stock structure hypotheses (Yasunaga *et al.*, 2009, appendix II (Okamura)). The Working Group **recommends** that relevant commercial and incidental catch and effort data, along with the information identified by the 1987 CPUE Workshop (IWC, 1989), should be assembled, GLM standardised where possible, and be available at the First Intersessional Workshop of the *Implementation Review*. Data on flipper colour and conception dates should also be assembled and presented to the Preparatory Meeting of the First Intersessional Workshop of the *Implementation Review*.

9. OTHER BUSINESS

9.1 Review of proposed timetable for future *Implementations* and *Implementation Reviews* (IWC/62/7rev Appendix B, p. 37)

The Working Group **agreed** that it had completed the *pre-Implementation assessment* (see also Item 11.1) and the Committee should be able to complete the *Implementation Review* in 2012. The work plan (Item 11) outlines how the Working Group plans to ensure that it is able to complete the *Implementation Review* as scheduled. This will require adequate resources and planning.

9.2 Review of the Scientific Assessment Report

The Working Group reviewed the IWC Scientific Assessment Group (SAG) deliberations related to western North Pacific common minke whales. It noted that it was not possible to apply the RMP to the data for these minke whales owing to the considerable changes to the understanding of stock structure in recent years. It **agreed** that the present uncertainty precludes giving adequate advice regarding the catches in table 4 of IWC/62/7. The Working Group generally **agreed** with the conclusions of the SAG. A summary of the Working Group conclusions is as follows.

(1) The *Implementation* process should be completed as quickly as possible. Completing the *Implementation Review* will allow advice on catches to be based on the RMP, which has been selected to ensure that catches are sustainable.
(2) A high priority should be accorded to research to determine the proportions of 'O' and 'J' stock in sub-area 12 because the implications of any proposed catches for both 'O' and 'J' stock clearly differ depending on this proportion. In this respect, the Working Group welcomed the survey of sub-area 12 planned for summer 2010 and **emphasised** the importance of collecting as much data as possible to estimate stock proportions in sub-area 12.
(3) The proposed catches by coastal whalers in table 4 of IWC/62/7 may not help to improve the status of 'J' stock compared to current JARPN II catches. The incidence of 'J' stock in the catch decreases with distance offshore. The Working Group received an analysis which estimated the number of 'J' stock animals under catch levels of 150 inshore and 70 offshore (Appendix 8). The Working Group recognised the value of analysis such as those in Appendix 8 and **recommended** that further analyses be conducted using a finer spatial resolution and quantifying the uncertainty associated with the predictions, including the likely level of inter-annual variation in catches of 'J' stock animals.
(4) The Working Group was unable to agree on the impact of the proposed catches on the 'O' stock. However it **agreed** that the risk to the 'O' stock will be minimised if the *Implementation* is completed as soon as possible so that advice can be based on the RMP and hence also **agreed** that catches of 'O' stock should not exceed present levels.

Regarding distance from the coastline, Baker noted that accuracy of these data was particularly important to investigation of the nearshore distribution of 'J' stock, relative to the proposed small-type coastal whaling operation. Pastene responded that, in view of those inconsistencies, the analyses to investigate on 'J' stock the effect of limiting whaling operations to 10 n.miles or more from the coast was repeated using the correct data for distance from coastline. Results were very similar to those found in previous analyses.

The Working Group noted, but did not discuss, SC/62/NPM31 on reconsideration of the population status of the 'J' stock of common minke whales.

10. INITIAL DISCUSSIONS OF FUTURE EXPERIMENTAL AND ANALYTICAL WAYS TO DISTINGUISH AMONG COMPETING HYPOTHESES

Much of the remaining disagreement about competing stock-structure hypotheses centres on the question of whether minke whales in sub-areas 7 and 2 represent a mixture of 'O' and 'J' stock animals or a single stock with intermediate characteristics. Accordingly, the Working Group **agreed** that trying to resolve this issue should be a top priority, using both genetic and non-genetic data. Regarding the latter, under the 'pure' Sea of Japan stock hypothesis, 'J' stock whales are thought to have fall conception dates and a mix of flipper colour morphologies. To date, only winter conception dates and a single flipper colour morphology have been seen in the Pacific Ocean. If the mixture hypothesis is true, a mix of these biological traits should be seen in coastal sub-area 7, so data on these two biological traits from that area would be very useful.

IWC (2010b, p.207) identified a number of additional analyses of genetic data that might be informative regarding stock structure. This list is as follows, with annotations [in brackets] noting accomplishments since last year.

- Identify strata where only one stock occurs, or individuals from other stocks are sufficiently rare that genetic data from these strata can be used to characterise the stock of interest. These analyses might profitably start in sub-areas 7E and 8, where available data suggest that only a single stock occurs [PCA analyses in SC/62/NPM30 touch on this issue; addressed in part in SC/62/NPM20].
- Approach (1) could be performed in a sequential fashion, perhaps progressing from the western to eastern side of Japan [addressed in part in SC/62/NPM20].
- Focus particular attention on JE and O in sub-area 7, where over 1,000 samples have been collected [PCA analyses in SC/62/NPM11 did this; addressed in part in SC/62/NPM20].
- Increase the number of loci so that STRUCTURE can at least reliably separate all 'O' and 'J' stock individuals.
- Evaluate robustness of STRUCTURE results to use of admixture vs no-admixture and correlated vs uncorrelated allele frequency options [this was done intersessionally but not formally reported; according to

Kanda, results were not strongly affected by these variations].

- Do some new STRUCTURE runs that focus on unassigned individuals and/or 'O' plus unassigned individuals [SC/62/NPM11 did this].
- Use mtDNA haplotypes to verify STRUCTURE results and produce more robust population assignments. This would require concerted efforts to update the mitochondrial and nuclear DNA baselines with Korean data [Integration of Korean data is discussed in SC/62/NPM11 and SC/62/NPM21. SC/62/NPM20 shows results using the mtDNA haplogroup assignments].
- The program IM or a similar program could be used to test whether existing data are more compatible with an equilibrium model with migration or an isolation model.
- Consider feasibility of using the program GeneLand, which is similar to STRUCTURE but allows the inclusion of spatially-explicit data for each individual [this was done in conjunction with work reported in SC/62/NPM30. The program TESS was applied to the data but no meaningful results were obtained (O. Gaggiotti, pers. comm.)].
- Re-do the Boundary Rank analyses using new data [completed in SC/62/NPM30].
- Examine geographic and temporal patterns of occurrence of close kin [not done, but proposed again in SC/62/NPM29].
- Update the study of Taylor and Martien (2004) that used simulations to evaluate distribution of dispersal estimates that are compatible with existing mtDNA data [done in SC/62/NPM30].

In addition, four new items were suggested:

(1) Expanding the principal components analysis in SC/62/NPM30 to include multiple regression of additional factors (such as distance from shore and collection month and year) that might help explain patterns in the genetic data.
(2) Produce a more detailed description of methods for data quality assurance and efforts to standardise scoring between laboratories.
(3) Provide more detail about results of PCA analyses (described in SC/62/NPM30) under purging scenarios 2–4. In particular, what patterns of heterogeneity are seen and how do they differ from results under Scenario 1.
(4) Repeat SC/62/NPM20 using corrected haplotypes and Korean samples (subject to DAA).

11. RECOMMENDATIONS TO THE SCIENTIFIC COMMITTEE

11.1 Progress on the *pre-Implementation assessment*

The Working group **agreed** that it had successfully addressed all of the items required for a *pre-Implementation assessment* and therefore **agreed** that the *pre-Implementation assessment* was completed.

11.2 Other

The Working Group **recognised** that there is a considerable amount of work that needs to be done to complete the *Implementation Review*. Specifically, there is a need: (a) to assemble the data so that they can be used when conditioning the operating models on which the *Implementation Simulation Trials* are based; (b) to specify and code the operating models themselves; and (c) to fit the operating models to the agreed data sets (conditioning). The Working Group **agreed** that it would be infeasible to conduct all of the work in a single meeting (i.e. the First Intersessional Workshop). Rather, it **agreed** that the probability of completing the work during the first year of the *Implementation Review* would be maximised if two meetings were to take place. The main objective of the first meeting (the Preparatory Meeting) would be to determine the structure (time-steps, sub-areas and population components) of the operating models so that all relevant data can be assembled at the appropriate spatial and temporal resolutions in time for the First Intersessional Workshop, and to start to specify the operating models and how they will be conditioned. Appendix 9 outlines the work plan in more detail, including tentative dates for deadlines and for holding the Preparatory Meeting and the First Intersessional Workshop.

The Workshop proposed a Steering Group under Butterworth with members from Allison, An, Baker, Butterworth, de Moor, Donovan, Double, Hammond, Kitakado, Park, Pastene, Punt, Wade and Waples to coordinate any intersessional work and to facilitate holding the Preparatory Meeting and the First Intersessional Workshop.

12. ADOPTION OF REPORT

The report was adopted at 22:36 on 7 June 2010. The Working Group thanked the Chair for guiding them through a very difficult agenda. The Chair thanked the rapporteurs for their work on what was a long and detailed report.

REFERENCES

Choi, S.G., Kim, Z.G., An, Y.R. and Park, K.J. 2008. Plan for the Korean sighting survey in the East Sea in 2009. Paper SC/60/NPM3 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 3pp. [Paper available from the Office of this Journal].

Hatanaka, H. and Miyashita, T. 1997. On the feeding migration of Okhotsk Sea-West Pacific stock minke whales, estimates based on length composition data. *Rep. int. Whal. Commn* 47: 557–64.

Heide-Jørgensen, M.P., Nordoy, E.S., Øien, N., Folkow, L.P., Kleivane, L., Blix, A.S., Jensen, M.V. and Laidre, K.L. 2001. Satellite tracking of minke whales (*Balaenoptera acutorostrata*) off the coast of northern Norway. *J. Cetacean Res. Manage.* 3(2): 175–78.

International Whaling Commission. 1989. Report of the Comprehensive Assessment Workshop on Catch Per Unit Effort (CPUE), Reykjavík, 16–20 March 1987. *Rep. int. Whal. Commn (special issue)* 11:15–20.

International Whaling Commission. 1997. Report of the Scientific Committee, Annex J. Report of the Working Group on North Pacific minke whale trials. *Rep. int. Whal. Commn* 47:203–26.

International Whaling Commission. 2003. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 5:1–92.

International Whaling Commission. 2004. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 10. North Pacific minke whale *Implementation Simulation Trial* specifications. *J. Cetacean Res. Manage. (Suppl.)* 6:118–29.

International Whaling Commission. 2005a. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 2. Requirements and Guidelines for *Implementation*. *J. Cetacean Res. Manage. (Suppl.)* 7:84–92.

International Whaling Commission. 2005b. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. Appendix 3. Requirements and Guidelines for Conducting Surveys and Analysing Data within the Revised Management Scheme. *J. Cetacean Res. Manage (Suppl.)* 7:92–101.

International Whaling Commission. 2007. Report of the First Intersessional AWMP Workshop for the 2007 Bowhead *Implementation Review*, 24–27 April 2006, Seattle, USA. *J. Cetacean Res. Manage. (Suppl.)* 9:431–47.

International Whaling Commission. 2010a. Report of the Expert Workshop to Review the Ongoing JARPN II Programme, 26–30 January 2009, Yokohama, Japan. *J. Cetacean Res. Manage. (Suppl.)* 11(2):405–50.

International Whaling Commission. 2010b. Report of the Scientific Committee. Annex G1. Report of the Working Group on the In-Depth Assessment of Western North Pacific Common Minke Whales, with a focus on 'J' stock. *J. Cetacean Res. Manage (Suppl.)* 11(2):198–217.

Jones, M. 1994. PCR products and CITES. *Science* 266: 1,930.

Kanda, N., Goto, M., Kishiro, T., Yoshida, H., Kato, H. and Pastene, L.A. 2009. Update of the analyses on individual identification and mixing of the J and O stocks of common mike whales around Japanese waters examined by microsatellite analysis. Paper SC/61/JR5 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 14pp. [Paper available from the Office of this Journal].

Kato, H. 1992. Body length, reproduction and stock separation of minke whales off northern Japan. *Rep. int. Whal. Commn* 42: 443–53.

Kato, H., Kishiro, T., Fujise, Y. and Wada, S. 1992. Morphology of minke whales in Okhotsk Sea, Sea of Japan and off the East coast of Japan, with respect to stock identification. *Rep. int. Whal. Commn* 42: 437–42.

Miyashita, T., Okamura, H. and Kitakado, T. 2009. Abundance of J-stock common minke whales in the Sea of Japan using the Japanese sighting data with *g*(0) = 1. Paper SC/61/NPM7 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 10pp. [Paper available from the Office of this Journal].

Morin, P.A., Martien, K.K., Archer, F.I., Cipriano, F., Steel, D., Jackson, J. and Taylor, B.L. 2009. Applied conservation genetics and the need for quality control and reporting of genetic data used in fisheries and wildlife management. *J. Heredity* 101(1): 1–10.

Omura, H. and Sakiura, H. 1956. Studies on the little piked whale from the coast of Japan. *Scientific Reports of the Whales Research Institute, Tokyo* 11: 1–37.

Taylor, B.L. and Martien, K. 2003. A summary of data and analyses relating to stock structure of minke whales in the western North Pacific. Paper SC/55/IST9 presented to the IWC Scientific Committee, May 2003, Berlin (unpublished). 7pp. [Paper available from the Office of this Journal].

Taylor, B.L. and Martien, K.K. 2004. Report of the Second Workshop on North Pacific Common Minke Whale *Implementation Simulation Trials*, 15–18 January 2003, Seattle, USA. Annex C. Dispersal estimates for western North Pacific minke whales. *J. Cetacean Res. Manage. (Supplement)* 6: 440–41.

Wada, S. 1984. A note on the gene frequency differences between minke whales from Korean and Japanese coastal waters. *Rep. int. Whal. Commn* 34: 345–47.

Wada, S. 1991. Genetic structure of Okhotsk Sea-West Pacific stock of minke whales. Paper SC/43/Mi32 presented to the IWC Scientific Committee, May 1991 (unpublished). 17pp. [Paper available from the Office of this Journal].

Yasunaga, G., Kato, H., Kishiro, T., Yoshida, H., Nishiwaki, S., Saito, T., Tabata, S., Okamoto, R., Maeda, H., Nakamura, G., Inoue, S., Otani, S., Iwasaki, T., Kanaji, Y., Mogoe, T., Murase, H., Wada, A., Nakai, K., Matsumoto, A., Gokita, A., Yamasaki, K., Oikawa, H., Onodera, K., Shiraishi, K. and Nagashima, H. 2009. Cruise report of the second phase of the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN II) in 2008 (part II) – coastal component off Sanriku. Paper SC/61/O6 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 24pp. [Paper available from the Office of this Journal].

Zenitani, R., Kato, H. and Fujise, Y. 2000. Some analyses on biological parameters of western North Pacific minke whales, from a view point of stock identification. Paper SC/F2K/J13 presented at the JARPN Review Meeting, Tokyo, Japan, 7–10 February 2000 (unpublished). 18pp. [Paper available from the Office of this Journal].

Appendix 1

AGENDA

1. Convenor's opening comments
2. Election of chair and appointment of rapporteurs
3. Adoption of Agenda
4. Review of documents
5. Stock structure
    - 5.1 Brief overview of past discussions
    - 5.2 Summary of available genetic and non-genetic data
    - 5.3 Consideration of new information/analyses
    - 5.4 Stock-structure hypotheses
6. Catches
    - 6.1 Review of information on any uncertainties in commercial catch reports
    - 6.2 Review information regarding incidental catches
    - 6.3 Development of a set of hypotheses for alternative removal series for use when conditioning trials
    - 6.4 Spatial and temporal disaggregation of removals
    - 6.5 Areas and timing for future harvesting
    - 6.6 Future work
7. Abundance estimates
    - 7.1 Summary of available information and past discussions
    - 7.2 General issues
    - 7.3 Selection of the years and areas for which abundance estimates will be available for use in conditioning of trials
    - 7.4 Selection of the years and areas for which abundance estimates will be available for use in *CLA* in trials
    - 7.5 Plausible range for *g*(0)
    - 7.6 Plans for future surveys
8. Other issues
    - 8.1 Reviewing the information to estimate dispersal rates and mixing proportions
    - 8.2 Specification of biological parameters
        - 8.2.1 Biological parameters
        - 8.2.2 MSYR
    - 8.3 Other information
9. Other business
    - 9.1 Review of proposed timetable for future *Implementations* and *Implementation Reviews* (IWC/62/7rev Appendix B, p.37)
    - 9.2 Review of the Scientific Assessment Report
10. Initial discussions of future experimental and analytical ways to distinguish among competing hypotheses
11. Recommendations to the Scientific Committee
    - 11.1 Progress on the *pre-Implementation assessment*
    - 11.2 Other
12. Adoption of Report

Appendix 2

DATA LIST FOR *PRE-IMPLEMENTATION ASSESSMENT*

N. Kanda, Y.R. An, T. Miyashita and C.S. Baker

Table 1

Data list for Japan.

Details	Raw format	Where held	Analytical methods	Key papers	Comments
Operational data					
Catch and effort					
Japan, coastal whaling CPUE – Searching time, – no catch, vessel tonnage	Electronic	IWC, NRIFSF	Bayesian population model	Kawahara (2003)	
Abundance					
Shipboard					
Japan, dedicated sighting survey – Sea of Japan in 2006 and 2007, – Sea of Okhotsk in 2003, – East of Kuril Islands, – Kamchatka Peninsula – (Russian EEZ in 2005) Sighting, effort and weather data, distance and angle experiment data	Electronic suitable for Distance	NRISFS	IO passing mode line transect survey with $g(0)$ correction	SC/62/NPM7 SC/62/NPM9 SC/62/NPM8	
Japan, dedicated sighting survey – Sea of Japan in 2002–05 Sighting, effort and weather data, distance and angle experiment data	Electronic suitable for Distance	NRISFS	Normal closing mode line transect survey without $g(0)$ corrections	SC/62/NPM7 SC/62/NPM8	
Japanese Scouting Vessel sighting data (1965–88) Noon positions, research distance, no. sightings (schools and animals), weather conditions (water temperature, wind speed, wind direction, water colour)	Electronic form	IWC	Density index (no. animals/research distance)	Miyashita *et al.* (1994)	
Angle and distance experiment data	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Sighting data	Electronic	ICR, IWC		JARPN/JARPN II review*; SC/62/NPM2	1994–2007
Effort and weather data	Electronic	ICR, IWC		JARPN/JARPN II review*; SC/62/NPM2	1994–2007
Stock structure and dispersal rates					
Catch history					
Japan, coastal whaling biological data: date, time, position, length, sex., foetus length, stomach contents (species, quantity, size), foetus (number, sex, size), blubber thickness, testis weight, no. corpus luteum, no. corpus albicans, age.	Electronic? Data sheets	IWC, NRIFSF		Kato *et al*. (1992)	Conception date has been estimated from the foetus growth curve, and used in Kato *et al*. (1992)
Biological					
Sex	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Body weight	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Organ weight	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Maurity stage	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Corpora albicantia and lutea (number)	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Lactation condition	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Testis weight	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Foetus, number	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Foetus sex	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Foetus, body length	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007: Conception date can be estimated from the foetus growth curve, but the number of foetus data was 39 from JARPN II (IWC, 2010, pp.441–45).
Foetus, body weight	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Ecological					
Parasites (external)	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Parasite (internal)	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007, offshore
Blubber thickness	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Girth	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Stomach contents (IWC format)	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Stomach contents weights	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Main prey species in stomach contents	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007

Cont.

Details	Raw format	Where held	Analytical methods	Key papers	Comments
Ecological cont.					
Freshness of stomach contents	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
PCB concentrations (blubber)	Electronic	ICR, IWC		JARPN/JARPN II review*	2000–07, offshore
Total Hg levels (liver)	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Total Hg, methyl Hg and Se levels (liver)	Electronic	ICR, IWC		JARPN II review*	2000–07, offshore
Total Hg, methyl Hg and Se levels (kidney)	Electronic	ICR, IWC		JARPN II review*	2000–07, offshore
Total Hg, methyl Hg and Se levels (muscle)	Electronic	ICR, IWC		JARPN II review*	2000–07, offshore
Cookie cutter shark scars	Electronic	NRIFSF ICR, IWC		SC/62/NPM10 JARPN/JARPN II review*	1994–2007
Genetics					
Allozymes	Electronic	ICR, IWC		JARPN review*	1994–99
Mitochondrial DNA control region sequences	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
	Electronic	OSU, IWC		Lukoschek *et al.* (2005)	1999–2004, market samples
Microsatellites (16 loci)	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Morphometric					
Body length	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Body proportion	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007
Skull (length and breadth)	Electronic	ICR, IWC		JARPN/JARPN II review*	1994–2007

*For more details see JARPN review report (IWC, 2001) and JARPN II review report (IWC, 2010) or references therein.

Table 2

Data list for Korea.

Details	Raw format	Where held	Analytical methods	Key papers	Comments
Operational data					
Catch and effort					
Korea, coastal whaling CPUE – Searching time, no. of catch, vessel tonnage	Printed document	IWC, CRI	Bayesian population model	Gong and Hwang (1984)	
Abundance					
Shipboard					
Korea, dedicated sighting survey East Sea in 2000, 2002–03, 2005–07 and 2009 Yellow Sea in 2001, 2004 and 2008	Electronic suitable for Distance	CRI mode	Normal closing line transect survey without $g(0)$ corrections	SC/62/NPM16 SC/62/NPM7 SC/62/NPM8	
Angle and distance experiment data East Sea in 2000, 2002–03, 2005–07 and 2009 Yellow Sea in 2001, 2004 and 2008	Electronic	CRI			
Sighting data	Electronic	CRI			
Effort data	Electronic	CRI			
Stock structure and dispersal rates					
Biological					
Sex	Electronic	CRI			1999–2009 bycatch
Ecological					
Main prey species in stomach contents	Electronic	CRI			2007–09 bycatch
POPs (persistent organic pollutants) levels (muscle, liver)	Electronic	CRI		Moon *et al.* (2009)	2006 bycatch
PFCs (perfluorinated compounds) levels (liver)	Electronic	CRI		Moon *et al.* (2009)	2006 bycatch
Heavy metal (As, Cd, Cu, Hg, Pb and Zn) levels (muscle, liver)	Electronic	CRI		Kim *et al.* (2005)	2004 bycatch
Genetics					
Mitochondrial DNA control region sequences	Electronic	CRI		SC/62/NPM21	1999–2009 bycatch
	Electronic	OSU, IWC		Baker *et al.* (2007); SC/62/NPM20	1999–2005 market samples
Microsatellites (11 loci)	Electronic	CRI		SC/62/NPM11	1999–2009 bycatch
Morphometric					
Body length	Electronic	CRI			1999–2009 bycatch
Body proportion	Electronic	CRI			2004–09 bycatch

REFERENCES

Baker, C.S., Cipriano, F., Morin, P.A., Rosel, P., Dalebout, M.L., Lavery, S., Costello, M., Steel, D. and Ross, H. 2007. *Witness for the whales*, Vs 4.3: a comprehensive and evaluated dataset of DNA sequences for improved molecular taxonomy and identification of cetacean species. Paper SC/59/SD5 presented to the IWC Scientific Committee, May 2007, Anchorage, USA (unpublished). 8pp. [Paper available from the Office of this Journal].

Gong, Y. and Hwang, B.N. 1984. Effort, catch and sightings data for the minke whale fishery in Korean waters. *Rep. int. Whal. Commn* 34: 335–37.

International Whaling Commission. 2001. Report of the Workshop to Review the Japanese Whale Research Programme under Special Permit for North Pacific Minke Whales (JARPN), Tokyo, 7–10 February 2000. *J. Cetacean Res. Manage. (Suppl.)* 3:375–413.

International Whaling Commission. 2010. Report of the Expert Workshop to Review the Ongoing JARPN II Programme, 26–30 January 2009, Yokohama, Japan. *J. Cetacean Res. Manage. (Suppl.)* 11(2):405–50.

Kato, H., Kishiro, T., Fujise, Y. and Wada, S. 1992. Morphology of minke whales in Okhotsk Sea, Sea of Japan and off the East coast of Japan, with respect to stock identification. *Rep. int. Whal. Commn* 42: 437–42.

Kawahara, S. 2003. A review of Japan's small-type whaling and CPUE analyses to address the relative plausibility of trials on western North Pacific minke whale. Paper SC/55/IST16 presented to the IWC Scientific Committee, May 2003, Berlin (unpublished). 9pp. [Paper available from the Office of this Journal].

Kim, S.G., Kim, J.D., Jin, H.G., Park, J.S. and Kim, Z.G. 2005. Distribution of As, Cd, Cu, Hg, Pb and Zn in the liver and muscle of minke whales in the Korean coast. Paper SC/57/E15 presented to the IWC Scientific Committee, June 2005, Ulsan, Korea (unpublished). 6pp. [Paper available from the Office of this Journal].

Lukoschek, V., Funahashi, N., Lavery, S., Dalebout, M.L., Brook, C., Cipriano, F. and Baker, C.S. 2005. Temporal and geographic distributions of North Pacific minke whale J- and O-type products from Japanese markets, 1999 to 2004. Paper SC/57/NPM6 presented to the IWC Scientific Committee, June 2005, Ulsan, Korea (unpublished). 10pp. [Paper available from the Office of this Journal].

Miyashita, T., Shigemune, H. and Kato, H. 1994. Outline of sighting strategy of scouting vessels attached to Japanese whaling fleets. *Rep. int. Whal. Commn* 44: 273–76.

Moon, H.B., Choi, H.G., An, Y.R., Choi, S.G., Park, J.Y. and Kim, Z.G. 2009. Perfluorinated compounds (PFCs) in cetaceans from Korean coastal waters. Paper SC/61/E5 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 9pp. [Paper available from the Office of this Journal].

Appendix 3

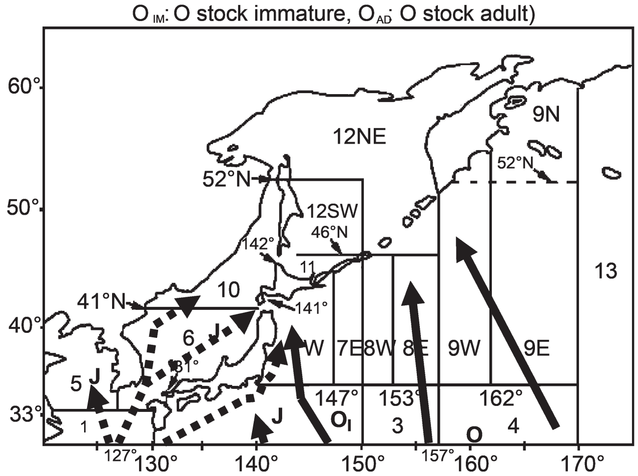
HYPOTHESES ON STOCK STRUCTURE IN WESTERN NORTH PACIFIC COMMON MINKE WHALES

Luis A. Pastene, Mutsuo Goto and Naohisa Kanda

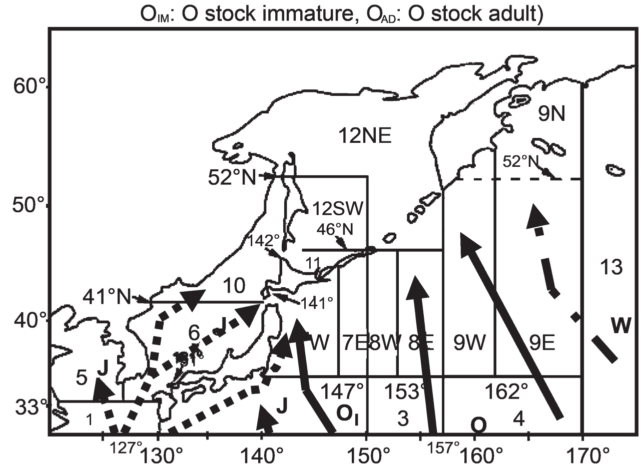
The best available scientific evidence is consistent with the following hypothesis, which is considered the most plausible:

(1) Single 'J' stock distributed in the Yellow Sea, Sea of Japan and Pacific side of Japan (pattern of interaction between 'J' and 'O' stocks along the Japanese coast as proposed by Kanda *et al*., 2009). Migration pattern of adult and juvenile 'J' stock is as suggested by SC/62/NPM1. Single 'O' stock in sub-areas 7, 8 and 9. Migration of 'O' stock is as suggested by Hatanaka and Miyashita (1997).

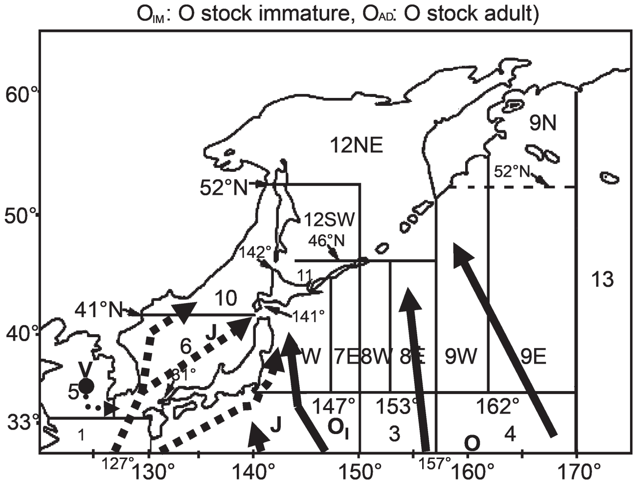
Hypothesis 1: (J/O: mixture of J and O stocks, O_{IM}: O stock immature, O_{AD}: O stock adult)



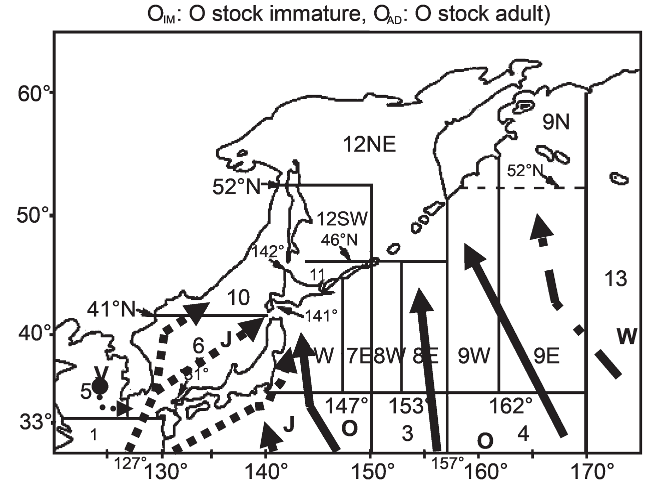
Hypothesis 2: (J/O: mixture of J and O stocks, O_{IM}: O stock immature, O_{AD}: O stock adult)



Hypothesis 3: (J/O: mixture of J and O stocks, O_{IM}: O stock immature, O_{AD}: O stock adult)



Hypothesis 4: (J/O: mixture of J and O stocks, O_{IM}: O stock immature, O_{AD}: O stock adult)



Three less plausible hypotheses are also postulated:

(2) Same as in (1) but W stock sporadically intrudes into sub-area 9.
(3) Same as (1) but a different stock (Y stock) resides in the Yellow Sea and overlaps with the 'J' stock in the south part of sub-area 6.
(4) Same as in (1) but with W stock sporadically intrudes into sub-area 9 and a different stock (Y stock) residing in the Yellow Sea, which overlaps with the 'J' stock in the south part of sub-area 6.

REFERENCES

Kanda, N., Goto, M., Kishiro, T., Yoshida, H., Kato, H. and Pastene, L.A. 2009. Update of the analyses on individual identification and mixing of the J and O stocks of common mike whales around Japanese waters examined by microsatellite analysis. Paper SC/61/JR5 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 14pp. [Paper available from the Office of this Journal].

Hatanaka, H. and Miyashita, T. 1997. On the feeding migration of Okhotsk Sea-West Pacific stock minke whales, estimates based on length composition data. *Rep. int. Whal. Commn* 47: 557–64.

Appendix 4

A PLAUSIBLE STOCK STRUCTURE HYPOTHESIS FOR WESTERN NORTH PACIFIC MINKE WHALES BASED ON EVIDENCE SUMMARISED IN SC/62/NPM15

C.S. Baker and P. Wade

The review of genetic and biological data from the western North Pacific minke whale provides evidence to address four primary uncertainties (SC/62/NPM15):

(1) Are whales in the Yellow Sea part of the same population that migrates into the Sea of Japan? No, there is genetic and biological evidence of differences. The population may overlap with the population in the Sea of Japan during part of the year.
(2) Are whales along the Korea coast part of the same population that migrates along the Japanese coast of the Sea of Japan? Yes, there is little evidence of differences between these two coasts. The population is at least partly non-migratory, as evidenced by year-round bycatch in sub-area 6.
(3) Are whales along the east coast of Japan part of the same population as those in the Sea of Japan? No, there is genetic and biological evidence of differences between these two coasts. The population is at least partly non-migratory, as evidenced by year-round bycatch in sub-area 2.
(4) Is there a coastal population in sub-area 7 that is different from the offshore population in the Pacific Ocean, even after accounting for some Sea of Japan whales (or other stocks) that might migrate into this area? Yes, there is genetic and biological evidence of differences between whales in near-shore sub-area 7 and those further offshore.

Together, the evidence relating to these four uncertainties is sufficient to propose a plausible hypothesis of 5 stocks, referred to as Y, Jw, Je, Ow and Oe. Finally, there is genetic evidence for heterogeneity to the east of the Oe stock, presumably representing a sixth stock, referred to previously as W.

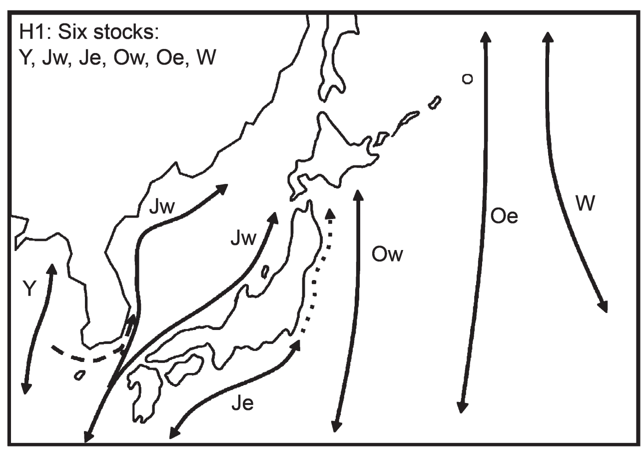


Fig. 1. Six stock hypothesis.

Appendix 5

COMMENTS ON SC/62/NPM15

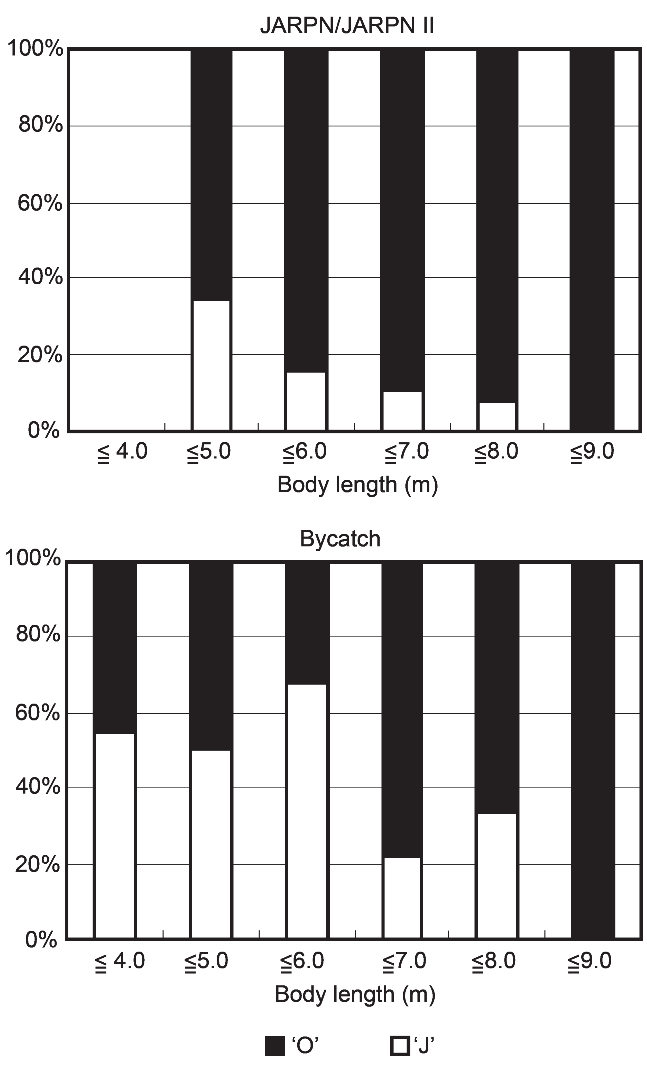
N. Kanda, LA. Pastene and H. Hatanaka

Paper SC/62/NPM15 proposed the existence of a distinct coastal stock in addition to the 'J' and 'O' stocks along the Pacific coast of Japan (sub-area 7W), rather than a mixture of the 'J' and 'O' stocks. Here, we argue against their hypothesis of a distinct coastal stock by presenting some pieces of evidence.

We have shown the results of assignments of the minke whales to the 'J' and 'O' stocks by conducting a STRUCTURE analysis (e.g. SC/62/NPM11). If there is a distinct coastal stock in sub-area 7W as they proposed, it is predicted that proportions of the two identities should be almost the same by: (1) body length; and (2) distance from the coastline. In addition, (3) the sample of all minke whales from sub-area 7W should be under the Hardy-Weinberg expected genotypic proportions.

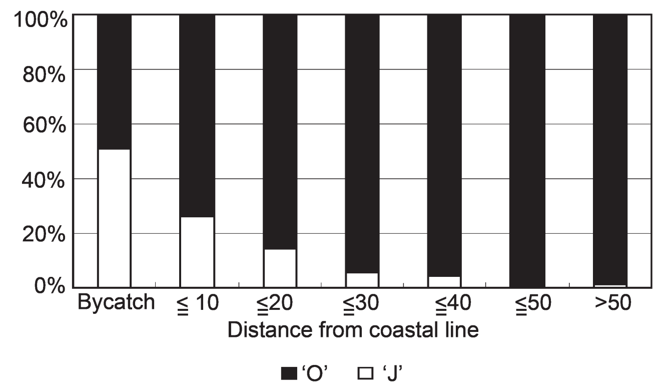
(1) Body length

The histograms below indicate that those assigned to the 'O' stock tend to be larger than those assigned to the 'J' stock.



(2) Distance from the coastline

The figure below shows the proportion of the minke whales assigned to 'J' and 'O' stocks by the distance from the coastline. The proportion of the whales assigned to the 'O' stock increases offshore.



(3) Hardy-Weinberg expected genotypic proportions

The table below shows the result of the tests for deviation from the Hardy-Weinberg expected genotypic proportions at each of the 16 microsatellite loci in the sample of all common minke whales collected from sub-area 7W (i.e. both bycatch and JARPN/JARPN II samples (n = 1,106)). Four of the 17 loci showed significant deviation from the Hardy-Weinberg expected genotypic proportions. All of these significant results were due to the homozygote excess, supporting the mixture of two stocks.

Table 1

Results of tests for deviation from the Hardy-Weinberg expected genotypic proportions in minke whales from sub-area 7W.

Locus	p-value
EV37	0.8778
EV1	0.1290
GT310	0.0000*
GATA28	0.0401
GT575	0.0495
EV94	0.6931
GT23	0.0157
GT509	0.0000*
GATA98	0.4467
GATA417	0.0461
GT211	0.0298
EV21	0.1517
DlrFB14	0.0389
EV14	0.0003*
GT195	0.0000*
TAA31	0.0474
All loci	Highly significant

*Significant after correction for multiple tests.

In conclusion, these results presented here support that the minke whales distributed in sub-area 7W are a mixture of the 'J' and 'O' stocks, rather than a single coastal stock.

Appendix 6

COMMENT ON MIXING IN SUB-AREA 7W: HARDY-WEINBERG IS PLAUSIBLE OR NOT?

C.S. Baker and P. Wade

Wada (1984) provided the first genetic evidence for a distinct stock of minke whales in the Sea of Japan, based on a comparison of allele frequencies of the Adh-1 allozyme locus. Wada (1991) updated this analysis comparing the genotype frequencies of n = 903 whales taken by Japanese small-type coastal whaling in areas A, B, C and D. In area A (now referred to as sub-area 11), the results showed a significantly higher frequency of the Adh-1^D allele and a deviation of genotype frequencies from Hardy-Weinberg (an excess of homozygotes), particularly in the month of April, compared to areas B and C (now referred to a sub-area 7W). Wada (1991) attributed the deviation in sub-area 11 to a mixing of whales from the Sea of Japan, where the frequency of Adh-1^D is nearly fixed (Adh-1^D = 0.93, with whales from the Pacific coast, where Adh-1^D = 0.31. In sub-area 7W, Wada (1991) found no evidence of deviation from Hardy-Weinberg equilibrium in analyses of the total sample, or in stratification by year, month, sex or age class.

Appendix 4 reports deviation from Hardy-Weinberg at 4 of 17 loci for a sample of n = 1,106 minke whales taken as bycatch and in scientific hunting in sub-area 7W. These authors attribute this deviation (an excess of homozygotes) to the mixing of whales from two distinct stocks (e.g. 'J' and 'O') in the near-shore waters of Honshu and Hokkaido.

In summary, the allele frequencies and Hardy-Weinberg equilibrium of the Adh-1 locus in the small-type coastal whaling from sub-area 7W, as reported by Wada (1991), are inconsistent with the simple mixing of two stocks, as proposed in Appendix 4, and with the proposed 'feeding migratory route' of juvenile 'J' stock whales, as proposed by Goto *et al.* (SC/62/NPM1).

REFERENCES

Wada, S. 1984. A note on the gene frequency differences between minke whales form the Korean and Japanese coastal waters. *Rep. int. Whal. Commn* 34:345–347.

Wada, S. 1991. Genetic structure of Okhotsk Sea-West Pacific stock of minke whales. Paper SC/43/Mi32 presented to the IWC Scientific Committee, May, 1991 (unpublished). 17pp. [Paper available from the Office of this Journal].

Appendix 7

MINORITY STATEMENT REGARDING PLAUSIBILITY OF STOCK STRUCTURE HYPOTHESES

H. Hatanaka, L.A. Pastene, N. Kanda, T. Gunnlaugsson, J.Y. Park, S.G. Choi and Y.R. Rock

After the deliberations on plausible stock structure hypotheses during the PIA for western North Pacific minke whales, Baker and Wade proposed some hypotheses for the Pacific side of Japan which we believe are not consistent with the current available data. We do not support the hypotheses of J_e and O_w stocks in the Pacific side of Japan because they are not supported by the existing data. However, we did not want to block the consensus which would have stopped the process from moving to the next step. Therefore we reluctantly accepted that the Baker and Wade hypotheses be included on the basis of assurances from both the chair of NMP and the IWC Head of Science that: (a) the *pre-Implementation assessment* requires only an agreement on stock structure hypotheses that meet some minimum standard of plausibility and does not prejudge actual plausibility of hypotheses; (b) there would be opportunities at a later stage of the process to delete hypotheses; and that (c) not all hypotheses included at this point would need to be tested. Again, this does not mean we agree with these hypotheses.

Baker and Wade proposed a coastal 'J' stock in sub-area 2 (J_E) and a coastal 'O' stock in sub-area 7 (O_W). Japanese scientists have demonstrated through the analysis of biological and genetic data that both 'J' and 'O' stocks mix with each other along the Pacific side of Japan. Baker and Wade made use of mixed samples of both stocks in their mtDNA haplogroup analysis to reach their conclusions that there are stocks with intermediate haplotype frequencies. Their analytical approach is contrary to previous recommendations from the Scientific Committee to exclude 'J' stock animals from analysis on stock structure of the 'O' stock. Furthermore an updated Boundary Rank analysis did not support the occurrence of an O_W stock. Previous results from this method had been the only evidence for supporting an O_W stock in the past. Given the results of the updated Boundary Rank analyses their hypothesis should not have been listed as plausible hypotheses at this stage in the process.

The hypothesis they proposed is especially hard to address with additional data. Therefore we consider reasonable that they provide reasonable logic to support their claim of plausibility for this stock structure scenario by the next Scientific Committee meeting. Without the provision of a reasonable logic their hypotheses should be dropped from the list of plausible hypotheses.

Appendix 8

LIMITING WHALING OPERATIONS ON 'O' STOCK COMMON MINKE WHALES TO WATERS 10 NAUTICAL MILES OR MORE FROM THE JAPANESE PACIFIC COAST MINIMISES CATCH OF 'J' STOCK WHALES

N. Kanda, H. Hatanaka and M. Goto

Introduction

Concerns have been expressed that providing a quota for 'O' stock common minke whales to be taken in the Pacific coastal waters of Japan as part of an agreement on the 'future of IWC' will increase the accidental take of 'J' stock animals. In this regard, the report of the Scientific Assessment Group (IWC/M10/SWG6) indicates that introducing a 10 n.mile buffer zone would limit the number of 'J' stock animals accidentally caught in coastal whaling operations to 27 and noted that 'if it is possible for catch effort to be moved further offshore then this is likely to reduce the likelihood of catches of 'J' stock animals'. This Appendix provides more detailed analysis of the effect of introducing a 10 n.mile buffer zone on the number of 'J' stock animals to be accidentally caught based on both past commercial whaling data and data from JARPN and JARPN II. Whaling operations proposed in the agreement will in any event be mostly well beyond a 10 n.mile buffer zone. Japan's proposal for the agreement would change the current research take of 120 coastal and 100 offshore minke whales to a quota of 150 coastal and 70 offshore.

Materials and methods

Sampling of common minke whales during JARPN II coastal component surveys is conducted in coastal waters within 50 n.miles from the whaling ports. Analyses of these whales taken by JARPN II surveys, as well as bycaught whales from set net fisheries (bycatch), indicates that the 'J' stock whales tend to be distributed in the area close to the coast line (10 n.miles or less). Proposed future coastal whaling plans to operate in coastal waters more than 10 n.miles from the coastal line in order to avoid 'J' stock animals. The extent to which such a limit to the operation of future whaling on the 'O' stock minimises the catch of 'J' stock whales is shown below.

Identification of the stocks among the individuals was according to Kanda *et al*. (2009). Microsatellite genetic variation was analyzed using 16 sets of primers in order to obtain genotypic data from coastal and offshore surveys of JARPN and JARPN II from 1994 to 2007 (n = 1711) and bycatches from 2001–07 (n = 831). The Bayesian clustering approach implemented in the computer program STRUCTURE version 2.0 (Pritchard *et al*., 2000) was used to determine the most likely number of genetically distinct stocks present in our samples and stock assignment. Individuals taken by the JARPN and JARPN II surveys from sub-area 7W were used to determine the proportion of 'J' stock individuals by the distance from the coastline. For the calculations, only the stock-determined whales were used.

Results

Fig. 1 shows the sampling locations of the minke whales collected during JARPN/JARPN II surveys in the coastal waters of Japan illustrating that more 'J' stock whales were taken in waters near the coastline than in offshore waters. Table 1 shows the number and proportion of 'J' and 'O' stock whales by survey and distance. Table 2 shows the expected number of 'J' stock whales that would be included in the catch with and without a 10 n.mile limitation on whaling operation. Our estimation shows that the number of the 'J' stock whales' caught would decrease under the 10 n.mile limitation. For a catch of 120 animals the number of 'J' stock whales would decrease from 28.3 to 23.4. Similarly, for a catch of 150 animals the number of 'J' stock whales

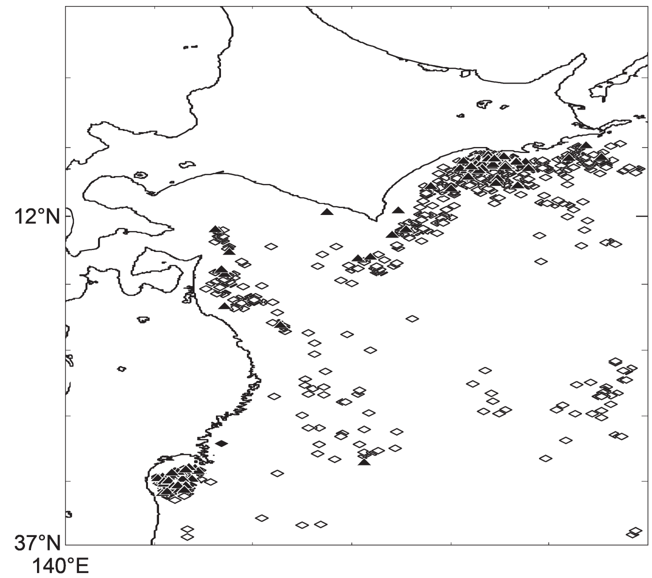


Fig. 1. Sampling locations of the minke whales near the coastline during JARPN/JARPN II. 'O' stock (Diamonds) and 'J' stock (Triangles).

Table 1

The number of 'J' and 'O' stock animals in past JARPN II surveys (2000–07).

	Total		10 n.miles or more	
	'J'	'O'	'J'	'O'
Kushiro	38	190	19	145
Sanriku	41	164	26	110
Coastal	79	354	45	255
	0.182	0.818	0.150	0.850
Offshore*	24	346	19	336
	0.065	0.935	0.054	0.946

*Minke whales collected in sub-area 7W from 1994 to 2007.

Table 2

Expected number of 'J' stock animals accidentally caught in proposed catch limit.

		Include <10 n.miles			Only over 10 n.miles		
Coastal	Offshore	Coastal	Offshore	Total	Coastal	Offshore	Total
n = 120	n = 100	21.8	6.5	28.3	18.0	5.4	23.4
n = 150	n = 70	27.3	4.5	31.8	22.5	3.8	26.3

would decrease from 31.8 to 26.3 animals. These results clearly show that for future coastal whaling operations, implementation of a 10 n.mile buffer zone minimises the catch of 'J' stock animals. When we compare the expected catch of 'J' stock whales between the current coastal operation under JARPN II (120 without a 10 n.mile buffer zone) and the proposed coastal whaling by Japan (150 with a 10 n.mile buffer zone) in combination with estimated catch of 'J' stock animals in offshore operations, the catch of 'J' stock whales would slightly decrease from 28.3 to 26.3 animals.

Figs 2, 3a, and 3b show the catching locations of minke whales from past commercial whaling in the coastal waters of Japan illustrating that most catches were taken well beyond 10 n.miles from shore. In a similar fashion, future coastal whaling operations with no takes within 10 n.mile from shore would be conducted well beyond the 10 n.mile line. This would therefore address the comment from the Scientific Assessment Group that moving the catch effort further offshore would likely reduce the likelihood of catches of 'J' stock animals.

Conclusions

Future coastal whaling operations under a regime that includes a 10 n.mile buffer zone and with actual catches taken further offshore will not increase and in fact will reduce any accidental catch of 'J' stock animals.

REFERENCES

Kanda, N., Goto, M., Kishiro, T., Yoshida, H., Kato, H., and Pastene, L.A. 2009. Individual identification and mixing of the 'J' and 'O' stocks around Japanese waters examined by microsatellite analysis. Paper SC/J09/JR26 presented to the JARPN II Review Workshop, Tokyo, January 2009 (unpublished). 9pp. [Paper available from the Office of this Journal].

Pritchard, J.K., Stephens, M., and Donnelly, P. 2000. Inference of population structure using multilocus genotype data. *Genetics* 155:945–959.

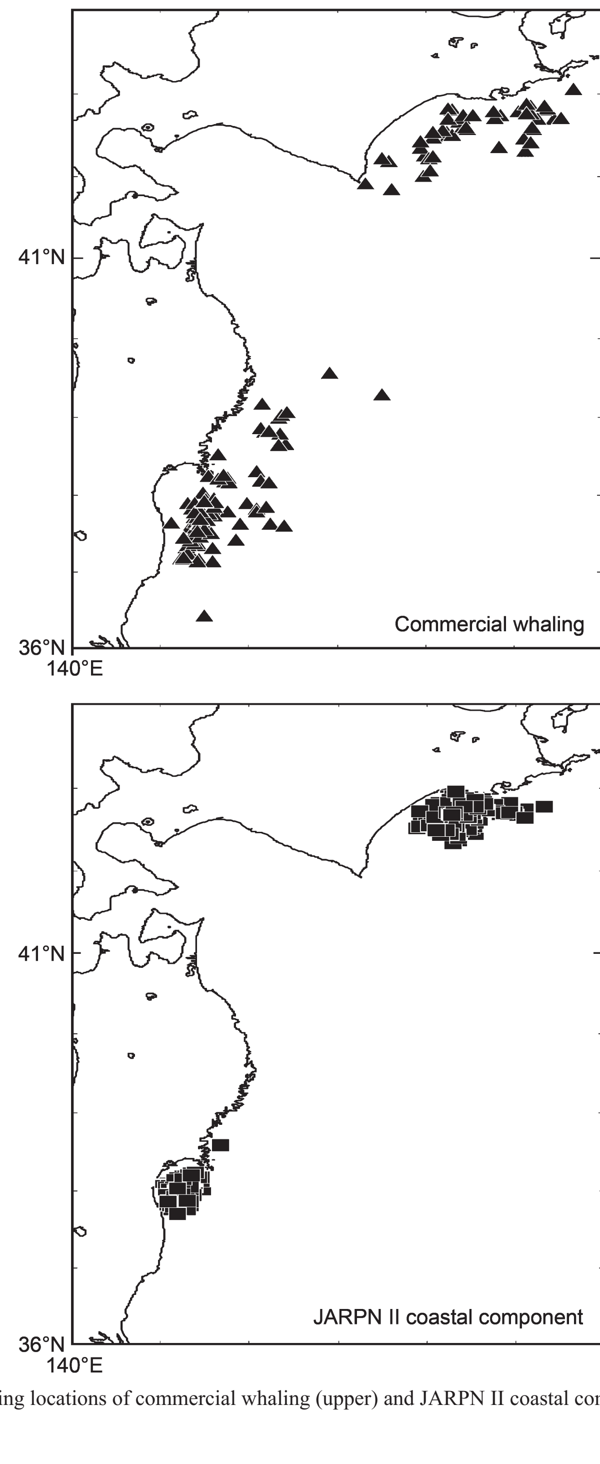


Fig. 2. Sampling locations of commercial whaling (upper) and JARPN II coastal component (lower).

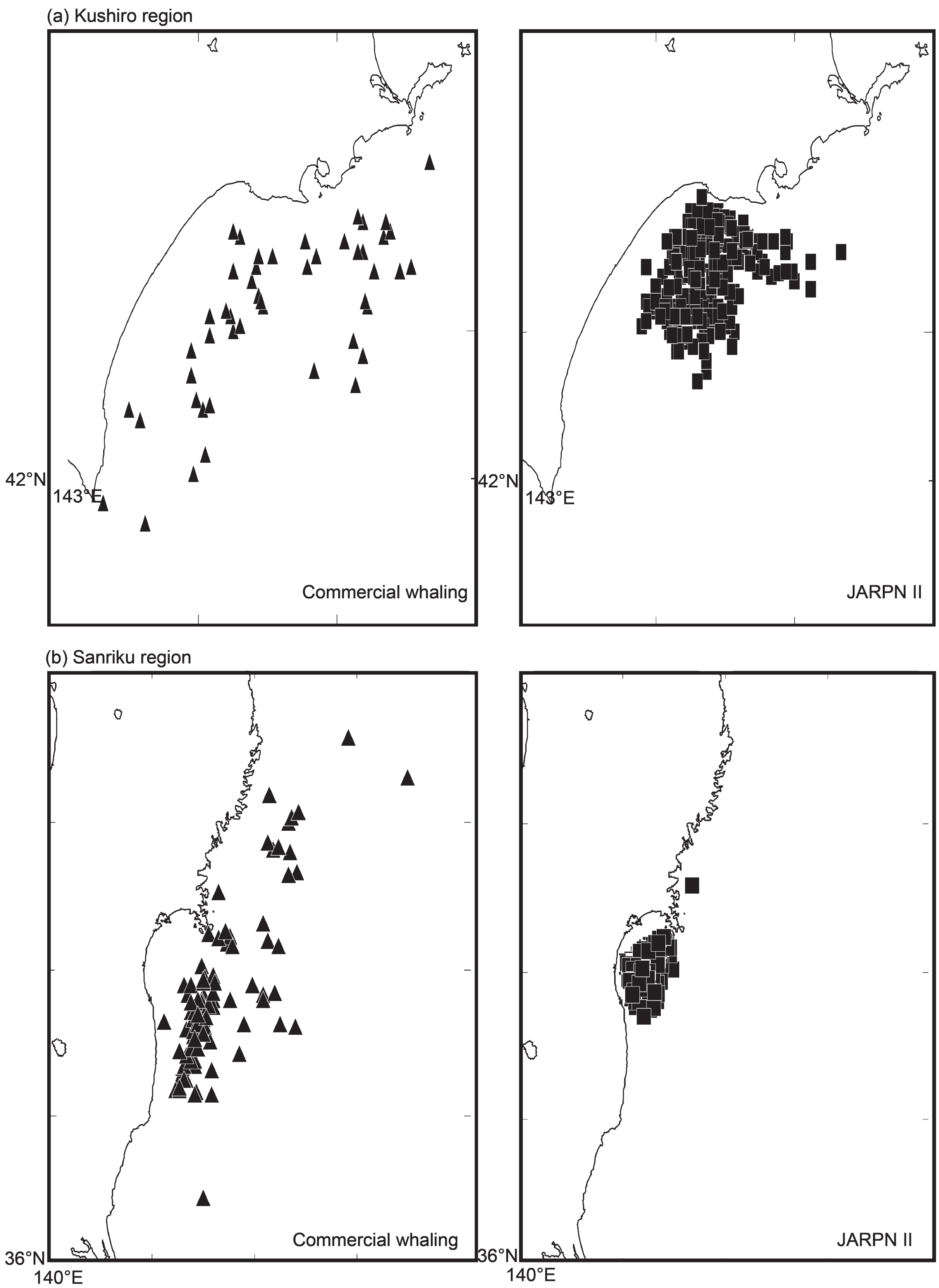


Fig. 3a. Detail of the Kushiro region and Fig. 3b. Detail of the Sanriku region.

Appendix 9

IMPLEMENTATION REVIEW – DRAFT WORKPLAN

The schedule for an *Implementation Review* specifies that between the finalisation of the *pre-Implementation assessment* and the following Annual Meeting of the Scientific Committee, a First Intersessional Workshop shall be held to address at least the following items (IWC, 2005, p.86):

(1) A final review of the plausible hypotheses arising from the *pre-Implementation assessment* (and, if appropriate), elimination of any hypotheses that are inconsistent with the data) – this will take into account the probable management implications of such hypotheses to try to avoid unnecessary work in the precise specifications of hypotheses for which these are very similar.
(2) An examination of more detailed information in expected operations, including whether coastal, pelagic, on migration, on feeding, on breeding or combinations of these. When providing such information, users and scientists may provide options or suggest modifications to the pattern of operations.
(3) The determination of the small geographical areas ('sub-areas') that will be used in specifying the stock structure hypotheses and operational pattern.
(4) The development of (options for) potential *Small Areas* and management variants.
(5) The specification of the data and methods for conditioning the trials that will be carried out before the next Annual Meeting (an e-mail correspondence group will be established to make revisions should any problems arise).
(6) Further consideration of experimental ways to distinguish amongst competing hypotheses.

Because the *pre-Implementation assessment*, though developing the stock structure hypotheses to be considered, did not achieve the level of spatio-temporal detail to allow preparation of data (e.g. sighting survey estimates of abundance) in the form needed for (5) above, it will be necessary to hold a Preparatory Meeting to prepare for the First Intersessional Workshop. The following sets out the associated schedule and requirements.

Work required prior to Preparatory Meeting

(a) The proponents of the two sets of stock structure hypotheses (the Y, J, O and W set, and the Y, J_W, J_E, O_W, O_E and W set) must develop documents setting out these hypotheses in a manner that specifies the areas in which these minke whale stocks (and as pertinent their components: juvenile, adult male, adult female) are to be found by month.
(b) Data for consideration at the Preparatory Meeting must be prepared at the level of detail appropriate to topics for that meeting listed below: commercial and by-catches (by sex where available); catch length and possibly age information (where available); CPUE for both commercial and incidental catch; genetic data; abundance surveys (specifically plots showing survey tracklines with achieved coverage, overall area covered and survey period).

Deadline: Mid-September 2010.

Preparatory Meeting (3–4 days)

This meeting will:

(a) Determine the sub-areas, time steps and population components to be used in *Implementation Simulation Trials* (i.e. complete item (3) above).
(b) Describe fully (though not completely finalise) the specifications of the various stock-structure and associated movement hypotheses (i.e. partially address item (1) above).
(c) Partially address the selection of the data and methods needed for conditioning the *Implementation Simulation Trials*, at least to the extent that the work specified below as needed to be completed before the First Intersessional Workshop can be undertaken, and arrange for persons to undertake that work (i.e. partially address item (5) above).

Deadline: End-September 2010

Further work required before the First Intersessional Workshop

(a) Disaggregate commercial and incidental catches into sub-areas and time steps (and, to the extent that may be necessary, population components) agreed at the pre-meeting.
(b) Similarly develop abundance estimates from surveys (and commercial and incidental catch CPUE, as appropriate) corresponding to these sub-areas and time-steps, together with their variance-covariance matrices.
(c) Evaluate mixing proportions of different stocks in pertinent sub-areas and time steps using genetic (and perhaps other, e.g. flipper colour) data.
(d) Evaluate dispersal rates between stocks using genetic data (this may require iteration after the First Intersessional Workshop).
(e) Preparation of Simple Model Filter software (see below).

Deadline: End November 2010

First Intersessional Workshop (4–5 days)

The Workshop will address and finalise where necessary items (1) to (6) above (excluding (3) which will have been finalised at the Preparatory Meeting). This will include finalisation of items (1) concerning details of hypotheses and item (5) concerning data and methods. In addressing item (1), the Workshop may make use of the Simple Model Filter approach to assess whether some hypotheses may be inconsistent with the data. The workshop will also detail any further work required to facilitate the conditioning of the trials specified in time for the next Annual Meeting.

Deadline: End December 2010

Budgetary implications

Allowance needs to be made for the cost of two intersessional meetings, and the attendance of up to 8 invited participants at each for a total of 8 days of meetings (in additional to national scientists).

REFERENCE

International Whaling Commission. 2005. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cet. Res. Manage. (Suppl.)* 7:77–113.

Annex E

Report of the Standing Working Group on the Aboriginal Whaling Management Procedure (AWMP)

Members: Donovan (Convenor), Acquarone, Allison, Bickham, Borodin, Brandão, Brandon, Breiwick, Brockington, Butterworth, Childerhouse, Clapham, Clark, Darling, de Moor, Deimer-Schütte, Edwards, Elvarsson, Flores, Frasier, Gallego, Gedamke, Givens, Gunnlaugsson, Holloway, Iñíguez, Jérémie, Ivashchenko, Kitakado, Koski, Lang, Mate, Lopez Mirones, Lovell, Luna, Mate, Nelson, Okada, Palka, Palsbøll, Punt, Reeves, Ritter, Robbins, Roel, Rose, Rojas-Bracho, Rowles, Scordino, Stachowitsch, Suydam, Uoya, Urbán, Wade, Walløe, Weinrich, Weller, Witting, Yoshida, Young.

1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks

Donovan welcomed the participants, noting that the Standing Working Group (SWG) had a very heavy Agenda this year, with a focus on the *Implementation Review* for gray whales as well as its usual work on Greenlandic hunts and providing management advice.

1.2 Election of Chair

Donovan was elected Chair.

1.3 Appointment of rapporteurs

Brandon, Givens and Punt were appointed as rapporteurs with assistance from the Chair.

1.4 Adoption of Agenda

The adopted Agenda is shown in Appendix 1. In addition to the normal business of the SWG, there were two issues to be considered in view of the proposed consensus decision of the Chair and Vice-Chair of the Commission (IWC/62/7rev).

(1) The conservation implications, if any, of increasing the catch limits by five animals per year to account for 'stinky whales'.
(2) The footnote to the gray whale section in Table 4. In the Table, the number 145 appears in each of the seasons 2010/11 to 2019/29. The footnote reads: 'This is the maximum number of animals that may be struck in any one year. The total number of animals that may be landed over the 10 seasons from 2011–20 is 1,290 (i.e. an average catch of 129 over the 10-year period)'.

These issues are addressed under Item 2.8.2.

1.5 Documents available

The documents considered by the SWG were SC/62/AWMP1-2, BRG 1, 5, 8, 11, 13, 21, 32, 35, Laake *et al.* (2009), IWC/62/9 and SC/62/Rep3.

2. *IMPLEMENTATION REVIEW* OF EASTERN GRAY WHALES

Implementation Reviews are subject to the Data Availability Agreement (IWC, 2004) incorporating a timetable of events. Although many datasets and analyses were completed within the appropriate timelines, unfortunately, just before adoption of the report, the SWG realised that the photo-identification and genetics data central to its discussions of stock structure and movements under Item 2.2 had not formally been submitted to the IWC under the DAA (although the papers themselves had met the appropriate deadlines). The same is also true for the telemetry data that, while not central to the conclusions reached, were also discussed under that Agenda Item; in this case the paper did not meet the appropriate deadline.

The SWG recognised that discussions of these data cannot be considered as part of the *Implementation Review.* Thus although the *Implementation Review* is considered complete with respect to the discussions involving the data properly made available under the DAA, the SWG **recommends** that a new *Implementation Review* takes place at the next Annual Meeting. This is to enable the SWG to take properly into account the important new information received this year that had not met the DAA timeline. This issue is referred to where appropriate in other parts of this report.

The Chair of the SWG has **agreed** to take responsibility to ensure that all likely contributors to the new *Review* are made aware of the DAA and timelines as well as the guidelines for genetic analyses and data, to make sure that this unfortunate event does not happen again.

2.1 What is an *Implementation Review*?

In 2004 (IWC, 2005), the Committee presented the Commission with its recommended Gray Whale *Strike Limit Algorithm* (the *Gray Whale SLA*) and this was endorsed by the Commission. The scheduled 2009 *Implementation Review* had been postponed because a number of key analyses would not be ready in time.

The purpose of an *Implementation Review* is to update information on catch history and abundance and to determine whether any other new information that has become available in the intervening (normally) 5-year period indicates that the present situation is outside the region of parameter space tested during *SLA* development. If this is the case, additional trials will need to be developed to test the performance of the *SLA* in this new region. If performance is found to be unacceptable under these new trials, revisions to the *SLA* will be required.

A few key aspects of the trials include:

(a) a single stock;
(b) a need envelope based on strikes from 150 in 2003 to a maximum of 530, 100 years later;
(c) survey frequency 10 years; and
(d) MSYR 1.5%–5.5%.

Full details of the parameter space investigated in the development of the *Gray Whale SLA* can be found in IWC (2005). In practical terms, the most important issues relevant to the present *Implementation Review* relate to the issues of stock structure and updated information on abundance/trends.

2.2 Stock structure and movements

In the development process for the *Gray Whale SLA*, there had been a discussion of stock structure at several meetings. While the possibility of a summer feeding aggregation along the Pacific coast between California and southeast Alaska was noted (e.g. IWC, 2001), the Committee had agreed that a single stock scenario was the most appropriate (IWC, 2001).

Considerable new information has been collected since that time on the animals feeding along the Pacific coast and the SWG received three papers of relevance to stock structure at this meeting (unfortunately, as noted above, these did not meet all of the DAA requirements). Although different names have been used in the past by different authors (e.g. the southern feeding group, the Pacific Coast Feeding aggregation), the SWG **agreed** to refer to the animals that spend the spring, summer and autumn feeding in coastal waters of the Pacific coast of North America from California to southeast Alaska as the Pacific Coast Feeding Group or PCFG.

SC/62/AWMP1 presented data on the genetic differentiation between the southern feeding group (the PCFG in SWG parlance) of eastern North Pacific gray whales and the larger population. The impetus for this work was based on photo-identification (photo-id) studies reporting a high re-sighting rate of identified individuals over time, suggesting that whales show fidelity to this southern feeding area. The hypothesis was that this sighting pattern was based on maternally-directed site fidelity, where, as with many other baleen whale populations, feeding area usage is passed on from mother to offspring. The study compared mitochondrial DNA sequences from 40 individuals sampled off western Vancouver Island to sequences obtained from 83 individuals sampled in the winter breeding/calving areas off Baja California that had previously been published by Goerlitz *et al.* (2003). The rationale was that these latter samples should be representative of the larger population. Significant differences in the frequencies of mitochondrial haplotypes were found between the two sample sets (F_{ST} = 0.01975, P = 0.00391), rejecting the hypothesis of panmixia. Moreover, estimates of Θ ($N_e\mu$ for mitochondrial data) were significantly different (P = 0.000135), and relative migration rates were estimated at << 1%. The authors concluded that in combination, these results suggest that the matrilines of the southern feeding group are demographically independent from those of the rest of the population, and therefore require separate management consideration.

SC/62/BRG32 reported the results of an 11-year (1998–2008) collaborative study examining the abundance and the population structure of eastern gray whales that spend the spring, summer and fall feeding in coastal waters of the Pacific Northwest conducted over a number of regions from northern California to British Columbia using photographic identification. With respect to stock structure, SC/62/BRG32 concluded the population structure of gray whales using the Pacific Northwest in summer and fall is complicated and involves two elements. There is one group of whales that return frequently and account for the majority of the sightings in the Pacific Northwest during summer and autumn (i.e. the PCFG). This group is certainly not homogeneous and even within this group, there is some degree of preference for certain subareas. Despite widespread movement and interchange among areas, some of these gray whales are more likely to be seen returning to the same areas they were seen before. A second group of whales, apparent stragglers, were encountered in this region after the migration. These animals are seen in only one year, tend to be seen for shorter periods than a year, and in more limited areas.

SC/62/BRG21 presented information on satellite telemetry work on eastern gray whales. One of the authors (Mate) was asked to summarise the results of this paper and previous telemetry studies, focussing on stock structure issues. His summary of this work follows. A total of 18 eastern gray whales considered to be part of the PCFG were marked off Oregon and northern California from September to December 2009. Biopsy samples were collected from 14 tagged whales (5 females and 9 males) and twelve tags were fully deployed. Follow-up observations and photographs of tagged whales were taken from September 2009 to April 2010 and will continue.

On the summer/autumn foraging grounds, tagged whales showed a high degree of variability in their movements and the number of areas used, as noted in past photo-ID studies (Calambokidis *et al.*, 2002; Darling, 1984; Darling *et al.*, 1998). However, the majority of the field work in those studies took place before mid-November, whereas the data from the satellite tags provide insights into movements over a longer time period. Of the first 6 whales tagged during 3 consecutive days along the central Oregon coast, 4 whales moved south during the first 2 weeks, and the 2 other whales stayed in the immediate tagging area, indicating whales in the same area and time do not necessarily subsequently do the same thing. Within 2 weeks, one tagged whale moved south to Cape Blanco and then north to the west coast of Vancouver Island, BC, covering all of its previous known range from 15 years of photo-id studies. Travel speeds during transits were similar in speed to migrations, suggesting the whales moved directly from one spot to the next without much *en route* 'sampling'.

Eight whales began their migration from near Point St. George, CA, from 4 December to 13 February and 6 whales arrived at Laguna Ojo de Liebre near Guerrero Negro, BCS Mexico. The apparent site fidelity to Ojo de Liebre Lagoon of these PCFG whales may be a general feature of PCFG whales. However, with large numbers of whales breeding in this lagoon, the mechanism to maintain a genetic subset of the overall population is most likely to be along maternal lines. An earlier 2005 tagging study tracked six gray whales tagged in Ojo de Liebre to the Chukchi Sea, showing they were part of the much larger subpopulation which summers in the Arctic (Mate and Urbán-Ramirez, 2006). If the PCFG comprises around 200 animals, they would be a small percentage of whales using that lagoon, so it is not surprising that only 'Arctic' animals were tagged even if PCFG whales were present.

Northbound migration was documented for three whales in this study, with two of them reaching PCFG feeding destinations. Whale 23041 exhibited a great deal of mobility, moving back and forth repeatedly between the OR and WA coasts. Whale 5938, on the other hand, travelled initially to Vancouver Island where it remained for one month, prior to moving to Icy Bay, AK, where it has stayed for five weeks (as of April 28). Although their sample size was small, Calambokidis *et al.* (2002) documented an inter-annual resighting of one animal between southeast Alaska and Washington, and suggested that either the range of the PCFG extends farther north than the efforts of their study, or that there are other feeding aggregations along the west coast with some interchange among them. It seems reasonable the PCFG may contain animals with differing sized home ranges and that annual environmental changes may result in animals using different portions of their home ranges to find adequate food.

The SWG thanked Mate for the update on this work and noted that the tagging data may provide the best estimator of residency times for PCFG gray whales in order to evaluate their relative vulnerability with respect to the spatial and temporal characteristics being considered for the Makah hunt. Analogous data from non-PCFG whales may also help determine if there are differences between PCFG and non-PCFG whales with regard to their migrations (distances from shore, water depths or timing) or other behaviours. Therefore, the SWG **recommended** that the satellite tagging work should continue and that these data be analysed with the goal of providing input (e.g. as required in mixing matrices, etc.) as necessary for any future trials of the *Gray Whale SLA*.

The SWG thanked the authors for these comprehensive papers. There was considerable discussion of them and their implications for stock structure. A number of interesting issues were raised, including: the choice of the genetic reference set used in SC/62/AWMP1 (a re-analysis with a larger reference set is provided in Appendix 2, and this did not alter the conclusions); the patterns observed from photo-id data collected in other areas; the conclusions that could be drawn from satellite tagged animals (see also Item 2.7). Despite some differences in interpretation and recognising that further analyses could be carried out, the SWG **agreed** that the hypothesis of demographically distinct southern feeding group is plausible and warranted further investigation. The implications of this for the *Implementation Review* are discussed later in the report.

2.3 Catch data

Allison informed the SWG that the catch series had been updated to incorporate new information. The complete series can be found in Tables 1a and 1b.

Table 1a

Aboriginal removals from the eastern north Pacific stock of gray whales 1600–1845 (see Appendix 3).

Years	Annual kill
1600–1675	182
1676–1750	183
1751–1840	198
1841–1845	194
Total kill 1600-1845	**46,300**

Table 1b

Catches from the eastern North Pacific stock of gray whales 1846–2009.

Year	Male	Female	Total	Year	Male	Female	Total
1846	105	123	228	1859	311	683	994
1847	127	196	323	1860	369	834	1,203
1848	123	182	305	1861	293	690	983
1849	99	98	197	1862	176	294	470
1850	103	102	205	1863	182	304	486
1851	102	102	204	1864	228	413	641
1852	120	156	276	1865	228	427	655
1853	162	297	459	1866	198	322	520
1854	162	293	455	1867	224	390	614
1855	144	237	381	1868	178	245	423
1856	162	284	446	1869	148	172	320
1857	175	318	493	1870	157	182	339
1858	304	649	953	1871	157	188	345

Cont.

Table 1b (cont.)

Year	Male	Female	Total	Year	Male	Female	Total
1872	139	140	279	1941	38	39	77
1873	136	141	277	1942	60	61	121
1874	125	125	250	1943	59	60	119
1875	112	113	225	1944	3	3	6
1876	105	105	210	1945	25	33	58
1877	114	115	229	1946	14	16	30
1878	110	110	220	1947	11	20	31
1879	126	127	253	1948	7	12	19
1880	114	114	228	1949	10	16	26
1881	110	111	221	1950	4	7	11
1882	111	111	222	1951	6	8	14
1883	109	108	217	1952	17	27	44
1884	110	111	221	1953	21	27	48
1885	94	93	187	1954	14	25	39
1886	71	71	142	1955	22	37	59
1887	72	72	144	1956	45	77	122
1888	69	69	138	1957	36	60	96
1889	70	70	140	1958	55	93	148
1890	66	66	132	1959	74	122	196
1891	43	43	86	1960	58	98	156
1892	42	43	85	1961	77	131	208
1893	42	43	85	1962	59	92	151
1894	39	39	78	1963	68	112	180
1895	39	39	78	1964	90	129	219
1896	35	34	69	1965	71	110	181
1897	35	34	69	1966	95	125	220
1898	35	34	69	1967	161	213	374
1899	32	32	64	1968	89	112	201
1900	31	31	62	1969	89	125	214
1901	30	31	61	1970	71	80	151
1902	30	31	61	1971	57	96	153
1903	30	31	61	1972	61	121	182
1904	30	31	61	1973	97	81	178
1905	28	29	57	1974	94	90	184
1906	28	29	57	1975	58	113	171
1907	28	29	57	1976	69	96	165
1908	28	29	57	1977	87	100	187
1909	28	29	57	1978	94	90	184
1910	28	30	58	1979	58	125	183
1911	29	29	58	1980	53	129	182
1912	28	29	57	1981	36	100	136
1913	28	30	58	1982	57	111	168
1914	37	39	76	1983	46	125	171
1915	28	29	57	1984	59	110	169
1916	26	26	52	1985	54	116	170
1917	26	26	52	1986	46	125	171
1918	26	26	52	1987	48	111	159
1919	26	26	52	1988	43	108	151
1920	27	27	54	1989	61	119	180
1921	46	44	90	1990	67	95	162
1922	32	29	61	1991	67	102	169
1923	26	26	52	1992	0	0	0
1924	27	26	53	1993	0	0	0
1925	99	87	186	1994	21	23	44
1926	51	43	94	1995	48	44	92
1927	36	48	84	1996	18	25	43
1928	30	34	64	1997	48	31	79
1929	23	27	50	1998	64	61	125
1930	23	24	47	1999	69	55	124
1931	5	5	10	2000	63	52	115
1932	10	10	20	2001	62	50	112
1933	38	37	75	2002	80	51	131
1934	66	60	126	2003	71	57	128
1935	71	83	154	2004	43	68	111
1936	93	105	198	2005	49	75	124
1937	12	12	24	2006	57	77	134
1938	32	32	64	2007	50	82	132
1939	19	20	39	2008	64	66	130
1940	56	69	125	2009	59	57	116

2.4 Abundance and trends

SC/62/BRG1 presented calf counts from shore-based surveys of northbound eastern North Pacific gray whales. These surveys have been conducted each spring between 1994 and 2009 at the Piedras Blancas Light Station in central California. Results from the 1994 to 2000 portion of the study have previously been published (Perryman *et al.*, 2002) and paper SC/62/BRG1 presented an update of information from these counts for 2001–2009. Estimates for the total number of northbound calves in 2001 to 2009 were 256, 842, 774, 1528, 945, 1020, 404, 553 and 312, respectively. These calf estimates were highly variable between years, with no sign of a positive or negative trend. Calf production indices, as calculated by dividing the estimates of northbound calves by estimates of abundance for the population (Laake *et al.*, 2009), ranged between 1.6–8.8% with an overall average of 4.2%. No significant trend in the median migration date was observed, although a trend toward a later median date beginning in 2002 was apparent. The annual indices of calf production reported reflect, at least to a large degree, calf loss due to postnatal mortality, but may ultimately overestimate recruitment into the population because they do not account for the possibly significant level of predation on gray whale calves by killer whales occurring north of survey site. The relatively low reproductive output in this population is consistent with the reports of little or no growth in this population over the same time period – see Laake *et al.* (2009) and SC/62/AWMP2. Based on comparisons of Arctic sea ice distributions taken from satellite images and estimates of northbound calves, Perryman *et al.* (2002) suggested that there is a link between the timing of the melt of seasonal ice and calf production in this population the following winter. These authors hypothesize that a late retreat of seasonal ice may delay access to the feeding areas for pregnant females and reduce the probability that existing pregnancies will be carried to term.

The SWG noted that the calf production indices were particularly low (<3%) during two periods (1999–2001 and 2007–09). During the first period, calf counts were low and high numbers of strandings also occurred. However, although the calf counts were low during 2007–09, there is no evidence for higher numbers of strandings during these years (see also discussion of SC/62/BRG35). Moreover, unlike 1999–2000, there are no observations that that the proportion of ‘skinny’ whales in the Mexican lagoons were higher during 2007–09 than during the years immediately prior to 2007. The SWG noted that the calf production indices in SC/62/BRG1 are being used to quantify the extent and temporal auto-correlation in reproductive rates (see Item 2 of SC/62/Rep2; Item 2 of Annex D). Although the time-series of calf counts is now 16 years long, this is only just long enough to allow estimation of these parameters. The SWG therefore **recommended** that these data continue to be collected, and reviewed during future *Implementation Reviews*.

In discussion, the SWG noted that the calf count data had been used during the initial development and *Implementation* for eastern gray whales. It **agreed** that the information provided in SC/62/BRG1 did not indicate any need to modify the trials structure.

SC/62/BRG36 reported on changes in the abundance of gray whales inferred from boat surveys at Laguna Ojo de Liebre (1980–83, 1985, 1987–89, and 1996–2010) and Laguna San Ignacio (1978–82, 1996–2000, and 2006–10). In Laguna Ojo de Liebre, the most whales during the peak of the season occurred during 2004 (889 cow-calf pairs and 233 single whales), while this peak occurred in 1984 in Laguna San Ignacio (137 cow-calf pairs and 270 single whales). There was a decrease in the numbers of cow-calf pairs in both lagoons during 2007 to 2009, similar to the results from shore-based surveys at Piedras Blancas during the northbound migration. The counts of cow-calf pairs in both lagoons in 2010 were the lowest over the last 15 years.

The SWG welcomed the information in SC/62/BRG36, and noted that the series of cow-calf counts in lagoons, which provide a relative index not absolute estimates, are consistent with the calf counts in SC/62/BRG1. The lagoon data were not used when conditioning the operating models used to evaluate candidate *SLA*s for the ENP gray whales. The correlation between these data and the calf counts in SC/62/BRG36 suggest that their inclusion when conditioning would not have impacted the evaluation of how well the *Gray Whale SLA* performed.

SC/62/BRG8 reported a ‘new’ counting approach that has recently been adopted for the counts of southbound migrating whales at Granite Canyon, California, which form the basis of abundance estimation for the ENP gray whales. In 23 years, between 1967 and 2007, counts of the number of observed pods have been rescaled by a series of correction factors to provide abundance estimates. The ‘traditional’ counting approach involved a single observer independently searching for whales and hand-recording entries onto a data form. The ‘new’ counting approach involves a team of paired-observers working together, using a computer to log data and map whale sightings. SC/62/BRG8 compares the performance of the traditional and new counting approaches during simultaneous and independent trials conducted during the 2006/07 and 2007/08 southbound migrations. In general, the number of pods counted showed a high degree of similarity between stations. However, there was a tendency for the new paired-observer teams to count fewer pods but estimate relatively higher numbers of whales. This probably represents a tendency for the paired-observers to lump rather than split whales into recorded pods because the tracking software facilitated the repeated relocation of whales in close proximity to each other. However, there may also have been a differential pod size estimation bias. The authors note the need for new calibration data to evaluate the different pod size estimation biases of new counting methods and new observers before count data can be reliably rescaled to estimate abundance.

The SWG welcomed this report. It noted the importance of ensuring comparability among years in any long-term monitoring effort. It **recommended** that data be collected to re-evaluate pod size bias given the change in survey protocol and that variance estimates for future survey estimates of abundance account for the uncertainty associated with calibration of abundance estimates computed using different survey protocols.

Laake *et al.* (2009) re-evaluated the data from all 23 seasons of shore-based counts for the Eastern North Pacific stock of gray whales conducted throughout all or most of the southbound migration near Carmel, California using a common estimation procedure and an improved method for treatment of error in pod size and detection probability estimation. Population estimates have been derived from these surveys using a variety of techniques that were adapted as the data collection protocol evolved. The resulting time series of estimates was used to evaluate trend and population status, resulting in the conclusion that the population was no longer endangered and had achieved its optimum sustainable population level under the US MMPA. The newly derived abundance estimates between 1967 and 1987 were generally larger (–2.5% to 21%) than previous abundance estimates. However, the opposite was the case for survey years 1992 to 2006, with estimates declining by –4.9% to –29%. This pattern is largely explained by the differences in the correction for pod size bias which occurred because the pod sizes in the calibration data overrepresented pods of two or more whales and underrepresented single whales relative to the estimated true pod size distribution.

The SWG thanked the authors for this comprehensive and careful review of this extremely valuable time-series of absolute abundance estimates. It **recommends** that the estimates of abundance given in Table 2 be **adopted** for use in the *Implementation Review* and for use when applying the *Gray Whale SLA*.

Table 2

Time-series of agreed abundance estimates of eastern gray whales for use in the *Gray Whale SLA* (taken from Laake *et al.* 2009).

Year	Estimate	CV	Year	Estimate	CV
1967/68	13,426	0.094	1979/80	19,763	0.083
1968/69	14,548	0.080	1984/85	23,499	0.089
1969/70	14,553	0.083	1985/86	22,921	0.081
1970/71	12,771	0.081	1987/88	26,916	0.058
1971/72	11,079	0.092	1992/93	15,762	0.067
1972/73	17,365	0.079	1993/94	20,103	0.055
1973/74	17,375	0.082	1995/96	20,944	0.061
1974/75	15,290	0.084	1997/98	21,135	0.068
1975/76	17,564	0.086	2000/01	16,369	0.061
1976/77	18,377	0.080	2001/02	16,033	0.069
1977/78	19,538	0.088	2006/07	19,126	0.071
1978/79	15,384	0.080			

As noted under Item 2.2, SC/62/BRG32 reported the results of an 11-year (1998–2008) collaborative study examining the abundance and the population structure of the ENP gray whales that spend the spring, summer and fall feeding in coastal waters of the Pacific Northwest conducted over a number of regions from Northern California to British Columbia using photographic identification. Some 12,679 identifications representing 872 unique gray whales were obtained. Gray whales seen after 1 June (after the northward migration) were more likely to be seen repeatedly and in multiple regions and years and 1 June was used as the seasonal start date for the data included in the abundance estimates. Gray whales using the Pacific Northwest during summer and fall include two groups: (1) whales that return frequently and account for the majority of the sightings; and (2) apparent stragglers from the migration seen in only one year, generally for shorter periods and in more limited areas. SC/62/BRG32 concluded the population structure of gray whales using the Pacific Northwest in summer and fall is complicated and involves two elements; the PCFG animals and the 'stragglers'. Abundance estimates for whales present in summer and autumn were estimated using both open and closed population models. Methods were proposed in SC/62/BRG32 for removing the 'stragglers' from both types of analyses to estimate abundance only of regularly returning whales. Three methods and four geographic scales revealed the abundance of animals that regularly return to the Pacific Northwest to be at most a few hundred individuals. Abundance estimates were lower for more limited ranges, but these more limited areas do not reflect closed populations. The proportion of calves documented was generally low, but varied dramatically among years and may have been biased downward by weaning of calves prior to much of the seasonal effort. Observations of calves returning to the Pacific Northwest in subsequent years, provides one possible mechanism for recruitment to the area.

The SWG **agreed** that these data would be extremely useful during the proposed 2011 *Implementation Review*, along with telemetry data, to determine the probability that animals from the putative feeding aggregation in the Pacific northwest are at risk of being caught during hunts in that area (see Item 2.6). The estimates in SC/62/BRG32 will also be useful to condition any trials developed to examine the performance of *SLA* variants for this feeding aggregation.

2.5 Other

2.5.1 Assessment

SC/62/AWMP2 fitted an age- and sex-structured population dynamics model to data on the catches and abundance estimates for the ENP stock of gray whales using Bayesian methods. The prior distributions used for these analyses incorporated the revised the estimates of abundance in Laake *et al.* (2009) and SC/62/BRG1, and accounted explicitly for the drop in abundance caused by the 1999–2000 mortality event. A series of analyses were conducted to evaluate the sensitivity of the results to different assumptions. The baseline analysis estimated the ENP gray whale population to be above the maximum sustainable yield level (MSYL), because the posterior mean for the ratio of 2009 abundance to MYSL is 1.29 (with a posterior median of 1.37 and a 90% probability interval of 0.68–1.51). The baseline analysis estimated a probability of 0.884 that the population is above MSYL. These results are consistent across all the model runs. The baseline model also estimated the 2009 ENP gray whale population size (posterior mean of 21,911) to be at 85% of its carrying capacity (posterior mean of 25,808), and this was also consistent across all the model runs.

The analyses of SC/62/AWMP2 only estimated an extra mortality parameter for 1999–2000. In discussion, it was noted that this choice was supported by the calf count data, the strandings records and the results of an analysis in which annual parameters were estimated for reproduction and survival (Brandon and Punt, 2009). It was noted that a large drop in abundance is estimated to have occurred between 1987–88 and 1992–93 (Table 2). There are no calf count data for this period but the strandings records provide no evidence for a mortality event of the scale of that which occurred in the late 1990s.

The SWG thanked the authors of SC/62/AWMP2 for the updated assessment. It **agreed** that the results of the assessment were within the bounds considered during the *Implementation*. Specifically, although the base operating model used to estimate the *Gray Whale SLA* did not explicitly include the 1999–2000 event, robustness tests involving catastrophic mortality events were conducted and the *Gray Whale SLA* performed as expected for these tests.

2.5.2 Strandings data

SC/62/BRG25 provided a summary of all gray whale strandings in California, Oregon and Washington between 1 January 2010 and 31 May 2010. The SWG welcomed this information, **agreed** that it showed that stranding levels were now similar to 'normal' years, and **recommended** that these data continue to be collected and presented to the SWG.

2.6 Consideration of need for new trials (and, if applicable, results of those)

The SWG refers to its earlier comments on the situation with respect to the DAA and the need for an *Implementation Review*.

Although some of the papers/data available to the SWG could not be considered in terms of the 2010 *Implementation Review*, the SWG agreed that the information provided on the PCFG was such that its existence represents a plausible hypothesis, not considered in the original *Implementation,* such that it was sufficient to trigger a new *Implementation Review* in 2011. The reason that this hypothesis is important from an AWMP perspective relates to the potential harvesting in this region by the Makah Tribe and thus the need for the SWG to provide advice/develop an *SLA* to fulfil both the 'conservation' and 'user' objectives given by the Commission. It noted that the situation for PCFG is not the same as for the Greenlandic feeding aggregation of humpback whales, in that the latter case involves a feeding aggregation that does not occur (even in the short-term during migration) with animals from other feeding aggregations in the waters where the hunt takes place. In the case of the proposed area for the Makah hunt, both PCFG and migrating whales from the other feeding areas co-occur at least some of the time.

The SWG **agreed** therefore that the information on stock structure and hunting warranted the development of trials to evaluate the performance of *SLA*s for hunting in the Pacific Northwest at the 2011 *Implementation Review*. The question of a timetable for this work is discussed later in the report.

The SWG also noted that the assessment work discussed above showed that the population as a whole is in a healthy state. It **agreed** that for the purposes of the 2011 *Implementation Review*, the primary focus should be the PCFG.

That being said, it agreed that over the next few years, further work should be undertaken to investigate the possibility of structure on the northern feeding grounds, especially in the region of the Chukotkan hunts. It **recommends** that additional information be collected from the Chukotkan region, in particular, where possible, including genetic samples and photographs from the hunt. In addition, the collation of information on the geographical and temporal distribution of the hunt will be valuable.

To provide some general guidance for the 2011 *Implementation Review*, the SWG **agreed** that any acceptable future *SLA* for the hunt in the Pacific Northwest must include a feedback mechanism. It was unable and not appropriate for it to fully specify a set of trials during the present meeting. However, it had preliminary discussions on those aspects that could form part of a final set of trials for the 2011 *Implementation Review.* A summary of the key factors is given below.

(1) **Current abundance**. The best estimate of current (1+) abundance for the PCFG would be 200 based on the estimates in SC/62/BRG32. A 'low' value of 150 would also be considered in trials. This latter value is lower than would be expected from the confidence intervals in SC/62/BRG32, but would be informative about the performance of a *SLA* and reflects uncertainties that may not have been captured in SC/62/BRG32. In addition, this value is close to the average of the number of individuals identified in recent years (SC/62/BRG32).
(2) **Relative availability of PCFG and non-PCFG whales to the hunters**. The SWG is currently unable to specify ranges for this parameter. It **recommended** that best estimates and lower and upper values could be obtained by analysing data from a variety of sources including the estimates of abundance in SC/62/BRG32 and information from satellite-tagged animals. The hunt is likely to be restricted to certain periods of the year and if this is the case, the measures of availability will need to pertain to those periods. The impact of inter-annual variability in availability will need to be accounted for in the trials. It is desirable for attempts to be made to estimate this variation.
(3) **Need**. The level of need (in the form of a need envelope) will need to be provided to the SWG by the US. The SWG **recommended** that the Chair of the SWG discuss its requirements for need envelopes with the hunters and members of the US delegation. The SWG will also need to be provided with any domestic regulations (such as time-area restrictions) that will be imposed on the hunt so that these can be accounted for in the trials to evaluate *SLA*s.
(4) **MSYR**. The SWG will explore a similar range of MSYR values to those considered for the development of the *Gray Whale SLA*.

2.7 Conclusions and recommendations

In light of the DAA difficulties discussed earlier, the SWG **agreed** that it had completed the *Implementation Review* on the basis of the data that had been made available to it in accord with the DAA. However, given the new information available that did not meet the DAA conditions, it **agreed** that a new *Implementation Review* should occur in 2011 to take into account information provided on the PCFG presented outside the DAA. The Chair of the SWG **agreed** to ensure that all likely contributors to the review are made aware of the DAA requirements as well as the guidelines for genetic analyses and data.

The SWG **agreed** that the following would assist in the trial development process:

(1) collection/analysis of genetic data that would allow more robust comparison of such data from animals in the northern and southern feeding areas;
(2) collection/analysis of genetic data from Kodiak Island to California to further examine the probable range of the PCFG;
(3) collection/analysis of genetic data to compare further animals seen in only one year with animals that are frequently seen within the hunting area;
(4) collection/analysis of additional information (including telemetry data) on the relative temporal 'availability' of PCFG animals within the hunting area (e.g. by month); and
(5) an updated analysis of any additional data to obtain the most recent abundance estimate for the PCFG at the time of the 2011 *Implementation Review.*

2.8 Management advice

2.8.1 Summary of previous season's catch data

A total of 115 gray whales (58 males, 57 females) was harvested in Chukotkan waters in 2009 and 1 was lost. A total of 6 of the 115 individuals were considered as unfit for consumption in 2009 (samples were taken from all 6). Biological sampling was conducted on 61 gray whales.

2.8.2 Management advice
As noted under Item 2, the SWG **agreed** that it has completed the *Implementation Review* but that a new *Implementation Review* should take place next year. In this context, the SWG **agreed** that its position with respect to the provision of management advice was unchanged from last year, i.e. the *Gray Whale SLA* remains the appropriate tool to provide management advice for eastern North Pacific gray whales. This remains the case, at least until the 2011 *Implementation Review* is completed.

In line with the values in table 4 of the proposed consensus decision (IWC/62/7rev), the Secretariat ran the *SLA* using the updated information on catches and abundance agreed at this meeting. This confirmed that an annual strike limit of 145 animals will not harm the stock (note that 145 is the maximum catch that can be taken in any one year; the annual average catch is 129 whales). In providing this advice, the SWG **draws attention** to the need for a new *Implementation Review* next year. It was noted that although table 4 included strike limits for 10 years, the proposed consensus decision envisages the usual periodic reviews of strike limits for indigenous whaling.

Borodin commented that the annual strike limit should include the actual number of struck-and-lost whales and 'stinky' whales (e.g. in 2009 the numbers were 1 and 6, respectively). If hunting is on large whales then the number of struck-and-lost whales will be higher. Within that context, he noted that the annual strike limit should not exceed 150 whales (the number included in the *Gray Whale SLA* trials for the early period of catches during the development process).

3. COMMON MINKE WHALES OFF WEST GREENLAND

3.1 Further discussion of the sex ratio method

3.1.1 Summary of discussions at the intersessional Workshop
The SWG reviewed its progress toward developing a sex-ratio method for assessing the West Greenland stock of common minke whales including, most recently, the Report of the Third AWMP Workshop on Greenlandic Hunts, held intersessionally, December 14–17, 2009, in Roskilde, Denmark (SC/62/Rep3). That meeting had focused on highly technical aspects of the estimation method, of which the topic with broadest implications was the specification of a new method for the calculation of one-sided confidence intervals for carrying capacity, *K*, and hence for other management related parameters including stock abundance.

The sex-ratio approach has been described in previous SWG reports (e.g. IWC, 2009b). The one-sided confidence limit approach proposed in Roskilde is described in Annex B of SC/62/Rep3. Put simply, for a given *K* the method is a parametric bootstrap of the left branch of the deviance function, defined to be the ordinary deviance if the bootstrap pseudo-estimate of *K* does not exceed the actual value, and zero otherwise (Fig. 1). One such bootstrap at each of a sequence of possible *K* values enables estimation of the 95% deviance contour which, when compared to the deviance function from the observed data, provides the desired confidence interval.

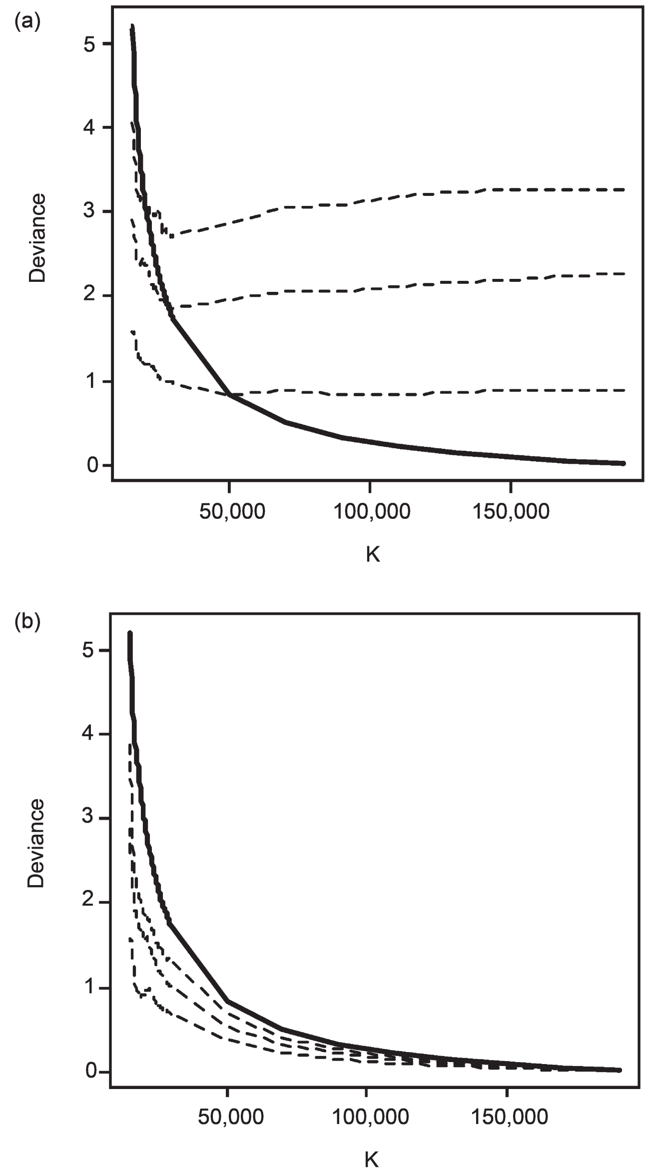


Fig. 1. Examples of the left branch of the deviance function and some expected quantiles of left deviance (a) and the left branch of the deviance function and some examples of quantiles of left deviance obtained using the algorithm agreed during the Third AWMP Workshop (b).

3.1.2 Results of intersessional work
Allison and Punt had implemented the 'Annex B' method after the Workshop. The numerical results they found raised concerns about whether the specification of the method was correct and appropriate. In particular, the quantiles of the left deviance function did not intersect the deviance based on the actual data. A variety of revisions and alternative approaches were explored by the Workshop participants before the SWG meeting, but there were no wholly satisfying results.

3.1.3 Review by the SWG
Givens was requested by the SWG to review the intersessional work and the various options surrounding the 'Annex B' approach. He stated that the original Annex B represented the correct approach. Appendix 4 details his recommended algorithm to implement this approach. The SWG **emphasised** the need to further refine this approach and to carefully ensure that the computer program is correctly implemented.

However, Givens had also identified a potential problem with the implementation of the parametric bootstrap, originating from the estimation procedure's truncation of parameter space at K = 200,000. The truncation had been introduced as a convenience to limit numerical search, since for many potential sex-ratio datasets the likelihood increases monotonically with K and hence the maximum likelihood estimate for K diverges to infinity. Adopting the notation in Appendix 4, the shape of the likelihood will often lead to $\hat{K}_{ig}$ values that exceed the truncation point of 200,000. In these cases, $LD_{ig}(\hat{K}_{ig}, K_g) > LD_{ig}(\hat{K}_{ig}, 200{,}000)$ when $K > 200{,}000$ and $LD_{ig}(200{,}000, K_g) < LD_{ig}(\hat{K}_{ig}, K_g)$. If such a simulation were to be discarded, or if $\hat{K}_{ig}$ were to be replaced with the value 200,000 so that $LD_{ig}(\hat{K}_{ig}, K_g)$ was replaced with $LD_{ig}(200{,}000, K_g)$, then the bootstrap simulation would not produce a sufficiently heavy right tail for the deviance distribution. Allison reported that the latter option was currently used. Either approach results in a downward bias when estimating $LD_g(.95)$, which in turn leads to a upward bias in the left confidence limit for K. This is the direction of bias that is least desirable in the sense that it could lead to over-exploitation of the stock.

In statistical terms, the truncation point perhaps creates an instance of right-censored data. Thus, the 95% left-deviance quantile at K_g should be estimated using a method that accounts for censored data, not with the direct empirical percentile method. Although seemingly a small problem, the censored instances occur quite frequently, and in a general sense the problem is indicative of the continued difficulties the SWG has faced with the likelihood function that underlies the sex-ratio approach.

Several remedies were considered by the SWG. The most promising of these was to re-parameterise the analysis by replacing K with $1/K$ or another suitable transformation. The SWG considered this to be a high-risk/high-reward option: it could provide a fundamentally more stable basis for estimation thereby eliminating many of the intricacies that continue to plague the current framework, but it may introduce new difficulties. The SWG **recommended** that this approach receive the highest priority during the next intersessional period. If a transformed analysis could be completed and agreed at the 2011 Scientific Committee meeting, the SWG would be prepared to use the sex-ratio method as a basis for abundance estimation and submit this to appropriate simulation trials to testing of performance and robustness. If these trials are passed, the approach could then be used for providing management advice.

The SWG also considered other options which would not require such a drastic change but which it considered had less chance of being successful. For example, the application of a censored data method for quantile estimation was also worth investigating. In addition, the likelihood function from recent aerial survey data could be incorporated into the approach, and this might change the deviance sufficiently to reduce some of the difficulties; however, application of this is not straightforward because, *inter alia*, the stock portion to which the estimate applies is uncertain. The SWG recognised that considering a new Bayesian approach (the original paper motivating the use of sex ratio data had followed a Bayesian approach) would probably not resolve the SWG's difficulties and would introduce a new set of challenges for the specification of priors. As a final option, the SWG considered raising the current truncation point. Work to examine whether this will be successful is underway and may be available by the Plenary sessions.

3.1.4 Conclusion on the use of the sex ratio method

The SWG **agreed** that the continued difficulties in successfully implementing a sex-ratio approach required a re-evaluation of the SWG's work plan. The original motivation for this work had been the Committee's inabililty to provide management advice for this hunt. Thus, reflecting the priorities of the Scientific Committee and the Commission, work on a sex-ratio estimation of abundance for West Greenland common minke whales has been the dominant focus of SWG effort for a number of Scientific Committee meetings and three intersessional workshops. The participants have devoted considerable research effort to this task, the work has been scientifically challenging and methodologically innovative and the potential gain in terms of providing adequate management advice extremely high. However, despite enormous effort, no satisfactory conclusion has been achieved to date.

Therefore, the SWG **agreed** that it would no longer prioritise development of the sex-ratio approach unless a comprehensive final analysis could be endorsed at the 2011 Scientific Committee meeting. The SWG believed that the transformation strategy may provide a promising basis for estimation in the short time remaining. Although it would be regrettable to abandon the sex-ratio effort without obtaining an agreed abundance estimate, there are many other urgent issues to which the SWG must turn its focus.

3.2 Management advice

3.2.1 Summary of previous season's catch

In the 2009 season, 153 minke whales were landed in West Greenland and 11 were struck and lost. Of the landed whales, there were 105 females, 47 males, and one whale of unreported sex.

3.2.2 Management advice

In 2007, the Commission agreed that the number of common minke whales struck from this stock shall not exceed 200 in each of the years 2008–12, except that up to 15 strikes can be carried forward. Last year, as it has said on several occasions in the past, the Committee has never been able to provide satisfactory management advice for this stock, although in recent years, the situation has been improving. Last year, the Committee was for the first time ever able to provide management advice for this stock, and adopted a new abundance estimate last year, although it is negatively biased, and has also agreed a method for providing interim management advice and this was confirmed by the Commission. Such advice can be used for up to two five-year blocks whilst *SLAs* are being developed (IWC, 2009a, p.16). Based on the application of the agreed approach, and the lower 5th percentile for the 2007 estimate of abundance (i.e. 8,918), the Committee **repeats its advice** of last year that an annual strike limit of 178 will not harm the stock.

3.3 Progress with *SLA* development

3.3.1 Summary of discussions at the intersessional workshop

In Greenland, a multispecies hunt occurs. The expressed 'need' is for 670 tonnes of edible products from large whales for West Greenland (IWC/62/9); at present this involves catches of common minke whales, fin whales and bowhead whales. Greenland has also requested a catch of humpback whales from the Commission (IWC/62/9). The flexibility among species is important to the hunters.

The issue of what is the 'correct' level of need itself is outside the scope of the Scientific Committee. In generic terms, the relevant Governments submit a 'need statement' to the Commission and it is then a Commission decision as to whether to accept that need request. Once that is agreed then the task of the Scientific Committee is to evaluate whether that need request can be achieved within the agreed conservation objectives of the Commission.

Where need is expressed as a number of animals of a particular species/stock this can be a relatively straightforward exercise. However, in developing long-term *SLA*s in the context of a 100-year simulation period, the Committee (and the Commission) has agreed that it is important to bound the likely levels of future need for testing purposes in order to avoid having re-evaluate the *SLA* itself every time an increased need request is accepted (should that occur). This bound is termed the 'need envelope' and has initially been developed by the Chair of the AWMP in conjunction with the hunters. It is important to note that this is a hypothetical upper bound in terms of the robustness of the *SLA* and neither commits the Commission to accepting increased need requests should these be presented nor indeed prevents the submission of need requests greater than the bound at some time in the future. In the latter case, the *SLA* would have to be re-evaluated as the circumstances would be outside the tested parameter space (this could be undertaken in the context of an *Implementation Review* in the same way that other new information might be obtained that led to the conclusion that further *Robustness Trials* were needed).

The Workshop noted that satisfying 'subsistence need' to the extent possible was a critical component of an *SLA*, yet the situation in Greenland, where there is a multispecies fishery with need expressed in tonnes of food and there is a request for flexibility amongst species, is complex. The Workshop considered some of the challenges presented by this issue (SC/62/Rep5), noting that the development of a combined approach to calculate strike limits for more than one species is beyond what the SWG and Scientific Committee have previously attempted. Consultation with both the hunters and the Commission will be required.

3.3.2 Further discussion and recommendations for further work

The SWG noted that the approach developed to provide safe interim advice was agreed for a limited time span of two consecutive 5-year blocks. It was not intended to replace or delay development of an appropriate *SLA* for this fishery but rather to allow time for this to be accomplished prior to the end of the second 5-year block. The SWG **reaffirmed** the importance of developing such an *SLA*. It had previously been awaiting the outcome of the evaluation of a sex ratio method approach; the decision potentially to cease work on a sex-ratio abundance estimate does not affect the need to begin work on an *SLA* as soon as possible such that a suitable *SLA* can be developed and tested before the current short-term advice expires. Section 11 describes the future work plan.

4. FIN WHALES OFF WEST GREENLAND

4.1 Management advice

4.1.1 Summary of previous season's catch data

A total of 8 (1 male; 7 females) fin whales were landed, and 2 struck and lost, in West Greenland during 2009 (SC/62/ProgRep Denmark). Genetic samples were collected for 5 of the 8 fin whales harvested during 2009.

4.1.2 Management advice

In 2007, the Commission agreed to a quota (for the years 2008–12) of 19 fin whales struck off West Greenland. The Committee agreed an approach for providing interim management advice in 2008 and this was confirmed by the Commission. It had agreed that such advice could be used for up to two five-year blocks whilst *SLA*s were being developed (IWC, 2009a). Based on the application of the agreed approach in 2008 (IWC, 2009a), the SWG **agreed** that an annual strike limit of 19 whales will not harm the stock.

4.2 Progress with SLA development

The general consideration of *SLA*s for Greenlandic fisheries was discussed at the intersessional workshop (SC/62/Rep3) and summarised under Item 3.3.1 above.

Simulation evaluation of *SLA*s requires the development and parameterisation of a set of operating models. Unlike the situation for West Greenland minke whales, the SWG has an assessment for West Greenland fin whales which means that it is in a better position to develop an *SLA* for fin whales. The SWG **agreed** last year that the set of RMP trials developed to evaluate variants of the *CLA* for North Atlantic fin whales are an appropriate starting point for developing trials for this case, and this year the SWG was presented with a summary of the stock structure hypotheses underlying those trials. The trials for the North Atlantic fin whales were focused on the areas likely to be subject to whaling off Iceland. These trials will need to be modified to focus more on the uncertainties pertinent to West Greenland if they are to form the basis for evaluation of *SLA*s for fin whales. The SWG did not have time to consider a working paper outlining the RMP trials at this meeting. It **re-emphasises** the importance of developing *SLA*s for Greenlandic fisheries as soon as possible. This is discussed further under the work plan.

5. COMMON MINKE WHALES OFF EAST GREENLAND

5.1 New information

Revised estimates of abundance for minke whales in parts of the central Atlantic were presented based on data collected during the 2007 T-NASS survey (SC/62/RMP5). Standard stratified line transect methods were used and estimation of $g(0)$ was not attempted. The resulting accepted abundance estimates for the CG and CIP *Small Areas* were 1,048 (CV 0.60) and 1,350 (CV 0.38) (see Item 3.3.2 of Annex D).

5.2 Management advice

5.2.1 Summary of previous season's catch data

Three males and one female common minke whale were struck (and landed) off East Greenland in 2009 (no animals were struck and lost) (SC/62/ProgRep Denmark). Genetic samples were obtained from two of these whales. The SWG noted that catches of minke whales off East Greenland are believed to come from the much larger Central stock of minke whales.

5.2.2 Management advice

In 2007, the Commission agreed to an annual quota of 12 minke whales from the stock off East Greenland for 2008–12, which the Committee stated was acceptable in 2007. The present strike limit represents a very small proportion of the Central Stock (see Table 3). The SWG **agreed** that the present strike limit would not harm the stock.

Table 3

Most recent abundance estimates for minke whales in the central North Atlantic.

Small Area(s)	Year(s)	Abundance and CV
CM	2005	26,739 (CV=0.39)
CIC	2007	10,680 (CV=0.29)
CG	2007	1,048 (CV=0.60)
CIP	2007	1,350 (CV=0.38)

6. MANAGEMENT ADVICE FOR HUMPBACK WHALES OFF WEST GREENLAND

In 2007, the Committee agreed an approach for providing interim management advice and this was confirmed by the Commission. It had agreed that such advice could be used for up to two five-year blocks whilst *SLA*s were being developed (IWC, 2009a, p.16). Using this approach, as last year, the SWG **agreed** that an annual strike limit of 10 whales will not harm the stock.

7. MANAGEMENT ADVICE FOR HUMPBACK WHALES OFF ST. VINCENT AND THE GRENADINES

7.1 Summary of previous season's catch data

The SWG was advised that three females (lengths 34', 34'3" and 43'2") were taken during 2010. Neither genetic samples nor photographs were available for these animals. The SWG has encouraged St. Vincent and The Grenadines to submit as much information as possible about any catches to the Committee via an annual progress report. The SWG **strongly recommended** collection of genetic samples for any harvested animals as well as fluke photographs, and submission of these to appropriate catalogues and collections. In respect of genetic samples, the SWG again **agreed** that the North Atlantic Whale Archive maintained by Per Palsbøll was an appropriate facility.

7.2 Management advice

In recent years, the Committee has agreed that the animals found off St. Vincent and The Grenadines are part of the large West Indies breeding population. The Commission adopted a total block catch limit of 20 for the period 2008–12. The SWG **agreed** that this block catch limit will not harm the stock.

8. SCIENTIFIC ASPECTS OF AN ABORIGINAL SUBSISTENCE WHALING SCHEME

8.1 Lessons learned from the bowhead *Implementation Review*

Donovan reported that there were two main issues arising from the bowhead *Implementation Review*: (1) stock structure and in particular genetic samples; and (2) data availability.

In relation to the first of these two issues, the SWG noted that there are now guidelines for DNA data quality which arose from, for example, the difficulties encountered during the bowhead *Implementation Review* (IWC, 2008, p.70).

In relation to data availability in general, members noted that some data sources (e.g. genetics samples) can be obtained fairly quickly (in contrast to, for example, survey results which frequently require several years of planning). The possibly multi-year *Implementation* and *Implementation Review* process adds some uncertainty with respect to the application of appropriate deadlines. In addition, there is a lack of guidance regarding which data sources need to be submitted (some data sources such as genetics and survey data must clearly be available, but this is less clear for other data sources such as age data which, for bowheads, are used to determine a prior distribution for survival rate which is used when conditioning trials). The SWG noted that one reason for this was the lack of explicit guidelines for conducting *Implementations* and *Implementation Reviews* and that the processes used when applying the RMP, particularly the structure of a *pre-Implementation assessment*, has provided more structure and hence clarity regarding data availability and timelines. The SWG recognised that having something similar for the *SLA* development and review process was desirable. It **requested** Donovan to provide a draft of such a document for consideration at next year's meeting.

8.2 Other

In 2002, the Scientific Committee **strongly recommended** that the Commission adopt the Aboriginal Subsistence Whaling Scheme (IWC, 2003, pp.22–23). This covers a number of practical issues such as survey intervals, carryover and guidelines for surveys. The Committee has stated the AWS provisions constitute an important and necessary component of safe management under AWMP *SLA*s and the SWG continues to **concur** with this view. It noted that discussions within the Commission of some aspects such as the 'grace period' are not yet complete.

9. OTHER MATTERS

9.1 Conversion factors for edible products for Greenland fisheries

Donovan introduced the background to IWC/62/9, an extensive 52 page report of the Small Working Group on conversion factors for the Greenlandic large whale hunt, and overviewed the contents of the report that has been available for several months. He noted that this report had arisen out of a request from the Chair of the Commission that a small group be formed to provide advice on conversion factors for the Greenlandic hunt. The full Terms of Reference for that group can be found in IWC/62/9. He stressed that the group (Donovan, Palka, George, Hammond, Levermann and Witting) had not been tasked to examine the Greenlandic need statement itself, which is expressed in terms of tonnes of edible products. The report of the group was presented to the Intersessional Commission meeting to consider Greenlandic strike limits. No decisions on catch limits could be taken at that intersessional meeting since there were insufficient members present to constitute a quorum. In discussion of the report at that meeting, it was agreed that there was no need for the report to be reviewed in detail by the Scientific Committee but that individual scientists should send comments to the authors so that the report could be revised, if necessary, by the Commission meeting in Agadir. That request was circulated to the Scientific Committee with a request for comments by 6 June. However, it had been agreed that this issue could be added to the SWG agenda.

As noted the report itself is a lengthy document. The work of the group included a number of phases: a field visit; a review of available data and publications on length-weight relationships; a review of available data from the Greenlandic hunts themselves; an analysis of conversion factors based on what was agreed to be the best available datasets for each species; and recommendations on possible conversion factors and future work.

A major part of the work involved determining if the available Greenlandic datasets (provided by hunters) could be used. Extensive analyses of these data, including comparison of these with available datasets from elsewhere was undertaken (different ways of measuring whales in Greenland when compared to elsewhere meant that allowance for this had to be made). The authors concluded that truncated datasets (the truncation approach taken is described in the report) for common minke whales and fin whales were sufficiently reliable for analysis, noting that for reasons given in the report the large dataset for common minke whales was more reliable than the considerably smaller dataset for fin whales. Data from elsewhere had to be used for bowhead and humpback whales.

The authors developed conversion factors for each of the species. For reasons documented in the report it was clear that the efficiency of flensing under local conditions was greater for common minke whales than for larger species. The factor for common minke whales was considered the most reliable and was in accord with similar data collected by scientists for North Pacific common minke whales. The factors derived for the other species were recommended to be used as interim conversion factors for a five-year block. The report provided advice on conversion factors based on a per animal basis as well as factors taking struck-and-lost animals into account and taking into account whether strike limits are met (the last of these allows estimation of the amount of edible products reaching Greenlanders). The authors made a number of recommendations for future accurate data collection that required collaboration amongst scientists, hunters and wildlife officers and offered to assist in the design of this work.

In discussion, Clapham provided a number of comments on the report; these comments focused on the underlying approach to calculating conversion factors, as well as to the quality of the data used by the authors. He recognized that the authors had done a very good job with some very difficult data. However, with regard to the underlying approach, he questioned whether conversion factors should be based only upon what product yield has been achieved in the past, or should in addition consider what could be achieved with significant improvements in processing efficiency. He noted that the primary approach taken by the authors of the report followed that of Witting last year, i.e. to base future factors on past data, without considering alternatives. He noted the problems with the length data, and also the considerable range in the weights at lengths of the various edible products. Clapham suggested that these problems partly reflected the likely inaccuracy and unreliability of the information on which the report was based. He cautioned that, in light of this uncertainty, he believed the proposed conversion factors may be substantially in error. He recognized the authors' attempt to adjust for these problems, but suggested that there is no way to know the extent to which the existing product yield data are in error. His reading of the authors' description of how such estimates are derived and reported suggested that: (a) there is great variation in the likely accuracy of the reports; and (b) there is very little independent verification of the data's reliability. In light of this, he suggested that Greenland be asked to come back next year with data of verifiable quality on length and product yield, and/or that the Scientific Committee be given details of the new data collection methods, together with information on the process by which the reliability of the product yield data is verified.

In response, the authors noted that they had spent considerable time and effort in investigating the original data, recognising that it had not been collected by scientists for the purposes of estimating conversion factors. In particular they had compared the datasets with those available from elsewhere as well as testing them for internal consistency. The large sample size and the consistency with edible product information collected by scientists in the North Pacific, revealed that the data for common minke whales were sufficient to calculate a robust conversion factor (as well as showing the flensing process to be efficient). The limitations of the conversion factors provided for the other species were recognised in the report and considered interim pending the collection of additional data on length correction and edible products. They also noted that it would take some time to obtain sufficient sample sizes for some species. They noted that matters of efficiency were appropriate for discussion by the Commission.

The SWG endorsed the **recommendations** of the report. In particular, it supported the recommendations for further work that data on both 'curved' and 'standard' measurements are obtained during the coming season for common minke whales, fin whales and bowhead whales and that new data on edible products be collected using properly-designed protocols, analysed appropriately and reviewed. It also supported the recommendation that the work be undertaken by scientists, hunters and wildlife officers since this would improve the ability of hunters, particularly those in remote areas, to obtain more accurate length and weight measurements. Witting noted that Greenland has already begun to implement some of the recommendations of the Small Working Group and they will be implementing all of them in the next season. There is now increased collaboration between hunters, scientists and managers and improved estimates of the three types of edible product should be possible by having each product stored in separate bins and weighed. It was also noted that collaboration between hunters from Alaska and Greenland was underway with the respect to flensing techniques for bowhead whales. Finally, the SWG **requested** Greenland to provide information on its sampling scheme and data validation protocols to next year's meeting.

10. WORK PLAN

The SWG agreed that its work plan for the 2011 Annual Meeting would be as follows:

(1) Working Group (Allison, Punt, Schweder, Witting) to further explore the correctness of the sex-ratio method.
(2) Butterworth to consider whether a suitable transformation can be identified for the sex-ratio method. Givens, Schweder, and Witting will review progress.
(3) Conduct a 5-day intersessional Workshop, with Terms of Reference:
    (a) Make progress on developing *SLA*s for West Greenland fin and common minke whales [with fin whales the highest priority].
    (b) Evaluate progress on the development of the sex-ratio method.

(c) Prepare for the *Implementation Review* for the ENP gray whales.

(4) Donovan to develop a short working paper on appropriate operating models for West Greenland minke whales to complement that developed for fin whales.

(5) Further consider possible stock structure hypotheses for the fin whales off West Greenland in preparation for developing a *SLA* for these whales.

(6) Donovan to develop an outline of document which lists the factors which need to be considered when conducting *Implementations* and *Implementation Reviews* for aboriginal hunts.

(7) Review any new scientific information related to conversion factors for edible products for Greenland fisheries.

11. ADOPTION OF REPORT

The report was adopted at 19:20 on 7 June 2010. The sub-committee thanked the Chair for guiding them though a long and difficult agenda. The Chair thanked the rapporteurs.

REFERENCES

Brandon, J.R. and Punt, A.E. 2009. Assessment of the eastern stock of North Pacific gray whales: incorporating calf production, sea-ice and strandings data. Paper SC/61/AWMP2 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 29pp. [Paper available from the Office of this Journal].

Calambokidis, J., Darling, J.D., Deeke, V., Gearin, P., Gosho, M., Megill, W., Tombach, C.M., Goley, D., Toropova, C. and Gisborne, B. 2002. Abundance, range and movements of a feeding aggregation of gray whales from California to southeastern Alaska. *J. Cetacean Res. Manage.* 4(3): 267–76.

Darling, J.D. 1984. Gray whales off Vancouver Island, British Columbia. pp.267–87. *In*: Jones, M.L., Swartz, S.L. and Leatherwood, S. (eds). *The Gray Whale, Eschrichtius robustus*. Academic Press, Orlando, Florida. xxiv+600pp.

Darling, J.D., Keogh, K.E. and Steeves, T.E. 1998. Gray whale (*Eschrichtius robustus*) habitat utilization and prey species off Vancouver Island, B.C. *Mar. Mamm. Sci.* 14(4): 692–720.

Goerlitz, D.S., Urban, J., Rojas-Bracho, L., Belson, M. and Schaeff, C.M. 2003. Pacific gray whales (*Eschrictius robustus*) on winter breeding grounds in Baja California. *Can. J. Zool.* 81: 1,965–1,972.

International Whaling Commission. 2001. 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.)* 3:126–60.

International Whaling Commission. 2003. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 5:1–92.

International Whaling Commission. 2004. Report of the Scientific Committee. Annex T. Report of the data availability working group. *J. Cetacean Res. Manage. (Suppl.)* 6:406–08.

International Whaling Commission. 2005. Report of the Scientific Committee. Annex E. Report of the Standing Working Group (SWG) on the Development of an Aboriginal Subsistence Whaling Management Procedure (AWMP). Appendix 3. Fishery Type 2: *Implementation* for Eastern North Pacific gray whales. *J. Cetacean Res. Manage. (Suppl.)* 7:127–38.

International Whaling Commission. 2008. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 10:1–74.

International Whaling Commission. 2009a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 11:1–74.

International Whaling Commission. 2009b. Report of the Scientific Committee. Annex E. Report of the standing working group on the Aboriginal Whaling Management Procedures. *J. Cetacean Res. Manage. (Suppl.)* 11:145–68.

Laake, J., Punt, A., Hobbs, R., Ferguson, M., Rugh, D. and Breiwick, J. 2009. Re-analysis of gray whale southbound migration surveys 1967–2006. *NOAA Tech. Mem. NMFS-AFSC* 203. 55pp.

Mate, B.R. and Urbán-Ramirez, J. 2006. The spring northward migration and summer feeding of mother gray whales in the eastern North Pacific Ocean, Bering Sea and Chukchi Sea. Paper SC/58/BRG16 presented to the IWC Scientific Committee, May 2006, St Kitts and Nevis, West Indies. 2pp. [Paper available from the Office of this Journal]

Perryman, W.L., Donahue, M.A., Perkins, P.C. and Reilly, S.B. 2002. Gray whale calf production 1994–2000: Are observed fluctuations related to changes in seasonal ice cover? *Mar. Mamm. Sci.*18(1): 121–44.

Appendix 1

AGENDA

1. Introductory items
    - 1.1 Convenor's opening remarks
    - 1.2 Election of Chair
    - 1.3 Appointment of rapporteurs
    - 1.4 Adoption of Agenda
    - 1.5 Documentation available
2. *Implementation Review* of eastern gray whales
    - 2.1 What is an *Implementation Review*?
    - 2.2 Stock structure and movements
    - 2.3 Catch data
    - 2.4 Abundance and trends
    - 2.5 Other
        - 2.5.1 Assessment
    - 2.6 Consideration of need for new trials (and, if applicable, results of those)
    - 2.7 Conclusions and recommendations
    - 2.8 Management advice
        - 2.8.1 Summary of previous season's catch data
        - 2.8.2 Management advice
3. Common minke whales off west Greenland
    - 3.1 Further discussion of sex ratio method
        - 3.1.1 Summary of discussions at the intersessional workshop
        - 3.1.2 Results of intersessional work
        - 3.1.3 Review by the SWG
    - 3.2 Management advice
        - 3.2.1 Summary of previous season's catch data
        - 3.2.2 Management advice
    - 3.3 Progress with *CLA* development
        - 3.3.1 Summary of discussions at the intersessional workshop
        - 3.3.2 Further discussion and recommendations for further work

4. Fin whales off west Greenland
   4.1 Management advice
      4.1.1 Summary of previous season's catch data
      4.1.2 Management advice
   4.2 Progress with *CLA* development

5. Common minke whales off east Greenland
   5.1 Management advice
      5.1.1 Summary of previous season's catch data
      5.1.2 Management advice

6. Management advice for humpback whales off west Greenland
   6.1 Management advice
      6.1.1 Summary of previous season's catch data
      6.1.2 Management advice

7. Management advice for humpback whales off St. Vincent and The Grenadines
   7.1 Management advice
      7.1.1 Summary of previous season's catch data
      7.1.2 Management advice

8. Scientific aspects of an aboriginal subsistence whaling scheme
   8.1 Lessons learned from the bowhead Implementation Review
   8.2 Other

9. Other matters
   9.1 Conversion factors for edible products for Greenland fisheries (IWC/62/9)

10. Work plan

11. Adoption of Report

Appendix 2

COMPARISON OF DATA FROM SC/62/AWMP1 WITH THOSE FROM DR. AIMEE LANG (WHICH INCLUDES DATA FROM LEDUC *et al.*, 2002)

Timothy R. Frasier and James D. Darling

Several members of the AWMP group expressed concerns regarding the reference dataset that SC/62/AWMP1 used as a proxy for the 'northern feeding group', specifically the dataset of Goertliz *et al*. (2003). Instead, several suggested that the dataset of Leduc *et al*. (2002) would be more appropriate. Dr. Aimee Lang noted that she had a more up-to-date data set that also contained all of the data from Leduc *et al*. (2002), and she was willing to share those data for the purposes of these analyses. Her data contained sequences from 136 individuals from the eastern population.

The comparison of our data to that dataset is below. The overall picture is the same as in the original analyses.

Results

Arlequin Analysis (Using ver. 3.5)

F_{ST} = 0.0605, $P < 0.0001$

Φ_{ST} = 0.02362, $P = 0.0332$

MIGRATE Analysis

Reject hypothesis that $\Theta_{southern} = \Theta_{northern}$, $P = 0.00257$.

Iteration

	$\Theta_{northern}$	$\Theta_{southern}$	$M_{southern\text{-}northern}$	$M_{northern\text{-}southern}$
1	0.0347	0.0147	875	870
	(0.0140–0.0570)	(0.00550–0.0245)	(640–1,000)	(645–1,000)
2	0.0325	0.0149	886	846
	(0.0150–0.0534)	(0.00580–0.0258)	(674–1,000)	(596–1,000)
3	0.0319	0.0159	869	849
	(0.0146–0.0520)	(0.00580–0.0278)	(638–1,000)	(590–1,000)
Average				
	0.0330	0.0152	877	855
	(0.0145–0.0541)	(0.00570–0.0260)	(651–1,000)	(610–1,000)

REFERENCES

Goerlitz, D.S., Urban, J., Rojas-Bracho, L., Belson, M. and Schaeff, C.M. 2003. Pacific gray whales (*Eschrictius robustus*) on winter breeding grounds in Baja California. *Can. J. Zool.* 81: 1,965–1,72.

LeDuc, R.G., Weller, D.W., Hyde, J., Burdin, A.M., Rosel, P.E., Brownell, R.L., Jr., Würsig, B. and Dizon, A.E. 2002. Genetic differences between western and eastern North Pacific gray whales (*Eschrichtius robustus*). *J. Cetacean Res.Manage.*4(1): 1–5.

Appendix 3

EASTERN NORTH PACIFIC GRAY WHALE CATCH NUMBERS

C. Allison, R. Reeves, T. Smith and M. Hughes

1. Pre 1846 catches

Table 1 lists the nominal estimated aboriginal catches (adjusted to account for hunting loss) from the eastern North Pacific stock of gray whales 1600–1845 as estimated by Mitchell and Reeves (1990 revised).

Table 1

Aboriginal removals from the eastern north Pacific stock of gray whales 1600–1845. The numbers are taken from Mitchell and Reeves (1990, revised), rounded up to the nearest integer. The sex ratio is assumed to be 1:1 (IWC 1993:243).

Years	Annual kill
1600–1675	182
1676–1750	183
1751–1840	198
1841–1845	194
Total kill 1600–1845	**46,300**

2. Catches 1846–1909

Commercial whaling on the eastern North Pacific stock of gray whales commenced in 1846. Table 2 lists the estimated catches (aboriginal and commercial) from 1846–1909. Herein, the term 'removals' is used to indicate secured catches (whales landed and processed) plus an adjustment (or correction) for whales killed or mortally injured but not secured (struck/lost). The estimates of removals are subject to various forms of uncertainty due to vagaries of reporting and due to statistical sampling errors. This is especially true for the 19th century removals (Reeves and Smith, 2010; Reeves *et al.*, 2010). Although the uncertainty values are not reported here, the median annual coefficients of variation were 21% for California shore whaling (Reeves and Smith, 2010) and 17% for ship-based whaling in Mexico (Reeves *et al.*, 2010).

Table 2 includes:

- aboriginal catches (Column A), taken from Mitchell and Reeves (1990 revised);
- estimated removals by shore whaling in California and Baja California 1854–1899 (Column B), taken from Reeves and Smith (2010, table 3) after applying their suggested loss rate factor of 1.2;
- estimated removals by ship-based whaling in Baja California and along the Mexican mainland 1846–1874 (Column C). These data are taken from Reeves *et al.* (2010, table 4) using the authors' 'medium-case' number of vessel-seasons and after applying a loss rate factor of 1.24. The loss rate is midway between their minimum value of 1.06 (animals which sank or escaped spouting blood) and 1.42 (total animals struck); and
- estimated ship-based removals outside of Baja California 1846–74 (Column D), taken from Henderson (1984, table 1) who estimated that 75, 232 and 232 gray whales were taken in the periods 1845/6–53/4, 1854/5–64/5 and 1865/6–73/4 respectively. The estimates include a loss rate factor of 1.34. The totals for the three time periods were allocated to years based on the number of vessel-seasons/year in the North Pacific fishery in Bockstoce and Botkin (1983).

Sex ratio of the catches

In the past (e.g. Butterworth *et al.*, 2002; IWC, 1993, pp.243 and 57; Lankester and Beddington, 1986, p.354) the sex ratio of all commercial catches from 1846–1909 was assumed to be 1:2 male:female. However, there is no basis for assuming a sex ratio different from 1:1 for the catches by shore whaling (Reeves and Smith, 2010) or for the catches in northern waters. Therefore, here we assume a 1:1 sex ratio for the California shore (Column B) and ship-based northern (Column D) catches.

The ship-based whaling in Mexico (Column C) includes whales taken both inside and outside the lagoons. Reeves *et al.* (2010, p.33) state that lagoon catches were 'strongly biased toward adult females and calves of the year', following Henderson's (1972, pp.149 and 54) comments that:

> 'The majority of the whales killed inside, or just outside, Scammon's and other lagoons were cows because their capture was easy in the shallow, crowded lagoon channels where cows were concentrated and encumbered by calves, and because outside the mouths of the lagoons whales retarded by the care of calves were easier marks than other whales'

and

> 'As at Scammon's Lagoon, whalers at Magdalena Bay had concentrated almost entirely upon capturing cows until the female population became so reduced that bulls had to be taken also.'

There is no basis for assuming other than a 1:1 sex ratio for whales taken outside the lagoons. We estimate that 66% of the catch in the Mexico ship-based fishery (1846–1874) was made inside the lagoons, based on the ratio of Henderson's (1984) estimated kill of 3,290 in 'Baja California lagoons and bays' and his estimate of the total kill by the ship-based Mexico fishery (4,968). Following Reilly (1981), we assume that Henderson's comments meant at least 80% and, as an upper bound, at most 100% of the whales killed inside the lagoons and bays were females. This gives a range of the proportion of females in the Mexico ship-based fishery from 0.70 to 0.83[1], corresponding to a 1:2.3 to 1:4.9 sex ratio. For the Column C point estimates in Table 2, we assume an intermediate sex ratio of 1:3.6 (or 76.4% female). Although this accounts for the over-representation of females in the lagoon portion of the fishery, it does not address the high calf mortality associated with selective hunting of 'cows' in the lagoons (see Reeves *et al.*, 2010).

Table 2

Estimated catches from the eastern North Pacific stock of gray whales 1846–1909. See text for details of the data sources.

Year	A. Aboriginal	B. California shore	C. Mexico ship	D. Ship north	Total	Total males	Total females
1846	193.5	0.0	34.7	0.0	228	105	123
1847	192.5	0.0	130.2	0.0	323	127	196
1848	192.5	0.0	112.8	0.0	305	123	182
1849	192.5	0.0	0.0	4.7	197	99	98
1850	192.5	0.0	0.0	12.8	205	103	102
1851	187	0.0	0.0	16.5	204	102	102
1852	187	0.0	68.2	21.0	276	120	156
1853	187	0.0	256.7	15.8	459	162	297
1854	187	15.6	248.0	4.2	455	162	293
1855	187	15.6	174.8	3.1	381	144	237
1856	187	24.0	230.6	4.0	446	162	284
1857	187	31.2	269.1	5.3	493	175	318
1858	187	69.6	653.5	42.9	953	304	649
1859	187	64.8	704.3	38.1	994	311	683
1860	187	111.6	882.9	21.7	1,203	369	834
1861	111	100.8	751.4	19.9	983	293	690
1862	111	126.0	224.4	8.9	470	176	294
1863	111	128.4	230.6	15.5	486	182	304
1864	111	144.0	350.9	35.4	641	228	413
1865	111	130.8	375.7	37.2	655	228	427
1866	111	133.2	234.4	41.5	520	198	322
1867	111	147.6	312.5	42.5	614	224	390
1868	111	153.6	127.7	30.7	423	178	245
1869	111	142.8	44.6	21.5	320	148	172
1870	111	153.6	45.9	28.2	339	157	182
1871	111	152.4	59.5	22.0	345	157	188
1872	111	150.0	0.0	17.9	279	139	140
1873	111	138.0	9.9	17.9	277	136	141
1874	111	129.6	0.0	9.7	250	125	125
1875	111	114.0	0.0	0.0	225	112	113
1876	110	99.6	0.0	0.0	210	105	105
1877	110	118.8	0.0	0.0	229	114	115
1878	110	110.4	0.0	0.0	220	110	110
1879	110	142.8	0.0	0.0	253	126	127
1880	110	117.6	0.0	0.0	228	114	114
1881	108	112.8	0.0	0.0	221	110	111
1882	108	114.0	0.0	0.0	222	111	111
1883	108	109.2	0.0	0.0	217	109	108
1884	108	112.8	0.0	0.0	221	110	111
1885	108	79.2	0.0	0.0	187	94	93
1886	108	33.6	0.0	0.0	142	71	71
1887	108	36.0	0.0	0.0	144	72	72
1888	108	30.0	0.0	0.0	138	69	69
1889	108	32.4	0.0	0.0	140	70	70
1890	108	24.0	0.0	0.0	132	66	66
1891	62	24.0	0.0	0.0	86	43	43
1892	62	22.8	0.0	0.0	85	42	43
1893	62	22.8	0.0	0.0	85	42	43
1894	62	15.6	0.0	0.0	78	39	39
1895	62	15.6	0.0	0.0	78	39	39
1896	62	7.2	0.0	0.0	69	35	34
1897	62	7.2	0.0	0.0	69	35	34
1898	62	7.2	0.0	0.0	69	35	34
1899	62	2.4	0.0	0.0	64	32	32
1900	62	0.0	0.0	0.0	62	31	31
1901	61	0.0	0.0	0.0	61	30	31
1902	61	0.0	0.0	0.0	61	30	31
1903	61	0.0	0.0	0.0	61	30	31
1904	61	0.0	0.0	0.0	61	30	31
1905	57	0.0	0.0	0.0	57	28	29
1906	57	0.0	0.0	0.0	57	28	29
1907	57	0.0	0.0	0.0	57	28	29
1908	57	0.0	0.0	0.0	57	28	29
1909	57	0.0	0.0	0.0	57	28	29
Totals	**7,278**	**3,775**	**6,534**	**539**	**18,127**	**7,333**	**10,794**

[1]0.70 (= 0.66*.80 + 0.34*.50) to 0.83 (= 0.66*1.0 + 0.34*.50)

3. Catches 1910–2009

The catches since 1910 are listed in Table 3 by area and operation type.

Table 3

Estimated catches from the eastern North Pacific stock of gray whales 1910–2009. See text for key.

Year	1. Baja California (ship)	2. California (LSt)	3. California (ship)	4. Washington (LSt + AbS)	5. Br. Colum. (LSt)	6. Alaska (LSt+Ship)	7. Alaska (Ab.S)	8. Bering/ Chukchi (Fl.F)	9. Chukotka (Ab.S)	Total
1910	0	0	0	1	0	0	0	0	57	58
1911	0	0	0	0	1	0	0	0	57	58
1912	0	0	0	0	0	0	0	0	57	57
1913	0	0	0	0	0	1	0	0	57	58
1914	19	0	0	0	0	0	0	0	57	76
1915	0	0	0	0	0	0	0	0	57	57
1916	0	0	0	0	0	0	0	0	52	52
1917	0	0	0	0	0	0	0	0	52	52
1918	0	0	0	0	0	0	0	0	52	52
1919	0	0	0	0	0	0	0	0	52	52
1920	0	2	0	0	0	0	0	0	52	54
1921	0	1	36	0	0	1	0	0	52	90
1922	0	5	4	0	0	0	0	0	52	61
1923	0	0	0	0	0	0	0	0	52	52
1924	0	0	0	1	0	0	0	0	52	53
1925	100	0	0	0	0	0	1	33	52	186
1926	41	1	0	0	0	0	0	0	52	94
1927	29	0	3	0	0	0	0	0	52	84
1928	9	0	1	0	0	2	0	0	52	64
1929	2	0	1	0	0	0	0	0	47	50
1930	0	0	0	0	0	0	0	0	47	47
1931	0	0	0	0	0	0	0	0	10	10
1932	0	0	10	0	0	0	0	0	10	20
1933	0	0	60	0	0	2	1	2	10	75
1934	0	0	60	0	0	0	2	54	10	126
1935	0	0	110	0	0	0	0	34	10	154
1936	0	0	86	0	0	0	0	102	10	198
1937	0	0	0	0	0	0	0	14	10	24
1938	0	0	0	0	0	0	0	54	10	64
1939	0	0	0	0	0	0	0	29	10	39
1940	0	0	0	0	0	0	0	105	20	125
1941	0	0	0	0	0	0	0	57	20	77
1942	0	0	0	0	0	0	0	101	20	121
1943	0	0	0	0	0	0	0	99	20	119
1944	0	0	0	0	0	0	0	0	6	6
1945	0	0	0	0	0	0	0	30	28	58
1946	0	0	0	0	0	0	0	22	8	30
1947	0	0	0	0	0	0	0	1	30	31
1948	0	0	0	0	0	0	0	0	19	19
1949	0	0	0	0	0	0	0	0	26	26
1950	0	0	0	0	0	0	1	0	10	11
1951	0	0	0	0	1	0	1	0	12	14
1952	0	0	0	0	0	0	2	0	42	44
1953	0	0	0	0	10	0	1	0	37	48
1954	0	0	0	0	0	0	3	0	36	39
1955	0	0	0	0	0	0	0	0	59	59
1956	0	0	0	0	0	0	1	0	121	122
1957	0	0	0	0	0	0	1	0	95	96
1958	0	0	0	0	0	0	3	0	145	148
1959	0	2	0	0	0	0	7	0	187	196
1960	0	0	0	0	0	0	0	0	156	156
1961	0	0	0	0	0	0	1	0	207	208
1962	0	4	0	0	0	0	0	0	147	151
1963	0	0	0	0	0	0	1	0	179	180
1964	0	20	0	0	0	0	2	9	188	219
1965	0	0	0	0	0	0	1	5	175	181
1966	0	26	0	0	0	0	0	0	194	220
1967	0	125	0	0	0	0	0	124	125	374
1968	0	66	0	0	0	0	0	0	135	201
1969	0	74	0	0	0	0	1	0	139	214
1970	0	0	0	0	0	0	5	0	146	151
1971	0	0	0	0	0	0	3	0	150	153
1972	0	0	0	0	0	0	1	0	181	182
1973	0	0	0	0	0	0	0	0	178	178
1974	0	0	0	0	0	0	3	0	181	184
1975	0	0	0	0	0	0	0	0	171	171
1976	0	0	0	0	0	0	0	0	165	165
1977	0	0	0	0	0	0	1	0	186	187

Cont.

Table 3 (cont.)

Year	1. Baja California (ship)	2. California (LSt)	3. California (ship)	4. Washington (LSt + AbS)	5. Br. Colum. (LSt)	6. Alaska (LSt+Ship)	7. Alaska (Ab.S)	8. Bering/ Chukchi (Fl.F)	9. Chukotka (Ab.S)	Total
1978	0	0	0	0	0	0	2	0	182	184
1979	0	0	0	0	0	0	5	0	178	183
1980	0	0	0	0	0	0	3	0	179	182
1981	0	0	0	0	0	0	0	0	136	136
1982	0	0	0	0	0	0	3	0	165	168
1983	0	0	0	0	0	0	2	0	169	171
1984	0	0	0	0	0	0	0	0	169	169
1985	0	0	0	0	0	0	1	0	169	170
1986	0	0	0	0	0	0	2	0	169	171
1987	0	0	0	0	0	0	1	0	158	159
1988	0	0	0	0	0	0	1	0	150	151
1989	0	0	0	0	0	0	1	0	179	180
1990	0	0	0	0	0	0	0	0	162	162
1991	0	0	0	0	0	0	0	0	169	169
1992	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	44	44
1995	0	0	0	0	0	0	2	0	90	92
1996	0	0	0	0	0	0	0	0	43	43
1997	0	0	0	0	0	0	0	0	79	79
1998	0	0	0	0	0	0	0	0	125	125
1999	0	0	0	1	0	0	0	0	123	124
2000	0	0	0	0	0	0	0	0	115	115
2001	0	0	0	0	0	0	0	0	112	112
2002	0	0	0	0	0	0	0	0	131	131
2003	0	0	0	0	0	0	0	0	128	128
2004	0	0	0	0	0	0	0	0	111	111
2005	0	0	0	0	0	0	0	0	124	124
2006	0	0	0	0	0	0	0	0	134	134
2007	0	0	0	1	0	0	0	0	131	132
2008	0	0	0	0	0	0	0	0	130	130
2009	0	0	0	0	0	0	0	0	116	116
Total	**200**	**326**	**371**	**4**	**12**	**6**	**66**	**875**	**9,216**	**11,076**

Key to Table is as follows:

1. Baja California, Mexico: Norwegian factory ships *Capella I*, *Kommandoren I*, *Ragnhild Bryde*, *Mexico* and *Esperanza.*
2. California: Moss Landing and Trinidad Land Stations and the Scientific permit catch off San Francisco 1959–69.
3. California: American ships Carolyn Frances, Herman, Lancing and California.
4. Washington: Bay City land station and Makah tribe, Neah Bay.
5. British Columbia: Sechart and Coal Harbour land stations.
6. Alaska: Port Armstrong and Port Hobron land stations.
7. Alaskan aboriginal subsistence catch (various villages) + 1 by *Carolyn Frances*.
8. Bering/Chukchi: factory ships *Kommandoren* (Norway), *Aleut* and another (USSR) and *Tonan Maru* (Japan).
9. Chukotka: Soviet/Russian aboriginal subsistence catch.

Data sources

1. Baja California, Mexico: Norwegian factory ships *Capella I*, *Kommandoren I*, *Ragnhild Bryde*, *Mexico* and *Esperanza.*

The data are taken from Allison (2010), Anon. (1915), Anon. (1925), Reeves (1984, p.191) and Rice and Wolman (1971). There are discrepancies in the data sources concerning the catches in 1925 and 1926:

Year	Blue	Fin	Sperm	Humpback	Sei/Bryde's	**Gray**	Total	Source
1925	156	4	1	403	26	**100**	690	Allison (2010) and Reeves (1984, p.191), including 82 gray by *Kommandoren I* (A/S Vega) and 18 gray by *Mexico* (A/S Mexico)
	220	1	4	493	45	**140**	903	Kellogg (1931) and Radcliffe (1933)
1926	239	0	3	499	34	**41**	816	Allison (2010), Reeves (1984, p.191) and Rice and Wolman (1971)
	239			498		**42**		Kellogg (1931) and Radcliffe (1933). The difference is due to a humpback in the individual data that is included as a gray whale in Anon. (1926a).

2. California Land Stations

Catches from Moss Landing and Trinidad land stations are taken from Starks (1922), Clapham *et al.* (1997) and Rice and Wolman (1971).

The scientific permit catches off San Francisco 1959–69 are taken from Allison (2010):

Date	Catch	Sexes	
Mar. 1964	20 gray whales	(15M, 5F)	
Mar. 1966	26 gray whales	(15M, 11F)	
Dec. 1966	26 gray whales	(4M, 22F)	
Jan.–Mar. 1967	99 gray whales	(48M, 51F)	Gives 1966/67 total of 125 whales (52M, 73F)
Jan.–Mar. 1968	66 gray whales	(41M, 25F)	
Dec. 1968	21 gray whales	(6M, 15F)	
Jan.–Mar. 1969	53 gray whales	(33M, 20F)	Gives 1968/69 total of 74 whales (39M+35F) including one lost and washed up later. Some sources, e.g. Wolman and Rice (1979), omit the lost whale.

3. California Ships

The catch by the Carolyn Frances in 1921 is taken from Tønnessen (1967, p.163) and by the Herman in 1922 from Henderson (1984, p.176). Catches by the Lancing in 1927 and 1928 are taken from Radcliffe (1933), Reeves (1984, p.195) and Rice and Wolman (1971). The 1929 catch is taken from Donahue and Brownell (2001), who cite Martin ([no date], unpublished manuscript, not seen).

Catches by the *California* 1932–37 are modified from those estimated in Brownell and Swartz (2006). The revised estimates, which are upper bounds, are summarised below together with details of the rationale.

Year	Total catch	Brownell and Swartz estimate	Revised estimate	Species division and notes	References
1932	50	20 gray	10 gray	~ 30 fin up to 1 December.	Radcliffe (1933); Anon. (1933a and b)
1933	200	180 gray	60 gray	Good runs of humpbacks in the first half of the year. In July a run of sulphur bottoms.	IWS[2] V:9 and IX:7; Anon. (1933c)
1934	205	185 gray	60 gray	Took nearly 60 fin and humpback whales in the first 4 months of the year. Operated virtually the entire year.	Anon. (1934); IWS VI:9 and IX:7
1935	189	186 gray	110 gray	Gaze (1936): 2 sperm, 1 humpback, the rest gray.	IWS VII:19 and IX:7
1936	96	86 gray	86 gray	Gaze (1936): 50+ taken by end of January are virtually all gray whales. Operation closed 29 June.	IWS IX: 7 and 13
1937	37	0 gray	0 gray	8 blue, 14 fin, 3 humpback and 12 sei. Gray whales protected.	Allison (2010)

Gray whales formed an important part of the catch by the *California* from 1932–37, as reported in Anon. (1938, p.458): 'the recent international treaty prohibiting the killing of gray whales, one of the principal species available to the California concern, apparently made profitable operation difficult, if not impossible'. The owners of the *California* went into liquidation after the 1937 season (Anon., 1938).

1932. Anon. (1933a) reports the *California* 'operating off St. Nicholas Island, the westernmost of the Santa Barbara group of southern California, had caught about 30 finback whales up to the first of December' and the captain expected the total 1932 catch to be ~50 whales. The final 1932 catch by the California was 50 whales (1933b). Brownell and Swartz (2006) assume the 20 unspecified whales were gray whales. We assume that no more than half of these (10) are likely to be gray whales as no mention was made of changing area and the total catch was as predicted.

1933. Brownell and Swartz (2006) note that the fictional book Keyes (1939) reports 27 (13%) of the total catch of 205 whales processed in the 1934 season were taken in the summer around Santa Barbara Island, California (and hence were not gray whales). From this they suggest a similar pattern of catching in 1933 such that 10% of the 1933 catch were non-gray whales taken in the summer and 90% (180) were gray whales taken in the winter.

Anon. (1933c, published in August 1933) reports the *California* resumed whaling on 5 July 1933 off San Diego where a run of sulphur-bottoms [blue whales] was reported. Prior to 5 July 1933 'The *California* has been off Monterey for several months with good runs of humpbacks'. 'The company thus far has delivered 4,000bbls of oil'. The total catch in 1933 was 200 whales and 6160bbls oil (IWS V:9). Since the *California* took ~65% of the total oil produced in 1933 mainly from humpbacks before July and further that Anon. (1934) states the *California's* 'most active season starts about July 1,' it is unlikely that gray whales made up more than 30% of the total 1933 catch of 200 whales.

1934. Anon. (1936a) reports 'In California waters the California Whaling Co. continued to operate its floating plant *California* keeping it active at one point or another along the coast through virtually the entire year.' The total catch is given as 205 whales (110 by catcher *Port Saunders* and 95 by *Hawk)*. Anon. (1934, dated May 1934) reports the *California* 'took nearly 60 fin and humpback whales in the first four months of the year' and further states that the fleet's 'most active season starts about July 1'.

From this we estimate that, at most, 30% of the total catch might have been gray whales.

1935. Gaze (1936, dated January 1936) reports 'A whaling fleet this week is well into its second season of operation off Point Dume, 15n.miles westerly from Santa Monica.... Its two killer boats captured 199 whales here last season and more than 50 this season thus far... With few exceptions, California gray whales (baylenes) are the only species caught in the vicinity of Point Dume. Sperm whales and humpbacks are the exceptions, two of the former and one of the latter having been taken.... The grays first appear in this area early in December and the majority have returned northward by the latter part of March or early in April.'

The figure of 199 in Gaze (1936) is taken to be a typo for 189, as is assumed in Brownell and Swartz (2006) who use these numbers (i.e. 186 gray and 3 other).

[2]IWS = International Whaling Statistics published annually by the Committee for Whaling Statistics, Sandefjord 1930–84.

Anon. (1936b) reports the *California* 'worked three months of the year off San Francisco and nine months off Los Angeles and San Diego' taking a total catch of 189 whales. We assume the nine month period included the Point Dume operation. However, gray whales are only off California for about four months of the year so even if the Point Dume operation was the most productive, other species must have been taken in the remaining months. If three times more whales/month were taken in the gray whale period than in the rest of the year, this gives an estimated maximum of ~110 gray whales.

1936. Gaze (1936) reports 50+ whales were taken off Point Dume as of the end of January. Anon. (1937) reports in 1936 the *California* operated only during the first half of the year and operations were suspended on 29 June and had not resumed to the end of the year. A total of 96 whales were taken.

4. Washington

Mitchell and Reeves (1980, p.712) show photographs of gray whales taken by the Makah tribe at Neah Bay in (a) 1910 and (b) 1922. However photograph (a) is similar to one given in Scheffer and Slipp (1948, fig. 3) whose caption says the whale was taken at Neah Bay in 'about 1910–1912' and photograph (b) is identical to one given in Scheffer and Slipp (1948, fig. 2) whose caption again says the whale was taken at Neah Bay in 'about 1910–1912'. We assume that at least one whale was taken in 1910–12 (included in Table 3 under year 1910), but do not include one in 1922.

The gray whale taken at Bay City land station in 1924 comes from Kellogg (1931) and Scheffer and Slipp (1948).

5. British Columbia

The catches from Sechart in 1911 and from Coal Harbour in 1951 ('taken in error') and 1953 (taken under scientific permit) are from Allison (2010).

6. Alaska, Port Armstrong and Port Hobron land stations and *Carolyn Frances*

There is a discrepancy between sources concerning the 1913 catch from Sechart land station as shown below. The 1928 and 1933 catches are from Allison (2010), Reeves *et al*. (1985) and Rice and Wolman (1971).

Year	Blue	Fin	Sperm	Humpback	Sei/Bryde's	**Gray**	Bottlenose	Total	Source
1913	58	29	73	21	3	**1**	1	186	Tønnessen (1967, p.554); Radcliffe (1933)
	58	40	52	28	8	**0**		186	IWS and Risting (1922, p.578)

The one gray whale caught by the *Carolyn Frances* in 1921 is from Tønnessen (1967, p.163).

7. Alaskan aboriginal subsistence catch (various villages).

Catches prior to 1981 are from Marquette and Braham (1982) as H. Braham (after consultation with Rice and Breiwick) advised this to be the best source; catches since 1980 are from the infractions reports submitted to the IWC by the USA. There are discrepancies between the data sources in some years as noted below.

Year	Gray whale	References	Notes
1959	7	Marquette and Braham (1980)	6 taken at Barrow + 1 at Cape Thompson
	6	Marquette and Braham (1982); Rice *et al.* (1984); Maher (1960)	All 6 taken at Barrow
1973	0	Marquette and Braham (1982); Rice *et al.* (1984)	
	1	Wolman and Rice (1979)	
1974	3	Marquette and Braham (1982); Rice *et al.* (1984)	
	1	Wolman and Rice (1979)	
1975	0	Marquette and Braham (1982); Rice *et al.* (1984)	
	7	Wolman and Rice (1979)	
1976	0	Marquette and Braham (1982); Rice *et al.* (1984)	
	2	Wolman and Rice (1979)	
1979	5	Infractions report (USA)	Taken at Gambell (2), Savoonga, St. Michael and Little Diomede Is.
	4	Marquette and Braham (1982)	Taken at Gambell (2), Savoonga, St. Michael
1980	3	Marquette and Braham (1982)	Taken at Savoonga, Sheshalik and Toksook Bay
	2	Infractions report (USA)	Taken at Savoonga and Sheshalik
1982	3	Infractions report (USA)	
	4	Rice *et al.* (1984)	
1987	1	Infractions report (USA)	1 unconfirmed taken at Hooper Bay

8. Bering/Chukchi: factory ships *Kommandoren* (Norway), *Aleut* and another (USSR) and *Tonan Maru* (Japan).

1925 *Kommandoren* (A/S Vega). Two versions of the individual data (from IWS) detail 5 blue, 153 fin, 73 humpback, 5 sei, **31 gray**, 18 sperm and 1 bottlenose (= 286 whales). Anon. (1926a, p.79) reports 5 blue, 152 fin, 72 humpback, 6 sei, 18 sperm and **33 gray** (= 286 whales) but Anon. (1926b) lists the lengths of **31 gray** whales.

Catches by the *Aleut* from 1933–47 are taken from Zenkovich (1937), Zenkovich (1955), Sleptsov (1955), Reeves (1984, p.197) and Yablokov and Bogoslovskaya (1984). Sleptsov (1955) and Rice and Wolman (1971) list the 1943 catch as **77 gray whales**; Reeves (1984, p.197) reports this figure was corrected to **99** by A.Yablokov (in letter of April 7 1982).

The 1940 catch by the *Tonan Maru* is from Reeves (1984, p.197–98) and data for the Soviet factory ships in 1964–7 are from Doroshenko (2000).

9. Chukotka: Soviet/Russian aboriginal subsistence catches.

1910–30. The catch numbers are from Mitchell and Reeves (1990 revised).

1931–43. Catches are from IWC (1993, p.243).

1944–47 The numbers are from Krupnik (1987, p.26–27) after assuming a loss rate of 50%. Krupnik reports the numbers landed as 3, 14, 4 and 15 in 1944, 5, 6 and 7 respectively and notes that the 1944–46 numbers are incomplete. He also notes that 'the rate of unproductive losses in the 1940s and 50s was rather high; some estimates suggest that up to 30% of the whales killed sank, with the same percentage being struck and lost (Ivashin and Mineev, 1981; Zimushko and Ivashin, 1980)'.

1948–81. Catches are from Yablokov and Bogoslovskaya (1984), Ivashin (1990) and Rice *et al*. (1984). There are discrepancies between the data sources in some years as noted below.

1982–2009. Catches are from information submitted directly to the IWC.

Year	Gray numbers	References
1955	59	Yablokov and Bogoslovskaya (1984); Zimushko and Ivashin (1980); Rice *et al.* (1984) and Ivashin (1990).
	69	Anon. (1980).
1957	95	Anon. (1980); Zimushko and Ivashin (1980); Rice *et al.* (1984) and Ivashin (1990).
	56	Yablokov and Bogoslovskaya (1984).
1969	139	Anon. (1980); Zimushko and Ivashin (1980); Wolman and Rice (1979) and Ivashin (1990); confirmed in Ivashin's letter of 6 Dec 1989.
	199	Yablokov and Bogoslovskaya (1984).
1973	178	IWC (1974, p.71); Ivashin (1990) and confirmed in Ivashin's letters of 28 Nov and 6 Dec 1989.
	173	Anon. (1980); Yablokov and Bogoslovskaya (1984); Zimushko and Ivashin (1980); Wolman and Rice (1979) and Rice *et al.* (1984).
1976	165	Wolman and Rice (1979); Ivashin (1990) and confirmed in Ivashin's letters of 28 Nov and 6 Dec 1989.
	163	Anon. (1980); Zimushko and Ivashin (1980) and Yablokov and Bogoslovskaya (1984).
1978	182 (93 male, 89 female)	Anon. (1980, p.167).
	182 (179 landed + 3 lost)	Ivashin's letter of 28 Nov 1989.
1979	178 (55 male, 123 female)	Ivashin (1981, p.221).
	178 (176 landed + 2 lost)	Infractions report and IWC circular of 10/10/80.
1996	38	Donahue and Brownell (2001) and Blokhin (1997). The Infractions Sub-committee was informed the number was 43 and not 38 (see IWC/49/7).
	43	Punt and Butterworth (1997).

Table 4 lists the catches known by sex. The catches of unknown sex are allocated to sex as given in Table 5. All catches of unknown sex are allocated in the ratio 1:1 except for the Aboriginal Subsistence catches off Chukotka which are allocated as follows:

1910–44 are allocated in the ratio 1:1 as specified in IWC (1993, p.243) (in the absence of specific data).

1945–91 are allocated in the ratio of the known catches off Chukotka (1965–91) = 1,330m : 2,239f. The changed sex ratio is attributed to the change in whaling technique. Ivashin and Mineev (1981) report that in the late 1940s and early 1950s the hunters began to change from canoes to whaling boats following the introduction of collective farms and agricultural co-operatives which 'contributed to improvements in whaling methods';

1994–96 are allocated in the ratio of known catches from 1994–99 = 235m : 209f. The 1994–99 period is used because different whaling methods were being used when catching resumed in 1994.

1997 on are allocated using the ratio of animals of known sex in that year (the only whales of unknown sex from 1997 on are lost whales).

Table 4

Summary of catches known by sex 1910–2009.

	California/Mexico				Washington/BC				Alaska				Bering and Chukchi Comm.				Chukotka Aboriginal			
Year	M	F	Unk	Total	M	F	Unk	Total	M	F	Unk	Total	M	F	Unk	Total	M	F	Unk	Total
1910			0	0			1	1			0	0			0	0			57	57
1911			0	0			1	1			0	0			0	0			57	57
1912			0	0			0	0			0	0			0	0			57	57
1913			0	0			0	0			1	1			0	0			57	57
1914			19	19			0	0			0	0			0	0			57	57
1915			0	0			0	0			0	0			0	0			57	57
1916			0	0			0	0			0	0			0	0			52	52
1917			0	0			0	0			0	0			0	0			52	52
1918			0	0			0	0			0	0			0	0			52	52
1919			0	0			0	0			0	0			0	0			52	52
1920			2	2			0	0			0	0			0	0			52	52
1921	1	0	36	37			0	0			1	1			0	0			52	52
1922	4	1	4	9			0	0			0	0			0	0			52	52
1923			0	0			0	0			0	0			0	0			52	52
1924			0	0	1		0	1			0	0			0	0			52	52
1925	46	36	18	100			0	0			1	1	17	14	2	33			52	52
1926	25	17	0	42			0	0			0	0			0	0			52	52
1927	2	14	16	32			0	0			0	0			0	0			52	52
1928	3	6	1	10			0	0	1	1	0	2			0	0			52	52
1929		2	1	3			0	0			0	0			0	0			47	47
1930			0	0			0	0			0	0			0	0			47	47
1931			0	0			0	0			0	0			0	0			10	10
1932			10	10			0	0			0	0			0	0			10	10
1933			60	60			0	0	0	2	1	3	2		0	2			10	10

Cont.

Table 4 (cont.)

	California/Mexico				Washington/BC				Alaska				Bering and Chukchi Comm.				Chukotka Aboriginal			
Year	M	F	Unk	Total	M	F	Unk	Total	M	F	Unk	Total	M	F	Unk	Total	M	F	Unk	Total
1934			60	60			0	0			2	2	30	24	0	54			10	10
1935			110	110			0	0			0	0	11	23	0	34			10	10
1936			86	86			0	0			0	0	45	57	0	102			10	10
1937			0	0			0	0			0	0			14	14			10	10
1938			0	0			0	0			0	0			54	54			10	10
1939			0	0			0	0			0	0			29	29			10	10
1940			0	0			0	0			0	0	23	35	47	105			20	20
1941			0	0			0	0			0	0			57	57			20	20
1942			0	0			0	0			0	0			101	101			20	20
1943			0	0			0	0			0	0			99	99			20	20
1944			0	0			0	0			0	0			0	0			6	6
1945			0	0			0	0			0	0			30	30			28	28
1946			0	0			0	0			0	0			22	22			8	8
1947			0	0			0	0			0	0			1	1			30	30
1948			0	0			0	0			0	0			0	0			19	19
1949			0	0			0	0			0	0			0	0			26	26
1950			0	0			0	0			1	1			0	0			10	10
1951			0	0	1	0	0	1			1	1			0	0			12	12
1952			0	0			0	0			2	2			0	0			42	42
1953			0	0	6	4	0	10			1	1			0	0			37	37
1954			0	0			0	0			3	3			0	0			36	36
1955			0	0			0	0			0	0			0	0			59	59
1956			0	0			0	0			1	1			0	0			121	121
1957			0	0			0	0			1	1			0	0			95	95
1958			0	0			0	0			3	3			0	0			145	145
1959	1	1	0	2			0	0	0	2	5	7			0	0			187	187
1960			0	0			0	0			0	0			0	0			156	156
1961			0	0			0	0			1	1			0	0			207	207
1962	4		0	4			0	0			0	0			0	0			147	147
1963			0	0			0	0			1	1			0	0			179	179
1964	15	5	0	20			0	0			2	2			9	9			188	188
1965			0	0			0	0			1	1			5	5	56	88	31	175
1966	15	11	0	26			0	0			0	0			0	0	23	18	153	194
1967	52	73	0	125			0	0			0	0			124	124	24	40	61	125
1968	41	25	0	66			0	0			0	0			0	0	16	32	87	135
1969	39	35	0	74			0	0			1	1			0	0	5	13	121	139
1970			0	0			0	0			5	5			0	0	66	75	5	146
1971			0	0			0	0			3	3			0	0	2	2	146	150
1972			0	0			0	0			1	1			0	0	3	22	156	181
1973			0	0			0	0			0	0			0	0	95	77	6	178
1974			0	0			0	0			3	3			0	0	91	88	2	181
1975			0	0			0	0			0	0			0	0	58	113	0	171
1976			0	0			0	0			0	0			0	0	68	95	2	165
1977			0	0			0	0			1	1			0	0	86	100	0	186
1978			0	0			0	0			2	2			0	0	93	89	0	182
1979			0	0			0	0	1	0	4	5			0	0	55	123	0	178
1980			0	0			0	0			3	3			0	0	52	126	1	179
1981			0	0			0	0			0	0			0	0	36	99	1	136
1982			0	0			0	0	0	1	2	3			0	0	54	106	5	165
1983			0	0			0	0			2	2			0	0	45	123	1	169
1984			0	0			0	0			0	0			0	0	59	109	1	169
1985			0	0			0	0			1	1			0	0	54	114	1	169
1986			0	0			0	0			2	2			0	0	45	123	1	169
1987			0	0			0	0			1	1			0	0	46	108	4	158
1988			0	0			0	0			1	1			0	0	43	107	0	150
1989			0	0			0	0			1	1			0	0	60	118	1	179
1990			0	0			0	0			0	0			0	0	66	94	2	162
1991			0	0			0	0			0	0			0	0	29	37	103	169
1992			0	0			0	0			0	0			0	0	0	0	0	0
1993			0	0			0	0			0	0			0	0	0	0	0	0
1994			0	0			0	0			0	0			0	0	4	8	32	44
1995			0	0			0	0			2	2			0	0	44	40	6	90
1996			0	0			0	0			0	0			0	0	9	17	17	43
1997			0	0			0	0			0	0			0	0	48	31	0	79
1998			0	0			0	0			0	0			0	0	62	60	3	125
1999			0	0		1	0	1			0	0			0	0	68	53	2	123
2000			0	0			0	0			0	0			0	0	62	51	2	115
2001			0	0			0	0			0	0			0	0	62	50	0	112
2002			0	0			0	0			0	0			0	0	80	51	0	131
2003			0	0			0	0			0	0			0	0	70	56	2	128
2004			0	0			0	0			0	0			0	0	43	67	1	111
2005			0	0			0	0			0	0			0	0	45	70	9	124
2006			0	0			0	0			0	0			0	0	55	74	5	134
2007			0	0			1	1			0	0			0	0	48	78	5	131
2008			0	0			0	0			0	0			0	0	63	64	3	130
2009			0	0			0	0			0	0			0	0	58	57	1	116
Total	**248**	**226**	**423**	**897**	**8**	**5**	**3**	**16**	**2**	**6**	**64**	**72**	**128**	**153**	**594**	**875**	**2,151**	**3,066**	**3,999**	**9,216**

Table 5

Summary of catches allocated to sex 1910–2009. See text for method of allocation of animals.

	Calif./Mexico		WA/BC		Alaska		Bering/Chukchi		Chukotka AS		Totals		
Year	M	F	M	F	M	F	M	F	M	F	M	F	Total
1910	0	0	0	1	0	0	0	0	28	29	28	30	58
1911	0	0	1	0	0	0	0	0	28	29	29	29	58
1912	0	0	0	0	0	0	0	0	28	29	28	29	57
1913	0	0	0	0	0	1	0	0	28	29	28	30	58
1914	9	10	0	0	0	0	0	0	28	29	37	39	76
1915	0	0	0	0	0	0	0	0	28	29	28	29	57
1916	0	0	0	0	0	0	0	0	26	26	26	26	52
1917	0	0	0	0	0	0	0	0	26	26	26	26	52
1918	0	0	0	0	0	0	0	0	26	26	26	26	52
1919	0	0	0	0	0	0	0	0	26	26	26	26	52
1920	1	1	0	0	0	0	0	0	26	26	27	27	54
1921	19	18	0	0	1	0	0	0	26	26	46	44	90
1922	6	3	0	0	0	0	0	0	26	26	32	29	61
1923	0	0	0	0	0	0	0	0	26	26	26	26	52
1924	0	0	1	0	0	0	0	0	26	26	27	26	53
1925	55	45	0	0	0	1	18	15	26	26	99	87	186
1926	25	17	0	0	0	0	0	0	26	26	51	43	94
1927	10	22	0	0	0	0	0	0	26	26	36	48	84
1928	3	7	0	0	1	1	0	0	26	26	30	34	64
1929	0	3	0	0	0	0	0	0	23	24	23	27	50
1930	0	0	0	0	0	0	0	0	23	24	23	24	47
1931	0	0	0	0	0	0	0	0	5	5	5	5	10
1932	5	5	0	0	0	0	0	0	5	5	10	10	20
1933	30	30	0	0	1	2	2	0	5	5	38	37	75
1934	30	30	0	0	1	1	30	24	5	5	66	60	126
1935	55	55	0	0	0	0	11	23	5	5	71	83	154
1936	43	43	0	0	0	0	45	57	5	5	93	105	198
1937	0	0	0	0	0	0	7	7	5	5	12	12	24
1938	0	0	0	0	0	0	27	27	5	5	32	32	64
1939	0	0	0	0	0	0	14	15	5	5	19	20	39
1940	0	0	0	0	0	0	46	59	10	10	56	69	125
1941	0	0	0	0	0	0	28	29	10	10	38	39	77
1942	0	0	0	0	0	0	50	51	10	10	60	61	121
1943	0	0	0	0	0	0	49	50	10	10	59	60	119
1944	0	0	0	0	0	0	0	0	3	3	3	3	6
1945	0	0	0	0	0	0	15	15	10	18	25	33	58
1946	0	0	0	0	0	0	11	11	3	5	14	16	30
1947	0	0	0	0	0	0	0	1	11	19	11	20	31
1948	0	0	0	0	0	0	0	0	7	12	7	12	19
1949	0	0	0	0	0	0	0	0	10	16	10	16	26
1950	0	0	0	0	0	1	0	0	4	6	4	7	11
1951	0	0	1	0	1	0	0	0	4	8	6	8	14
1952	0	0	0	0	1	1	0	0	16	26	17	27	44
1953	0	0	6	4	1	0	0	0	14	23	21	27	48
1954	0	0	0	0	1	2	0	0	13	23	14	25	39
1955	0	0	0	0	0	0	0	0	22	37	22	37	59
1956	0	0	0	0	0	1	0	0	45	76	45	77	122
1957	0	0	0	0	1	0	0	0	35	60	36	60	96
1958	0	0	0	0	1	2	0	0	54	91	55	93	148
1959	1	1	0	0	3	4	0	0	70	117	74	122	196
1960	0	0	0	0	0	0	0	0	58	98	58	98	156
1961	0	0	0	0	0	1	0	0	77	130	77	131	208
1962	4	0	0	0	0	0	0	0	55	92	59	92	151
1963	0	0	0	0	1	0	0	0	67	112	68	112	180
1964	15	5	0	0	1	1	4	5	70	118	90	129	219
1965	0	0	0	0	1	0	2	3	68	107	71	110	181
1966	15	11	0	0	0	0	0	0	80	114	95	125	220
1967	52	73	0	0	0	0	62	62	47	78	161	213	374
1968	41	25	0	0	0	0	0	0	48	87	89	112	201
1969	39	35	0	0	0	1	0	0	50	89	89	125	214
1970	0	0	0	0	3	2	0	0	68	78	71	80	151
1971	0	0	0	0	1	2	0	0	56	94	57	96	153
1972	0	0	0	0	0	1	0	0	61	120	61	121	182
1973	0	0	0	0	0	0	0	0	97	81	97	81	178
1974	0	0	0	0	2	1	0	0	92	89	94	90	184
1975	0	0	0	0	0	0	0	0	58	113	58	113	171
1976	0	0	0	0	0	0	0	0	69	96	69	96	165
1977	0	0	0	0	1	0	0	0	86	100	87	100	187
1978	0	0	0	0	1	1	0	0	93	89	94	90	184
1979	0	0	0	0	3	2	0	0	55	123	58	125	183
1980	0	0	0	0	1	2	0	0	52	127	53	129	182

Cont.

Table 5 (cont.)

	Calif./Mexico		WA/BC		Alaska		Bering/Chukchi		Chukotka AS		Totals		
Year	M	F	M	F	M	F	M	F	M	F	M	F	Total
1981	0	0	0	0	0	0	0	0	36	100	36	100	136
1982	0	0	0	0	1	2	0	0	56	109	57	111	168
1983	0	0	0	0	1	1	0	0	45	124	46	125	171
1984	0	0	0	0	0	0	0	0	59	110	59	110	169
1985	0	0	0	0	0	1	0	0	54	115	54	116	170
1986	0	0	0	0	1	1	0	0	45	124	46	125	171
1987	0	0	0	0	1	0	0	0	47	111	48	111	159
1988	0	0	0	0	0	1	0	0	43	107	43	108	151
1989	0	0	0	0	1	0	0	0	60	119	61	119	180
1990	0	0	0	0	0	0	0	0	67	95	67	95	162
1991	0	0	0	0	0	0	0	0	67	102	67	102	169
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	21	23	21	23	44
1995	0	0	0	0	1	1	0	0	47	43	48	44	92
1996	0	0	0	0	0	0	0	0	18	25	18	25	43
1997	0	0	0	0	0	0	0	0	48	31	48	31	79
1998	0	0	0	0	0	0	0	0	64	61	64	61	125
1999	0	0	0	1	0	0	0	0	69	54	69	55	124
2000	0	0	0	0	0	0	0	0	63	52	63	52	115
2001	0	0	0	0	0	0	0	0	62	50	62	50	112
2002	0	0	0	0	0	0	0	0	80	51	80	51	131
2003	0	0	0	0	0	0	0	0	71	57	71	57	128
2004	0	0	0	0	0	0	0	0	43	68	43	68	111
2005	0	0	0	0	0	0	0	0	49	75	49	75	124
2006	0	0	0	0	0	0	0	0	57	77	57	77	134
2007	0	0	0	1	0	0	0	0	50	81	50	82	132
2008	0	0	0	0	0	0	0	0	64	66	64	66	130
2009	0	0	0	0	0	0	0	0	59	57	59	57	116
Total	**458**	**439**	**9**	**7**	**34**	**38**	**421**	**454**	**3,809**	**5,407**	**4,731**	**6,345**	**11,076**

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Kriss de Roo amd Bob Brownell are thanked for some useful comments on this paper.

REFERENCES

Allison, C. 2010. IWC individual catch database. Version 5 (1 October 2010). (Includes daily data from the Lagen collection, University of Washington).

Anon. 1915. Hvalfangeraktieselskapet 'Capella'. *Norsk Hvalfangsttid.* 1: 11.

Anon. 1925. Fangststatistik. *Norsk Hvalfangsttid.* 10: 126–27.

Anon. 1926a. Fangststatistik. *Norsk Hvalfangsttid.* 5: 79, 7:103, 12: 191.

Anon. 1926b. Graahvalen. *Norsk Hvalfangsttid.* 5: 79.

Anon. 1933a. Floating whaler *California* finds fair fishing. *Norsk Hvalfangsttid.* 2: 29. [From the *Pacific Fisherman*.]

Anon. 1933b. Whaling on the Pacific coast of North America. *Norsk Hvalfangsttid.* 3: 43–45. [From the *Pacific Fisherman*.]

Anon. 1933c. Whaling off San Diego. *Pacific Fisherman* 31(9): 47. [Reprinted in *Norsk Hvalfangst-Tidende* 9: 185].

Anon. 1934. All North Pacific whaling stations will be active this season. *Pacific Fisherman* 32(6): 55.

Anon. 1936a. All North Pacific whaling stations active in 1934. *Norsk Hvalfangsttid.* 5: 137. [From the *Pacific Fisherman*.]

Anon. 1936b. California whaling. *Norsk Hvalfangsttid.* 9: 276.

Anon. 1937. Pacific-kysten. *Norsk Hvalfangsttid.* 37: 198. [From the *Pacific Fisherman*.]

Anon. 1938. California Whaling Co. is ordered liquidated. *Norsk Hvalfangsttid.* 10: 458. From the *Pacific Fisherman*.

Anon. 1980. USSR. Progress report on cetacean research, June 1978–May 1979. *Rep. int. Whal. Commn* 30: 167–71.

Blokhin, S.A. 1997. The results of studies of the American population of gray whales taken in the coastal waters of the Chukotka Peninsula in 1996. Paper SC/49/AS15 presented to the IWC Scientific Committee, Bournemouth, September 1997 (unpublished). 10pp. [Paper available from the Office of this Journal].

Bockstoce, J.R. and Botkin, D.B. 1983. The historical status and reduction of the western Arctic bowhead whale (*Balaena mysticetus*) population by the pelagic whaling industry, 1848–1914. *Rep. int. Whal. Commn (special issue)* 5: 107–41.

Brownell, R.L. and Swartz, S.L. 2006. The floating factory ship *California* operations in Californian waters: 1932–1937. Paper SC/58/O1 presented to the Scientific Committee, May 2006, St. Kitts and Nevis, West Indies (unpublished). 8pp. [Paper available from the Office of this Journal].

Butterworth, D.S., Korrubel, J.L. and Punt, A.E. 2002. What is needed to make a simple density-dependent response population model consistent with data for the eastern North Pacific gray whales? *J. Cetacean Res. Manage.* 4(1): 63–76.

Clapham, P.J., Leatherwood, S., Szczepaniak, I. and Brownell Jr, R.L. 1997. Catches of humpback and other whales from shore stations at Moss Landing and Trinidad, California, 1919–1926. *Mar. Mammal Sci.* 13(3): 368–94.

Donahue, M.A. and Brownell, R.L., Jr. 2001. Twentieth century whaling statistics for eastern Pacific gray whales. Paper SC/53/BRG16 presented to the IWC Scientific Committee, July 2001, London, (unpublished). 24pp. [Paper available from the Office of this Journal].

Doroshenko, N.V. 2000. Soviet whaling for blue, gray, bowhead and right whales in the North Pacific Ocean, 1961–1979. pp.96–103. *In*: Yablokov, A.V. and Zemsky, V.A. (eds). *Soviet Whaling Data (1949–1979)*. Center for Russian Environmental Policy, Moscow. 408pp.

Gaze, E. 1936. Floating factory coverts giants of deep into marketable products. January 30 1936, *Evening Outlook*, Santa Monica, California.

Henderson, D.A. 1972. *Men and Whales at Scammon's Lagoon*. Dawson's Book Shop, Los Angeles. 313pp.

Henderson, D.A. 1984. Nineteenth century gray whaling: grounds, catches and kills, practices and depletion of the whale population. pp.159–86. *In*: Jones, M.L., Swartz, S.L. and Leatherwood, S. (eds). *The Gray Whale*. Eschrictius robustus. Academic Press, Inc., Orlando, Florida. xxiv+600pp.

Ivashin, M.V. 1981. USSR. Progress report on cetacean research June 1979–May 1980. *Rep. int. Whal. Commn* 31: 221–26.

Ivashin, M.V. 1990. Gray whale harvesting by Chukotkan aboriginal population. Paper SC/A90/G20 presented to the special meeting of the Scientific Committee on the Assessment of Gray whales, Seattle, April 1990 (unpublished). 37pp. [Paper available from the Office of this Journal].

Ivashin, M.V. and Mineev, V.N. 1981. The history of gray whale harvesting off Chukotka. *Rep. int. Whal. Commn* 31: 503–05.
International Whaling Commission. 1974. Report of the Scientific Committee. *Rep. int. Whal. Commn* 24:39–231.
International Whaling Commission. 1993. Report of the Special Meeting of the Scientific Committee on the Assessment of Gray Whales, Seattle, 23–27 April 1990. *Rep. int. Whal. Commn* 43:241–59.
Kellogg, R. 1931. Whaling statistics from the Pacific coast of North America. *J. Mammal.* 12(1 [Feb. 1931]): 73–77.
Keyes. 1939. *Blubber Ship*. George G Harrap and Co. Ltd, London.
Krupnik, I.I. 1987. The bowhead vs. the gray whale in Chukotkan aboriginal whaling. *Arctic* 40(1): 16–32.
Lankester, K. and Beddington, J.R. 1986. An age structured population model applied to the gray whale (*Eschrichtius robustus*). *Rep. int. Whal. Commn* 36: 353–58.
Maher, W.J. 1960. Recent records of the California gray whale (*Eschrichtius robustus*) along the north coast of Alaska. *Arctic* 13(4): 257–65.
Marquette, W.M. and Braham, H.W. 1980. The take and distribution of gray whales in northern Alaskan waters. Paper SC/32/PS12 presented to the IWC Scientific Committee, 1980 (unpublished). 13pp. [Paper available from the Office of this Journal].
Marquette, W.M. and Braham, H.W. 1982. Gray whale distribution and catch by Alaskan Eskimos: a replacement for the bowhead whale? *Arctic* 35(3): 386–94.
Martin, W.E. (compiler) [no date]. Sail and steam along the northern California coast 1900–1950. Unpublished manuscript available at the J. Porter Shaw Library, San Francisco National Park. [Not seen; cited from Donahue and Brownell, 2001].
Mitchell, E. and Reeves, R.R. 1980. The Alaska bowhead problem: a commentary. *Arctic* 33(4): 686–723.
Mitchell, E.D. and Reeves, R.R. 1990 revised. Aboriginal whaling for gray whales of the East Pacific stock. Paper SC/A90/G7 presented to the special meeting of the Scientific Committee on the Assessment of Gray whales, Seattle, April 1990 (unpublished). 131pp. (This document has been revised since the 1990 IWC Workshop on gray whales).
Punt, A.E. and Butterworth, D.S. 1997. Priors, likelihoods, Bayesian Synthesis and the assessment of of the Bering-Chuchki-Beaufort Seas stock of bowhead whales. Paper SC/49/AS2 presented to the IWC Scientific Committee, September 1997, Bournemouth (unpublished). 26pp. [Paper available from the Office of this Journal].
Radcliffe, L. 1933. Economics of the whaling industry with relationship to the Convention for Regulation of Whaling. 73rd Congr., 2d Session, Senate Comm. US Govt Print. Office, Washington, DC. 79pp.
Reeves, R.R. 1984. Modern commercial pelagic whaling for gray whales. pp.187–200. *In*: Jones, M.L., Swartz, S.L. and Leatherwood, S. (eds). *The Gray Whale*, Eschrichtius robustus. Academic Press Inc., Orlando Florida. xxiv+600pp.
Reeves, R.R., Leatherwood, S., Karl, S.A. and Yohe, E.R. 1985. Whaling results at Akutan (1912–39) and Port Hobron (1926–37), Alaska. *Rep. int. Whal. Commn* 35: 441–57.
Reeves, R.R. and Smith, T.D. 2010. Commercial whaling, especially for gray whales, *Eschrichtius robustus*, and humpback whales, *Megaptera novaeangliae*, at California and Baja California shore stations in the 19th century (1854–1899). *Mar. Fish. Rev.* 72(1): 1–25.
Reeves, R.R., Smith, T.D., Lund, J.N., Lebo, S.A. and Josephson, E.A. 2010. Nineteenth-century ship-based catches of gray whales, *Eschrichtius robustus*, in the Eastern North Pacific. *Mar. Fish. Rev.* 72(1): 26–65.
Reilly, S.B. 1981. Gray whale population history: an age structured simulation. Paper SC/33/PS8 presented to the IWC Scientific Committee, June 1981 (unpublished). 24pp. [Paper available from the Office of this Journal].
Rice, D.W. and Wolman, A.A. 1971. *The Life History and Ecology of the Gray Whale (Eschrichtius robustus)*. American Society of Mammalogists, Special Publication No. 3, Stillwater, Oklahoma. viii+142pp.
Rice, D.W., Wolman, A.A. and Braham, H.W. 1984. The gray whale, *Eschrichtius robustus*. *Mar. Fish. Rev.* 46 (Special Issue: The status of endangered whales): 7–14.
Risting, S. 1922. *Av Hvalfangstens Historie*. J.W. Cappelens Forlag, Kristiania. 625pp. Public 2 from Christensens Hvalfangstmuseum I Sandefjord. [In Norwegian].
Scheffer, V.B. and Slipp, J.W. 1948. The whales and dolphins of Washington state with a key to the cetaceans of the west coast of North America. *Amer. Midland Nat.* 39(2): 257–337.
Sleptsov, M.M. 1955. Biology of whales and the whaling fishery in Far Eastern seas. *Fisheries Research Board of Canada Translations Series* 118: 6pp. From *Biologiia i promysel kitov dalnevostochnykh morei Bishchepromizdat* (Food Industries Press), Moscow. 'Pishch. Prom.' [Translation with comments and conclusions only by WE Ricker. [In Russian].
Starks, E.C. 1922. A history of California shore whaling. *California Dept. of Fish and Game Fish Bull.* 6: 38pp.
Tønnessen, J.N. 1967. *Den moderne hvalfangsts historie. 2. Verdensfangsten 1883–1924. Del I. 1883–1914*. Norges Hvalfangstforbund, Sandefjord. i–xv + 619pp. [In Norwegian]
Wolman, A.A. and Rice, D.W. 1979. Current status of the gray whale. *Rep. int. Whal. Commn* 29: 275–79.
Yablokov, A.V. and Bogoslovskaya, L.S. 1984. A review of Russian research on the biology and commercial whaling of the gray whale. pp.465–85. *In*: Jones, M.L., Swartz, S.L. and Leatherwood, S. (eds). *The Gray Whale* Eschrichtius robustus. Academic Press Inc., Orlando, Florida. xxiv+600pp.
Zenkovich, B.A. 1937. More on the gray California whale (*Rhachianectes glaucus* Cope, 1864). [Eshche o serom Kaliforniiskom kite (*Rhachianectes glaucus* Cope, 1864]. *Vestn. Akad. Nauk SSSR, Dal'nevostochnyi Filiala* 23: 91–103. [In Russian. Translated by F.S. Essapian. 19pp. Available from NMML, NMFS, NOAA, Seattle, WA.].
Zenkovich, B.A. 1955. Part 1, Chapter 1. The whaling industry of the Soviet Union. *In*: Kleinenberg, S.E. and Makarova, T.I. (eds). *The whaling industry of the Soviet Union*. Rybnoe Khozyaistvo, Moskva. [In Russian].
Zimushko, V.V. and Ivashin, M.V. 1980. Some results of Soviet investigations and whaling of Gray whales (*Eschrichtius robustus*, Lilljeborg, 1961). *Rep. int. Whal. Commn* 30: 237–46.

Appendix 4

COMMENTS ON THE PARAMETRIC BOOTSTRAP OF THE DEVIANCE STATISTIC FOR ONE-SIDED CONFIDENCE LIMITS

Geof Givens

For several years the AWMP SWG has struggled to apply a parametric bootstrapping approach to estimate confidence limits in the analysis of the sex ratio data for West Greenland minke whales. Currently one topic is receiving a lot of attention: how to implement a one-sided confidence limit calculation. In our meeting, I asserted that the method implied by figure 2 in Annex B of the Report of the 3rd AWMP Workshop should be strictly adhered to as it stands (according to my interpretation of it), without any omissions of certain draws or setting certain quantities equal to zero as seems to be popular at the moment. However, this figure is difficult to translate to the WG minke case due to some of the notation used in text discussing this figure and the axis itself. The SWG asked me to write an explicit recipe for carrying out the calculation which is provided below together with a figure illustrating of some of the key conceptual aspects of the problem, although this is not intended as an illustration of the recipe.

Use the real data X to estimate $\hat{K}$

Let g index a grid of values for carrying capacity, $K_1,\ldots,K_G$.

For g = 1,…,G:

For i = 1,…,1000:

- Generate data X_{ig} from the model, treating K_g as the truth
- Calculate $\hat{K}_{ig}$ from X_{ig} using the sex ratio estimation approach
- Calculate $LD_{ig}(\hat{K}_{ig},K) = 2\log\{L(\hat{K}_{ig} \mid X_{ig})/L(K/X_{ig})\}\, I(K < \hat{K}_{ig})$. Note that LD_{ig} is a function of K that has the shape illustrated in figure 1 of Annex B.

End i loop

Histogram the 1,000 values for LD_{ig} for i = 1,…,g.

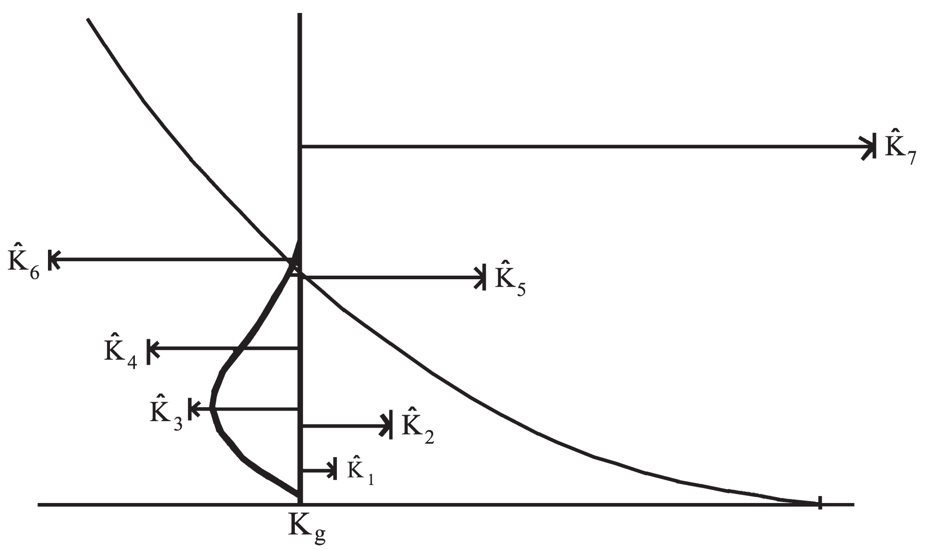
Calculate $LD_g(.95)$, specifically the 95th percentile of the histogram

End g loop

Connect the dots of $LD_g(.95)$ for g = 1,…,G.

Identify the K^* where $LD(\hat{K}, K^*)$ crosses the curve created in the previous step.

The other problem concerning the large number of simulations for which K is estimated to be > the truncation point (of 200,000) is different. When K_g is large, some $\hat{K}_{ig}$ may exceed the truncation point of 200,000 adopted for numerical stability. In these cases, $LD_{ig}(\hat{K}_{ig},K) > LD_{ig}(\hat{K}_{ig},200000)$ when $K > 200{,}000$, yet the actual value is uncalculated. These problematic cases are instances of right-censored data. The deviance quantiles at K_g should therefore be estimated using a method for censored data, not the percentile method. Such approaches include, I believe, methods relying on density estimation and/or the Kaplan-Meier approach.



Annex F

Report of the Sub-Committee on Bowhead, Right and Gray Whales

Members: Kitakado (Convenor), Acquarone, Baba, Bachmann, Bannister, Best, Bickham, Borodin, Brandão, Brandon, Breiwick, Brownell, Butterworth, Campbell, Cañadas, Castellote, Cerchio, Childerhouse, Clapham, Cooke, Darling, Deimer-Schütte, Donovan, Ensor, Ferguson, Flores, Frasier, Fujise, Funahashi, Galletti, Gedamke, Givens, Goodman, Groch, Heide-Jorgensen, Hoelzel, Iñiguez, Ivashenko, Jaramillo-Legorreta, Kanda, Kato, Koch, Koski, Lang, Larsen, Lyrholm, Mate, Matsuoka, Miyashita, Moore, Muir, Murase, Øien, Okada, Okamura, Palka, Pampoulie, Pastene, Punt, Reeves, Roel, Rojas-Bracho, Rosa, Rose, Rosenbaum, Rowles, Scordino, Sekiguchi, Simmonds, Sironi, Suydam, Taylor, Tyurneva, Uoya, Urbán, Vladimirov, Wade, Walløe, Waples, Weller, Werner, Wiig, Witting, Yamakage, Yasokawa, Yoshida, Young, Zerbini.

1. OPENING REMARKS, ELECTION OF CHAIR AND APPOINTMENT OF RAPPORTEURS

Kitakado welcomed the participants and was elected Chair. Best, Brandon and Suydam were appointed to act as rapporteurs with assistance of Kanda.

2. ADOPTION OF THE AGENDA

The adopted Agenda is given as Appendix 1.

3. REVIEW OF AVAILABLE DOCUMENTS

The documents available for discussion by the sub-committee included SC/62/BRG2–6, 9–11, 13–20, 23–31, 33–34, SC/62/O7, SC/62/NPM22, SC/62/E13, SC/62/Rep3, Higdon (2010), Pettis (2009a) and Wade *et al*. (2010).

4. BOWHEAD WHALES

4.1 Bering-Chukchi-Beaufort (B-C-B) Seas stock of bowhead whales

4.1.1 New scientific information

SC/62/BRG13 presented preliminary analyses of broad-scale aerial surveys for large whales in the northeastern Chukchi Sea that were conducted in 2008 and 2009, in comparison with results from similar surveys conducted in that region from 1982–91. The existing study area extends from 68° to 72°N and from 157° to 169°W, encompassing the Chukchi Sea Planning Area (CSPA), which is an area of renewed interest for the exploration, development, and extraction of offshore petroleum resources. There were 77 on-effort sightings of 107 bowhead whales in the Chukchi Sea from 1982–91 and 2008–09. Bowhead whales were seen in all survey months, with the greatest number of sightings in October. Most whales were seen west and southwest of Pt Barrow, with a few sightings in the northwestern region. Bowhead sightings were within the CSPA and close to active leases. The largest bowhead sighting rates (all years combined, uncorrected for detection bias) with respect to depth were in the outer shelf, in waters ranging from 50–200m depth. The distribution of bowhead sightings during the light ice years of the early period (1982, 1986, 1989, and 1990) was similar to the distribution of bowhead sightings during 2008–09. Aggregations of feeding bowhead whales were observed relatively close to shore between Point Franklin and Point Barrow on three occasions: (1) 17–18 October 1983 (in 70–80% ice cover); (2) 30 June to 11 July 2009 (5–80% ice cover); and (3) 19 September 2009 (no ice cover).

The other large whale species sighted during the COMIDA surveys were gray (254 on-effort sightings of 533 gray whales), fin (one sighting on 2 July 2008) and humpback (one sighting on 25 July 2009) whales. Most gray whale sightings were recorded as ‘feeding’ and were seen nearshore (0 to 35m depth) between Pt Barrow and Pt Lay, with an additional area of concentration in offshore shoal areas in autumn of 1989–91. Gray whale cow/calf pairs were seen mainly in nearshore areas during the month of July, and all were sighted in 0–10% ice cover. Gray whale calves were often undetected during initial on-effort sighting events, and many would likely have remained undetected if brief diversions off-effort were not initiated.

The sub-committee thanked the authors for this update, especially in light of the oceanographic and climactic changes that have occurred in the Chukchi Sea in recent decades. In discussion, it was noted that there did not appear to be any major shifts in cetacean distribution between the earlier surveys and those during 2008–09. But, there were no gray whale sightings in the offshore shoal areas during 2008–09, which was unexpected. It was also noted that the observations of feeding bowhead whales to the west of Pt Barrow may better delineate the range of that feeding aggregation. In general, it was noted that analysing cetacean distribution in relation to environmental factors like sea-ice was complicated with this dataset because the timing of the surveys was not consistent between years. The authors plan on addressing the challenges of analysing cetacean distribution and habitat relationships in future analyses.

SC/62/BRG14 presents preliminary results from broad-scale aerial surveys for bowhead whales in the Alaskan Beaufort Sea conducted by the Bowhead Whale Aerial Survey Project (BWASP) in 2000–09, with comparisons to historical data. The BWASP study area ranges from 140°–157°W and from the Alaskan coast to 72°N. The surveys have been conducted every autumn since 1979. During 2000–09, nearly 190,000 total km were flown in September and October, with over 93,000km on transect. A total of 1,429 bowhead whales were seen, distributed across the study area on the inner shelf (in waters less than 50m deep). Bowhead distribution was similar in 2000–09 compared with the observed distribution from earlier years with light ice cover. Feeding and milling bowhead whales were recorded across the study area, but with highest frequency in the westernmost region (154°–157°W longitude). Incidences of feeding behaviour by bowheads in the Alaskan Beaufort Sea is likely underrepresented in the BWASP database because the goal of conducting line-transect surveys impedes focal observations of individual sightings, resulting in very little time to observe and identify definitive characteristics of feeding behaviour. Bowhead cow/calf pairs were observed across the Alaskan Beaufort Sea. Bowhead calves were often undetected during the initial on-effort sighting event, and would likely have remained undetected if brief diversions off-effort (in search or circling mode) were not initiated.

The sub-committee thanked the authors for presenting these data and **recommended** that these surveys continue on an annual basis in the future in light of their capacity to monitor the effects of climate change and other factors (including anthropogenic activities) on cetacean distributions in the Beaufort Sea. In discussion, the author noted that it is not advisable to make detailed conclusions from the BWASP data without accounting for the spatiotemporal variability in the distribution of survey effort. The possibility of extracting trend data on a sightings-per-unit-effort basis was discussed, but the authors noted that this was not recommended until detection functions had been developed which could take into account sightability as a function of environmental variables and especially sea-ice cover (given that the latter is known to have changed through time). Likewise, no conclusions could be drawn with respect to bowhead calf sightings at present, because those had not been corrected for effort and any such analyses would also need to take into account the fact that cows and calves migrate farther offshore than the rest of the population.

SC/62/BRG17 provided information about acoustic monitoring during attempts to count migrating bowhead whales near Point Barrow, Alaska. In early April 2009, four marine autonomous seafloor recorders were deployed off Pt Barrow Alaska during the bowhead spring migration (see George and Suydam, 2009). The primary objective of this effort was to demonstrate that this equipment could effectively replace the previous mechanism that relied on an array of hydrophones deployed from the ice edge for recording calling and singing bowheads. Three of the four recorders were recovered in early August 2009. Preliminary analyses based on one hour of data/day detected singing or calling bowheads on 36 of the 40 days for the 10 April–18 May 2009 period. Preliminary analysis further indicates that the multi-channel data collected with this type of autonomous seafloor array can be used to reliably locate and acoustically track actively vocalising bowheads as they migrate past Barrow. Results from this 2009 acoustic effort demonstrate the efficacy of this new seafloor array procedure and indicate that it can be used in the future as the method for obtaining acoustic data for the bowhead census and population estimation process. In early April 2010 an array of five recorders were deployed along the ice edge, and their recovery is scheduled for sometime in early August 2010.

The sub-committee welcomed this report and **encouraged** the continued use of autonomous seafloor acoustic recorders when monitoring migrating bowhead whales.

SC/62/BRG29 summarised preliminary analyses on identifying yearling bowhead whales in aerial photographs collected during spring near Barrow, Alaska. Small whales were noticed near the end of the spring migration during photographic studies conducted 1985–92 and talks with whalers identified these late-season small whales as potential yearlings. Measurements of body length, snout-to-blowhole distance, fluke width, and width at the axilla, umbilicus, anus and peduncle from whales photographed during the spring of 2004 were investigated as a means of separating yearlings from older whales. The ratios of each of the latter six measurements to body length appeared to be most suitable for this purpose and non-overlapping values for yearlings and older animals were determined by assuming that animals seen after 5 May were yearlings and animals seen before 24 April were older than one year. Based on the date, body length, and ratio data, 85% of whales 6–10m long were classified as yearlings or older. Future studies will refine the criteria for separation and investigate models to more robustly separate yearlings from older animals but the preliminary analysis confirms it is possible to do so with a high degree of confidence. Using the methods in the calf index paper by Koski *et al*. (2008), the proportion of the population that are yearlings can be estimated and compared to the proportion of yearlings the previous year to estimate calf to yearling survival. Seven additional years of photographic data are available for analyses.

In discussion, the possibility was raised that the gaps between clustered groups of individuals might have been due to inconsistent survey effort during the course of the migration. That is, gaps in body measurements between groups of animals might have been an artefact of missing a component of the migration which consisted of intermediate sized whales. The authors noted that survey coverage was excellent in 2004, and that such patterns appear to be real differences in body shape between yearlings and older juvenile whales. The sub-committee **encouraged** the authors to continue this research and looks forward to seeing results from more years of data. Suydam summarised recent efforts to estimate the population size of B-C-B bowheads. In both 2009 and 2010, there were attempts to count migrating whales from observation perches on pressure ridges on the sea ice near Point Barrow, Alaska. In 2009, the lead in the sea ice was closed during most of April and May making a population estimate impossible. In 2010, the lead was opened in late March and early April. Of note, there was a sizable passage of whales at that time, which is unprecedentedly early compared to the past ~35 years. Typically bowheads are not seen until mid-April. The lead was then closed during most of the last two weeks of April. Based on previous years' counts, a large percentage of whales migrate past Point Barrow during that time. In 2010, a large number of calls and songs of bowheads were recorded on dipping hydrophones during late April. Because observations were not possible during the last two weeks of April when a very substantial proportion of bowheads pass the perches, the population size in 2010 will not be estimated. In addition to visual counts, acoustic monitoring occurred in both 2009 and 2010 (see SC/62/BRG17 for a summary). In addition to attempting to estimate the population size, there was also an effort to estimate detection probabilities using two independent perches. Approximately 1,200 'new' whales were seen from each of the perches, and these data will be used (after identifying matches) to estimate detection probabilities. A full survey effort is being planned again in 2011.

In discussion, it was noted that the timing of this year's migration highlights the importance of monitoring the tails of the distribution of migrating whales. While this issue has been considered in previous analyses of the migration data, the observations from 2010 suggest that this concern may be magnified for future surveys.

Members of the sub-committee discussed the possibility of developing a mark-recapture estimate from genetic data. But, it was concluded that the current sample sizes are far too limited for such an approach.

4.1.2 Catch information

SC/62/BRG18 summarised the data from the 2009 Alaskan hunt. A total of 38 bowhead whales were struck resulting in 31 animals landed, a bit less than the previous 10-year average of 40.1 (SD = 7.2). The efficiency (no. landed/no. struck) of the hunt was 82%, which is about the average during 1999–2008 (mean = 78%, SD = 8%). Challenging sea ice conditions and weather contributed to a poor hunt during the spring. Of the landed whales, 12 were males, 18 were females, and sex was not determined for one animal. Of the 18 females, 6 were presumably mature (based on length >13.4m). Only two were closely examined. One was pregnant with a 1.63m foetus. Biologists were not able to examine the others because they were landed in remote villages or were butchered in the water. Hunters mistakenly harvested two female calves (lengths of 6.2 and 6.6m) thinking they were small independent whales. Autumn calves are close in body length to yearlings and it is difficult to determine their status when swimming alone.

It was noted in discussion that there were no catches of bowhead whales by Russia this year.

4.1.3 Management advice

The sub-committee **reaffirmed** its advice from last year that the *Bowhead SLA* remains the most appropriate tool for providing management advice for this harvest. The results from the *SLA* show that the present strike and catch limits are acceptable.

The next *Implementation Review* for B-C-B bowheads is scheduled in 2012. The purpose of the *Implementation Review* is to evaluate new information which has become available since the last *Implementation Review* and assess whether the current state is outside the realm of plausibility covered by the *Implementation* trials. If so, it may be necessary to conduct further trials incorporating such information. Therefore, the sub-committee **encouraged** researchers to present relevant papers and new information for consideration during next year's meeting, so that preparations for the next *Implementation Review* can proceed efficiently.

The sub-committee reviewed the catch limits in table 4 of 'Proposed consensus decision to improve the conservation of whales from the Chair and Vice-Chair of the Commission' (IWC/62/7rev). For B-C-B bowheads, the maximum strike limit is 67 per year (plus a carryover provision of 15 unused strikes from the previous year) for total landed of 560 (580 written in footnote 8 should be a typographical error). The sub-committee **endorsed** the strike limits for B-C-B bowheads that are listed in table 4. These values are within the management advice provided by the *Bowhead SLA*.

4.2 Eastern Arctic bowhead whales

4.2.1 Stock structure

SC/62/BRG23 reported on the sexual segregation of bowhead whales sampled in Eastern Canada and West Greenland. This analysis of genetic markers was done in relation to the question of one or two stocks in the area (Baffin Bay-Davis Strait and Hudson Bay-Foxe Basin). One location was sampled in West Greenland: Disko Bay (April-June 2000–09) and four locations were sampled in Eastern Canada: Pelly Bay (September 2000–02), Cumberland Sound (June August 1997–2006), Foxe Basin (July–August 1994–2007) and Repulse Bay (September 1995–2005). Table 1 and fig. 1 of SC/62/BRG23 provide information about the samples. The same data were also used in the analyses presented in SC/62/BRG25 and BRG26.

The results showed that in Disko Bay 76% of the whales were females. The frequency was significantly different from 1:1, whereas in the other areas the sex ratio was not different from 1:1. In Disko Bay only adult whales and no calves have been observed. Few calves have been reported from other areas of Baffin Bay. However, females with calves and sub-adults are observed in Foxe Basin and in Gulf of Boothia/Prince Regent in late autumn. Historical whaling records clearly indicate that cows, calves, and sub-adult whales were taken in northwestern Hudson Bay. Based on these lines of evidence, the authors suggested that bowhead whales summering in the eastern Canadian Arctic and wintering off the west coast of Greenland must belong to one population; Baffin Bay is mainly used by adult males and resting/pregnant females whereas the Prince Regent, Gulf of Boothia, Foxe Basin and northwestern Hudson Bay animals are nursing females, calves and sub-adults.

The sub-committee thanked the authors for presenting these results and **encouraged** them to present an updated analysis next year, including data from 2010. It was noted in discussion that the available information is consistent with some form of structured movement, but this movement is still not well understood.

SC/62/BRG25 reported on the re-identification patterns of bowhead whales sampled in Eastern Canada and West Greenland, based on the samples and genetic markers described in SC/62/BRG23. This work was motivated by the question of stock structure (i.e. whether there is one or two stocks) of bowhead whales in the area. Samples were obtained from one location in West Greenland: Disko Bay (April–June 2000–09), and four locations in Eastern Canada: Pelly Bay (September 2000–02), Cumberland Sound (June–August 1997–2006), Foxe Basin (August 1994–2007) and Repulse Bay (September 1995–2005). The largest samples sizes were from Disko Bay (n = 359) and Foxe Basin (n = 192).

From the total of 647 identified individuals, 91 were identified within the same location and year. Of the remaining 556 individuals (208 males and 348 females), the authors found 16 re-identifications between years. Three of these were between sampling areas and all three had moved from the Hudson Bay-Foxe Basin area to the Baffin Bay-Davis Strait area. In addition, of the 20 new satellite tags put out in 2009 in Disko Bay, four animals had crossed assumed boundaries between putative stocks.

The authors concluded that: (i) the low number of re-identifications between years indicate that the population is relatively large; and (ii) the high proportion of re-identifications between areas indicate high rate of movement between the two putative stocks. Additionally, new and old satellite tag data confirms such movement between putative stocks. The results, therefore, indicate that tagged animals crossed the assumed stock boundaries in Hudson Strait and Heckla and Fury Strait. In the authors' view these results further indicate that there is only one stock of bowhead whales in the area.

The sub-committee thanked the authors for presenting their analyses and recognised the importance of the successful satellite tracking study. It was noted in discussion that it would be helpful if future presentations of the data provided the dates when re-identified whales were taken. In discussion, Givens noted that the specific stock boundaries assumed by the authors had not been based on specific data or past Scientic Committee consensus. There was considerable discussion about the resighting patterns within and between Disko Bay and Foxe Basin. But, at present there are still uncertainties in the interpretation of these patterns. The sub-committee **encouraged** the continuation of this work and looks forward to a presentation of a more in-depth analysis next year.

SC/62/BRG26 presented work on genetic differentiation of the Baffin Bay-Davis Strait and the Hudson Bay-Foxe Basin stocks of bowhead whales, using a ~450 bp fragment of the mitochondrial control region. The study included sequence data for 346 individuals from the Baffin Bay-Davis Strait and 197 individuals from the Hudson Bay-Foxe Basin stock. There was a slight but significant genetic differentiation of the two stocks in terms of F_{ST} based on haplotype frequencies. However, there was no differentiation between the Hudson Bay-Foxe Basin stock and the bowhead whales collected from Cumberland Sound, an area presumed to be within the range of the Baffin Bay-Davis Strait stock. In the context of other biological information available (SC/62/BRG23 and SC/62/BRG25) the authors consider the observed F_{ST} in line with the one stock hypothesis for the Baffin Bay-Davis Strait and the Hudson Bay-Foxe Basin stocks.

It was noted in discussion that in relation to significant F_{ST} values for mitochondrial haplotypes, that it appears that the level of genetic differentiation between years for samples taken at Disko Bay during 2007–09 is the same order of magnitude observed between samples taken from different areas (Baffin Bay, Foxe Bay and Hudson area). It was noted that there is not currently enough microsatellite data from Disko Bay to test for genetic differentiation at nuclear loci.

Rosenbaum summarised a paper submitted on genetic diversity and differentiation across all five IWC putative stocks of bowhead whales, including Baffin Bay-Davis Strait and Hudson Bay-Foxe Basin totalling more than 750 samples. In addition, the study utilised ancient specimens of bowhead whales from the central Canadian Arctic located in the modern BBDS stock range (500–800 years old Thule Inuit house ruins) and compared them with sequences from all five stocks. No difference was observed between modern samples from the two putative/hypothesised Canada-Greenland populations (HBFB and BBDS). These results differ from those observed in SC/62/BRG26; the latter study used more samples and a longer fragment of mtDNA, which may have improved the power of the analysis to detect potentially subtle differences between populations.

There was considerable discussion about the evidence for one or two stocks in Canada and Greenland. Some members of the sub-committee interpreted the fact that bowhead whales (detected via satellite tracking) moved seasonally between the two putative stocks areas to mean that there is a single stock. Other members of the sub-committee indicated that these movements are still consistent with shallow population structure between the two stocks and therefore the possibility of two stocks remain open (SC/62/BRG26). Furthermore, the satellite telemetry results need to be evaluated in the context of the most rigorous and complete population-level analyses and movement of whales of different ages and sexes.

Given the differences in sampling, the sub-committee **agreed** that the degree of population structure still needs to be tested with additional molecular markers (nuclear loci) before any conclusion is finalised about the number of stocks in this region. The sub-committee expressed considerable interest in receiving new information of this nature at SC/63.

4.2.2 Other new scientific information

SC/62/BRG28 reported that an aerial survey of the late-summer concentration of bowhead whales in Isabella Bay, Nunavut, Canada, was conducted on 19 September 2009. A total of 28 sightings were obtained during 155km survey effort. The resulting abundance of 1,105 (95% CI: 532–2,294) was corrected for whales that were submerged during the passage of the survey plane but not for whales missed by the observers because >90% of the sightings were detected by both platforms.

SC/62/BRG34 summarised a preliminary evaluation of the potential to use photographs and capture-recapture analyses to estimate the size of the Eastern Canada–West Greenland stock or stocks of bowhead whales. The large and often remote summer range of this stock or stocks make it difficult to obtain an aerial survey estimate of abundance in a short period of time. Estimates obtained from surveys that are temporally separated may lead to double counting of some animals or could lead to missing animals because of movements among summering areas between survey periods. Photographic surveys on the other hand benefit from mixing among the separate sampling areas and have been successfully used to estimate the size of several stocks of cetaceans including the B-C-B stock of bowhead whales. Results were summarised showing aggregation areas during spring, before bowheads can access summer feeding areas, and during summer. The authors proposed that photographic surveys conducted in two years be directed at these areas.

Photography methods and analyses for the proposed surveys would follow methods used for the B-C-B population estimate provided by Koski *et al*. (2010) for the B-C-B stock in 2004, which has been accepted by IWC as the current size of that stock. Closed population models would be used to estimate the number of marked whales in the population and the proportion marked would be assumed to be the same as the B-C-B stock. Justification for use of the B-C-B proportion marked is that both populations were historically depleted and appear to be recovering near their maximum possible rate based on our knowledge of bowhead whale biology. Other advantages of a photographic survey would include the compilation of a photographic catalogue which can be used to make future estimates of abundance using the model of Schweder *et al*. (2010) and estimation of other life-history parameters when additional surveys are conducted. Lengths of whales from these photographs would also provide life-history information for interpretation of genetic analyses.

In discussion it was noted that additional data will be included in an updated analysis presented during next year's meeting. The sub-committee thanked the authors for providing these analyses and looks forward to seeing future results.

4.2.3 Catch information

SC/62/BRG27 reported that five female and one male bowhead whale were taken for subsistence purposes in Disko Bay, West Greenland, in April–May 2009 and 2010 (no whales were struck in 2008 and no whales were struck and lost in 2009 and 2010). All the whales were sexually mature with body lengths exceeding 14m, one female was pregnant with a 3.87m foetus and two presumably with small foetuses that could not be detected in the field. Another female was resting with a maximum number of corpora albicantia of 7 but no mature follicles. Age determinations of three of the whales revealed that the whales were between 30 and 42 yrs old. Four of the whales had more than half full stomachs and they had been feeding intensively on calanoid copepods in particular *Calanus hyperboreus.*

In light of the uncertainties surrounding eastern Arctic bowhead stock structure and abundance, the sub-committee **strongly recommended** that data be provided on Canadian catches.

Reeves summarised the results in Higdon (2010), who compiled a comprehensive record of catches of bowhead whales in eastern Canada and West Greenland that includes both subsistence hunting by Inuit and commercial hunting by Basque, Dutch, British, German, Danish and American whalers. This includes estimates of Basque catches in the Strait of Belle Isle and Gulf of St. Lawrence between 1530 and 1713. The estimated total for commercial whaling from 1530–1915 was 55,916–67,537 (median 61,537), depending on assumptions about the intensity of the Basque harvest, and the estimated total for subsistence whaling from 1530–1915 was 8,406. A total of 65 bowhead whales are known to have been taken (either killed and secured or struck and lost) between 1918 and 2009. Thus the total estimate for all whaling from 1530–2009 is 70,008, with no allowance for struck and lost whales other than in the recent period after 1918. Higdon considered that at least parts of the catch series are incomplete or underestimated. Significantly, data quality varied considerably by nation and time period and the author used a 3-point scale of reliability to acknowledge this. More than half of the total catch estimate was derived from data regarded as 'least reliable'.

4.2.4 Management advice

In 2007, the Commission agreed to a quota for 2008–12 of two bowhead whales struck annually off West Greenland but the quota for each year shall only become operative when the Commission has received advice from the Scientific Committee that the strikes are unlikely to endanger the stock.

In 2008, the Committee was pleased to have developed an agreed approach for determining interim management advice. The sub-committee **agreed** that the current catch limit for Greenland will not harm the stock**.** It was also aware that catches from the same stock have been taken by a non-member nation, Canada. It noted that should Canadian catches continue at a similar level as in recent years, this would not change the sub-committee's advice with respect to the strike limits agreed for West Greenland.

The sub-committee reviewed the catch limits in table 4 of the 'Proposed consensus decision to improve the conservation of whales from the Chair and Vice-Chair of the Commission' (IWC/62/7rev). For Eastern Canada/West Greenland bowheads, the Greenland strike limit is two per year (plus a carryover provision of two unused strikes from the previous year). The sub-committee **endorsed** the strike limits for Eastern Canada/West Greenland bowheads that are listed in table 4. However, the sub-committee noted that Canada may allow for regular catches from this stock. Depending on the size of catches in Canada, the sub-committee's advice may change. If the Canadian catch increases, then the sub-committee wishes to draw attention to the fact that the total number taken from the stock may be greater than what is safe. The sub-committee **recommended** that the IWC should contact Canada requesting information about catches for bowheads.

4.3 Other stock of bowhead whales

SC/62/BRG3 summarised sightings of all cetaceans off western Kamchatka from existing published literature and other available sources. The waters off the western coast of Kamchatka in the Okhotsk Sea are highly productive and contribute a large fraction of Russian commercial fish and shellfish catches. This area is also the site of a sizeable oil and gas leasing area, which is in the exploratory phase of development. While fisheries-related research has been conducted off western Kamchatka for several decades, there has been essentially no directed research on cetaceans and other marine mammals in this region. In total, 351 sightings of 14 cetacean species have been recorded, reflecting a varying degree of occurrence, during the period from the 1940s until the present. Okhotsk Sea bowhead whales were recorded only a few times in the study area during the spring-autumn period, with one sighting during winter; however it is known from historical whaling data that this species was abundant in the area, particularly in the northern regions during periods of open water. The low number of bowhead, gray, and right whale sightings (see below) in recent times likely reflects their small population size and lack of appropriate surveys. Given the diversity and conservation status of species using this area, as well as the potential for this area to serve as recovery habitat for populations of bowhead, right, and gray whales, further research is required, notably in light of the potential impacts of existing fishery operations and expanding oil and gas development.

In discussion, it was inquired if there was any potential that some of the sightings presented were actually resightings of the same individual. The authors noted that there was no way of knowing if this was the case or not, given the available data.

SC/62/BRG20 reported the results of a survey for bowhead whales performed in the Fram Strait during 29 March–14 April 2010. Two observations were made. One whale was sighted, biopsied and tagged with a Spot 5 satellite transmitter on 3 April. However, the transmitter did not start to work until about three weeks after the deployment. Ten days later another sighting was made. This animal turned out to be the same individual as was encountered during the previous sighting as identified from scars on the back.

Witting reported that 12 sighting of bowhead whales were made in the Northeast Water Polynia off Northeast Greenland during an aerial survey for walrus August 2009. He also reported that a female with a calf was seen off Norske Island, Northeast Greenland on 26 July 2009.

In discussion it was noted two passive acoustic recorders were deployed in the Fram Strait from 2008–09 and that these instruments have detected numerous bowhead sounds including songs.

The sub-committee welcomed this information and **encouraged** future updates and research on these stocks.

5. RIGHT WHALES

5.1 North Atlantic right whales

Pettis (2009a) provided an update on North Atlantic right whales (*Eubalaena glacialis*) for the period May–October 2009, as an addendum to information presented in Pettis (2009b). The summary reflects the work of the North Atlantic Right Whale Consortium (NARWC), more than 100 individuals and groups that conduct coordinated research on this population across its known range. A shared photographic catalogue was used to produce a 'best' estimate of population size of 438 for 2008. This was the number of unique, catalogued individuals that had been seen alive between 2002 and 2008, not including calves observed through 2008 that could not be reliably re-identified. This total did not explicitly account for un-photographed whales in the population and may change slightly as additional data are incorporated into the catalogue. One right whale death was documented during the report period, but the cause was not determined. Additionally, there were three new entanglement cases and eight previous entanglement cases that had not yet been resolved.

The sub-committee considered that the documented growth in the catalogue plus successive years of improved calf production gave grounds for cautious optimism over the future status of this population.

5.2 North Pacific right whales

The review of cetacean sightings off western Kamchatka summarised in SC/62/BRG3 noted that the Okhotsk Sea is an important feeding ground for endangered western North Pacific right whales from spring to autumn. A number of sightings of these whales were made during Japanese-led surveys from 1989 to 2003; these were mostly restricted to the southern portion of study area. However, there were also a few sightings in earlier years by Soviet scientists, including in the northern part of the area. These sightings suggest that southwestern Kamchatka is currently an important feeding area for this population, but that northern regions may become more important as the population recovers. These sightings also highlight the need for directed research and monitoring of right whales off western Kamchatka in areas overlapping with fishery and oil and gas development activities.

SC/62/NMP22 provided results of observations of North Pacific right whales during the common minke whale sighting and biopsy survey conducted in the Okhotsk Sea in summer 2009. The research area was set north of 46°N, south of 57°N and west of 152°E in the Okhotsk Sea including the Russian 200 n.mile EEZ and 11 track lines totalling 2,219.9 n.miles were predetermined. The research vessel *Shonan-maru No. 2* conducted the survey from 18 July to 31 August. During the searching distance of 1,662.6 n.miles, 17 schools (29 animals) of North Pacific right whales were found, mainly in the offshore waters deeper than 200m. Of these, 16 schools were targeted for photo-id research and 22 animals in 15 schools were individually identified. Examination of digital images of the head (callosities and lip patches) indicated no re-sightings among them.

In response to a query whether the animals photographed on this cruise had been compared with any photographed in earlier cruises, Yoshida replied that there were plans for such a comparison once the survey planned for this year had been completed, noting that there were only a few suitable images available from previous years.

It was noted that there was a stranding of a single North Pacific right whale in Japan in 2009 (see SC/62/ProgRep Japan).

Wade *et al*. (2010) used photographic and genotype data to calculate the first mark-recapture estimates of abundance for right whales in the Bering Sea and Aleutian Islands. The estimates were very similar: photographic 31 (95% CL 23–54), genotyping 28 (95% CL 24–42). They also estimated that the population contained 8 females (95% CL 7–18) and 20 males (95% CL 17–37). Although these estimates may refer to a Bering Sea sub-population, other data suggest that the total eastern North Pacific population is unlikely to be much larger. The authors concluded that the population's precarious status is a direct consequence of uncontrolled and illegal whaling, and highlights the past failure of international management to prevent such abuses.

In a reply to a question regarding the technique used in genetic identifications of individuals, Wade responded that they used eight microsatellite loci, mtDNA haplotypes, and sex. Matching was first conducted with the microsatellite loci, and pairs with only a few alleles mismatching were compared using mtDNA haplotypes and sex. If this was inconclusive the comparison would be re-run. It was pointed out that the power of genetic matching is dependent not only on the number of markers used but also on the level of genetic diversity of these markers within the population, and that these needed to be calculated for the population.

When asked about the issue of co-variance when using model-averaging (as had been done in producing the population estimate from the genetic data) Wade replied that the program MARK was able to account for this.

Regarding the desirability of making a genetic or photo-identification comparison between right whales from the Eastern (ENP) and Western North Pacific (WNP), Wade responded that a comparison of photographs would be very useful. Two genetic samples from the WNP had been analysed and in assignment tests individuals were found to have a low probability of assignment to the ENP: a third sample was yet to be analysed. In response to a query from the Chair he said that more samples and images should be available from another survey planned in the ENP this year, and that he hoped to provide updated information at next year's meeting.

5.3 Southern right whales

5.3.1 Australian and New Zealand areas

SC/62/BRG16 presented new information on the stock structure of southern right whales around the subantarctic Auckland Islands (NZ subantarctic) and the main islands of New Zealand (mainland). It remains uncertain whether these two regions represent two relatively isolated stocks with different histories of exploitation and recovery, or a single stock with a poorly understood pattern of migratory habitat use. A third hypothesis, that the Mainland NZ population was extirpated and is now being recolonised by a range expansion from the NZ subantarctic, is also possible. To help address these hypotheses, SC/62/BRG16 presents the results of matching between DNA profiles from southern right whales sampled around the NZ Mainland (n = 22 individuals) and NZ subantarctic (n = 613 individuals). The DNA profiles were constructed by genotyping of microsatellite loci (up to 14, average 12.7 loci), sequencing of the mtDNA control region (minimum of 500bp) and sex identification using skin samples collected with a biopsy dart. The matching resulted in a number of matches within each region and 4 matches between the two regions; 3 females and one male, first identified as a calf. This is the first time that movement between the two regions has been documented and, along with other available data, is most consistent with either the one stock or the extirpation/recolonisation hypotheses.

When asked about the availability of historical right whale specimens (e.g. in New Zealand museums) that could provide genetic information Baker replied that initial enquiries had revealed little such material, and a reasonable sample size was required to address the issue of stock identity.

The possible genetic heterogeneity of between-year samples at the Auckland Islands was raised but the distribution of mtDNA haplotypes had proven to be surprisingly stable over the sampling period.

In discussion of the paper the issue of the desirability of sampling right whale calves was raised, with several speakers mentioning that they had experienced difficulties or complications in obtaining permits for such sampling. Although there were legitimate concerns over the possible disturbance that biopsy sampling might cause to mother-calf pairs, a published study of the effects of biopsying over 100 cow-calf pairs in South African waters had shown no adverse effect on the subsequent calving interval, although the statistical power was low (Best *et al.*, 2005). Given the potential value of such sampling, particularly in establishing issues of paternity, the sub-committee **recommended** that permitting authorities should view requests for biopsy sampling of cow-calf pairs on their scientific merit and apply appropriate safeguards to limit the degree of disturbance where necessary.

SC/62/BRG19 described satellite tracking of southern right whales (*Eubalaena australis*) at the Auckland Islands, New Zealand. Satellite tags were attached to six southern right whales off the Auckland Islands in sub-Antarctic New Zealand during July and August 2009. The tags lasted for an average of 75 days (range: 1–167 days) and provided data on migratory movements of three whales that had transmitting tags when they left the Auckland Islands. All of these travelled to the south of South Australia between 38° and 48°S, although one of these whales visited the New Zealand mainland before heading west towards waters to the south of Australia. There are no future plans to tag right whales in New Zealand.

The reason(s) for the extended silent period(s) of some tags was unknown: although it had been hoped that tagged animals would be re-sighted in the Auckland Islands so that the condition of the tags and of the animals themselves could be checked; in practice there was only one such re-sighting. It was noted that the telemetry study had shown that animals from this nursery area/breeding ground frequently moved north to their feeding ground, which was the reverse of the generally accepted migratory pattern for southern right whales.

SC/62/E13 presented new data on southern right whale contact calls from the Auckland Islands. It was brought to the attention of sub-committee members but dealt with more expansively in the SWG on Environmental Concerns. See Annex K for a more detailed description.

Bannister reported the results of the 17th annual survey undertaken since 1993 along the southern Australian coast between Cape Leeuwin (Western Australia) and Ceduna (south Australia in August/September 2009. As in previous years, counts and identification photographs were obtained of right whales within *ca.* 1 n.mile of the coast. The number recorded (782 animals including 244 cow/calf pairs) was the highest yet recorded, in marked contrast to the very low count (of 287 animals including only 57 cow/calf pairs) two years earlier, in 2007, and a high count in 2008. The percentage annual increase rate, 1993–2009, for cow/calf pairs is 7.51 (95% CI = 3.18–12.02). Minimum population size is estimated at 2,530, with a total Australian population of *ca* 3,000. A study taking into account the three-year reproductive cycle and likely different cohort strengths is being undertaken to determine future survey frequency.

5.3.2 South America area

A Workshop was held to investigate the causes of the high mortality of southern right whales around Península Valdés, Argentina. It took place from 15–18 March 2010 at the Centro Nacional Patagónico (CENPAT) in Puerto Madryn, Argentina. Participants included experts on the ecology and marine environment of the Península Valdés region, scientists studying right whales in the South Atlantic and international experts on whale strandings and mortality. Brownell introduced a chair's summary of the meeting.

Since 1971, small numbers of southern right whale strandings have been recorded, but starting in 2003, when the Southern Right Whale Health Monitoring Program (SRWHMP) was established, a total of 366 right whale deaths have been recorded, with peaks in 2003 (31), 2005 (47), 2007 (83), 2008 (95) and 2009 (79). Most (333 or 91%) of the deaths have been of first-year calves. The Workshop considered specific information on the sex ratio, seasonal timing, locations and sizes of stranded animals and the results of gross pathology examinations for 366 of them and histopathology analyses for 53 of them. In addition, the Workshop evaluated information on possible diseases or toxins on the calving or feeding grounds, measures of maternal condition between years and patterns of mitochondrial genetic differentiation among stranded calves in different years. No single threat or disease process was identified as the cause of the recurrent significant mortality of young right whales at Península Valdés.

The three leading hypotheses identified to explain the spikes in mortality of first-year whales (calves) were as follows: reduced food availability for adult females, biotoxins and infectious disease. It was not possible to determine which of these was most likely, and it was acknowledged that some combination of factors may have been involved in different years. A fourth possible contributing factor, chemical contaminants, was considered less likely, and demographic factors, killer whale attacks, disturbance from whale-watching activities, vessel strikes and fishing gear entanglement were ruled out as significant factors for the high mortalities.

The parasitic behaviour of kelp gulls, which eat the skin and blubber of live whales at Península Valdés, opening large wounds and significantly affecting the behaviour of whales, particular newborn calves, was given considerable attention. The frequency of gull attacks and the proportion of whales with gull-peck lesions (77% in 2008) have increased since first being observed in this population in the 1970s.

In light of the three leading hypotheses, the Workshop recommended the following steps to build a better understanding of the cause or causes.

- Continue and expand efforts to detect and investigate strandings, conduct necropsies and analyse patterns of mortality.
- Continue and expand investigations of environmental factors that may be affecting the whales in the calving/nursery area.
- Continue and expand long-term research on the demography and behaviour of live whales in the Península Valdés region.
- Update the population assessment by Cooke *et al.* (2003).
- Establish a reporting network to alert the research community when whale behaviour is observed that could be related to die-off causation.
- Develop a biopsy programme selectively targeting adult females.
- Make greater efforts to identify the feeding grounds of the Península Valdés right whales (satellite tagging) and investigate environmental factors that could affect their survival and reproduction.

The long-term aerial photo-identification programme, along with the SRWHMP, stood out as top priorities. The 40-year datasets on the population of right whales at Península Valdés should be maintained and data collection should continue. These data and complementary aerial surveys including both the annual photo-id flights (WCI/ICB) and the broader-scale surveys to assess population distribution and trends (CENPAT) and boat-based photo-id efforts are critical for monitoring population trends, describing the significance of the recent die-offs and testing causation hypotheses.

Cooperation and collaboration among research groups is essential for addressing complex questions concerning the die-offs. Efforts to improve such cooperation and collaboration should be a high priority for local and national governments, NGOs and IGOs.

The absence of conclusive information regarding the cause(s) of exceptional right whale mortality should not preclude authorities from proceeding with some management measures, particularly in relation to kelp gulls. Regardless of whether gull lesions are a contributing factor in whale mortality, they cannot be considered as anything other than harmful to the whales, especially the calves.

The considerable efforts of the researchers in Argentina (and abroad) to investigate the die-offs in the face of fiscal and logistical constraints and in view of the sheer numbers of dead whales were acknowledged as was the importance of governmental commitment to the long-term conservation of right whales in Argentina. A western South Atlantic right whale consortium along the lines of the North Atlantic right whale consortium centred in the United States and Canada was suggested as a good way to establish and maintain links among researchers and to share information. It is also important that information be shared among researchers in different parts of the range, e.g. Argentina (including areas outside Península Valdés), Brazil, Uruguay, South Africa, Australia and New Zealand.

The sub-committee thanked Brownell for his presentation. In discussion the issue of the control of gull predation was raised. Even if it could not be identified at this stage as a definite cause of the recent die-offs, the pattern of increasing gull attacks (especially on calves) and the resultant disturbance and physical damage to the whales must be considered an undesirable phenomenon. At the same time it was one of the few identified issues for which mitigation action was possible. The sub-committee therefore welcomed the announced intention of the Argentine authorities to introduce a pilot plan for the control of nuisance gulls this year.

The sub-committee recognised the value of the long-term photo-id programme of right whales at Peninsula Valdes that had now lasted 40 years, particularly in being able to describe the significance of the recent die-off events and test certain causation hypotheses. It **strongly recommended** the continuation of the survey programme. The sub-committee also noted that emergency funding had been needed this year from the US Marine Mammal Commission to enable the necropsy programme to take place and strongly **recommended** the continuation of this programme to investigate the reason(s) for the die-off.

Paper SC/62/BRG15 reported a preliminary assessment of the genetic structure of the southern right whales from Península Valdés, Argentina. Skin biopsies from 219 whales were collected in 2003–06. Two sets of skin samples from dead animals were used. Set A contains 43 samples from 2003–06. Set B contains 155 samples, and includes the above 43 samples plus 112 samples from the period 2007–09. 37 unique haplotypes were discovered in the 374 samples analysed. The overall haplotype and nucleotide diversity were 0.95 (± 0.01) and 1.63% (± 0.82%), respectively. Clade A contains 16 haplotypes and 54% (n = 201) of the total sample, while Clade W has 21 haplotypes and 51% (n = 189) of the total sample. Significant differentiation was found between live vs. dead whales in set A for the period 2003–2006. However, when set B was compared with live whales, no genetic differentiation was found (F_{ST} = 0.001). Significant genetic differentiation among years was recorded when the dead whales from set B were analysed, and this contrasts sharply with the live whales, which show no differentiation among years. The alignment of 35 haplotypes with the 37 haplotypes previously published by Patenaude *et al.* (2007) revealed 45 unique haplotypes of length 275 base pairs for the Southern Hemisphere. The overall haplotype diversity (h) for southern right whales is 0.955 (±0.003) and the overall nucleotide (π) diversity is 2.8% (±1.45%). Significant differentiation was detected among the six subpopulations. Argentina shared haplotypes with all populations. Nucleotide differentiation was significant when compared to other nursery areas but not to the feeding grounds (South Georgia and SW Australia).

The haplotype diversity currently detected at Península Valdés is relatively high and similar to levels previously reported for southern right whales. Nucleotide diversity is lower than previously reported, possibly due to the use of a longer sequence interval, much of which is well conserved. The low diversity in Clade A suggests that maternal lineages historically had a smaller population size or suffered more depletion than Clade W. A possible explanation for the equal frequency of both clades involves the influx of immigrants from areas that are rich in Clade A (South Africa and New Zealand; Patenaude *et al.*, 2007), indicating contemporary gene flow between formerly isolated populations. The among-year differentiation of the stranded animals does not result from just one year being distinct from all the others; instead, most pairwise comparisons present positive values of F_{ST}, and some of these are individually significant. This pattern suggests that at least some portion of the recent (2007–09) increase in calf mortality at Península Valdés has been caused by processes that occurred away from the Peninsula, on feeding grounds where the population shows modest levels of mitochondrial genetic differentiation.

The sub-committee welcomed this report and thanked the authors for their contribution, suggesting that it would be interesting to see the analysis of nuclear markers such as microsatellites on the same material. They were informed that this was under way and that a biopsy programme was planned for next year in an attempt to determine the identity and reproductive history of mothers of calves that had perished in the previous die-off. In reply to a question about how the yearly comparisons were conducted, given the unequal representation of clades over time, Sironi responded that the comparisons were pair-wise among the single year samples, but only where samples of live and dead whales were available. The inclusion of a further 155 previously unprocessed samples might *inter alia* help address the question of unequal sample size distribution between clades.

It was pointed out that the yearly heterogeneity found could have been a sampling artefact because the number of genetic samples, especially in some early years, was much smaller than the actual number of dead animals reported. The authors responded that this paper contained preliminary results and they will update their analyses with larger sample sizes and present the results at next year's meeting.

Three aerial surveys flown off Brazil in 2009 produced the smallest number of whales seen since 2003, 62 whales and 31 calves. Three years previously almost 200 whales had been seen.

The sub-committee agreed to the request to **recommend** the continuation of the surveys.

5.3.3 South Africa area

SC/62/BRG30 presented updated estimates of demographic parameters for southern right whales on the south coast of South Africa, incorporating a further three years data. Aerial counts of right whale cow-calf pairs recorded between 1971 and 2006 indicate an annual instantaneous population increase rate of 0.069 a year (95% CI = 0.064, 0.074). Annual photographic surveys since 1979 have resulted in 1,968 resightings of 954 individual cows with calves. Observed calving intervals ranged from 2 to 23 years, with a principal mode at 3 years and secondary modes at 6 and 9 years, but these made no allowance for missed calvings. Using the model of Payne *et al*. (1990), a maximum calving interval of 5 years produces the most appropriate fit to the data, giving a mean calving interval of 3.16 years with a 95% confidence interval of (3.13, 3.19). The same model produces an estimate for adult female survival rate of 0.990 with a 95% confidence interval of (0.985, 0.996). The Payne *et al*. (1990) model is extended to incorporate information on the observed ages of first reproduction of grey-blazed calves, which are known to be female. This allows the estimation of first parturition (median 7.74 years with 95% confidence interval (7.15, 8.33)). First year survival rate was estimated as 0.713 (0.529, 0.896) and the instantaneous population increase rate as 0.070 (0.065, 0.075). The current (2006) population is estimated as some 4,100 animals, or about 20% of initial population size: the latter parameter needs re-consideration.

A question was raised concerning the justification for the value of 75% for the proportion of females in the catch as used by Richards and Du Pasquier (1989) in estimating original population size. It was believed that this was based on assumptions regarding the composition of the 19th century catch, and it was possible that an improved estimate might be obtained from current biopsy sampling in coastal waters. It was also queried whether the issue of over-dispersion had been considered but Brandão replied that this had not yet been done.

SC/62/BRG31 examined the possibility of changes in some demographic parameters for right whales off South Africa through the analysis of re-sighting data for females with calves over the 1979–2006 period. No statistically significant change in either adult survival rate or population growth rate was detected. However the mean calving interval shows a decrease from 3.2 to 3.1 years somewhere between 1985 and 1990.

It was commented that it would be useful to show the likelihood profile for the years over which change occurs, and that it might be informative to try increasing the opportunities for change from one to two or three over the time series.

SC/62/BRG33 reported on the recent announcement of the intention to drill exploratory boreholes for natural gas in eight districts of the coastal region of the southwest coast of South Africa, three of which included nearshore waters that were home to the largest concentration of cow-calf pairs on the African coastline. About 75% of cow-calf pairs on the southern African coast occur in this region in spring, some of which are resident for up to three months, while the westward coastal movement seasonally means that an even larger proportion of the population almost certainly uses the region.

An enquiry was raised regarding the possible presence of oil with the gas reserves but there was insufficient information available to provide a definitive answer.

The sub-committee viewed this potential development with concern, noting the current lack of information available on the proposed activities. It **recommended** to the South African government that all permits issued for exploratory activities should contain mandatory mitigation measures to avoid disturbance to right whales, including confining all marine drilling activity to the season when right whales were absent (January to May). It also **recommended** that if gas production was ultimately planned for the region that the use of closed areas or the development of further mitigation measures such as directional drilling should be considered.

A proposal was put to the sub-committee for the establishment of a Southern Ocean Right Whale Photo-identification Catalogue, in which images of right whales taken in pelagic waters away from the southern continents, including the Antarctic, would be compiled and made available as in the Antarctic Humpback Whale Fluke catalogue (see Appendix 2). The intention was to provide a resource that could be consulted when researchers holding images taken in coastal waters wished to establish linkages with feeding grounds in pelagic waters. It was confirmed in discussion that this would be supplementary to such coastal catalogues. The sub-committee welcomed this proposal and **recommended** that it should be forwarded for consideration for funding. If funded, the sub-committee looked forward to receiving a progress report at its next meeting.

5.3.4 Plans to review Southern right whales

Brownell reported on progress in preparing for the Southern Right Whale Assessment Meeting. It was now planned to be held at Puerto Madryn, Argentina, in September 2011, and Bannister had agreed to act as Chair. Given that this meeting would be held very shortly after next year's IWC meeting, a budget would have to be prepared at this meeting (and reserved until 2011). A small group was set up under Brownell to draw up the budget (including provision for an appropriate selection of Invited Participants) and draft the Terms of Reference for the review meeting. Their report is included as Appendix 3.

In conclusion the chairman suggested and the sub-committee agreed that only important or urgent papers on southern right whales (such as reports on the reasons for the Argentine die-off) would be considered at next year's meeting, and all other right whale papers would be referred to the subsequent Southern Right Whale Review meeting for consideration.

6. WESTERN NORTH PACIFIC GRAY WHALES

6.1 New scientific information

Previous studies have documented genetic differentiation between eastern and western gray whale populations on the basis of mtDNA haplotype frequencies and nucleotide diversities (LeDuc *et al.*, 2002). In SC/62/BRG11, data generated using a panel of 13 microsatellite loci were combined with updated information from mtDNA control region sequences to further assess the population structure of gray whales in the North Pacific. Analyses were based on 136 samples collected from whales in the eastern Pacific and 142 samples collected from whales biopsied in the western Pacific while on the primary feeding ground off Sakhalin Island, Russia. Measures of nuclear genetic diversity were similar between the two populations (mean $H_e = 0.74$, eastern population; mean $H_e = 0.70$, western population). In contrast, mtDNA haplotype diversity was reduced in the western population ($h = 0.77$) when compared to the east ($h = 0.95$), although the western population has retained a relatively large number of mtDNA haplotypes ($n = 22$) given its small size.

Measures of genetic differentiation supported recognition of eastern and western populations as distinct, with highly significant differences observed in both mtDNA haplotype ($F_{ST} = 0.068$, $p \leq 0.001$) and microsatellite allele ($F_{ST} = 0.009$, $p \leq 0.001$) frequencies. The level of nuclear divergence between the two populations was relatively low, and results of sex-specific comparisons suggested that some limited degree of male-biased dispersal may be occurring between populations. Such dispersal could be mediated by gene flow, although the maintenance of significant genetic differences between the two populations suggests that any genetic exchange would likely be limited. Alternatively, the low level of differentiation could be generated by mixing of eastern and western animals while on feeding grounds without genetic exchange. Although the analyses utilised in this paper were not able to discriminate between these two possible explanations, increasing our understanding of the extent and nature of any dispersal between populations is important as each scenario could have different effects on the recovery of the western population.

Some concern was raised about the origin of the samples from eastern gray whales because of the genetic differences that have been found within the population. The samples from eastern gray whales were from stranded animals along the Pacific coast of the US and ~20 samples from feeding grounds. Some sub-committee members asked about possible gene flow between the east and west. Lang responded that there may be some gene flow but that observed genetic differentiation is supportive of two populations. Another question was asked about whether an admixture model, where $K = 3$, had been fit to the data. Lang replied that when an admixture model was tested with $K = 3$, most of the eastern population samples grouped together while the western population samples were separated into two groups, one of which was largely comprised of animals sampled in the west but which showed similarity to the east. However, under this model, the most likely number of clusters contained in the dataset was two.

SC/62/BRG10 presented the results of a paternity analysis conducted on the western gray whale population, utilising samples collected from 57 mother-calf pairs and 42 sampled males considered to be candidate fathers. Using data generated from 13 microsatellite loci, likelihood-based analysis of paternity identified putative fathers of 46% (n = 26) to 53% (n = 30) of calves. Eighteen males were assigned as putative fathers; the majority (56%) of those males was assigned paternity of only one calf during the 12 seasons of the study. Analysis of relatedness patterns among calves for which no putative father was identified indicated that the best estimate of the number of males needed to account for the unassigned paternities was 15.

Given that genetic samples have been collected from 83% of all gray whales photographically identified on the primary Sakhalin feeding ground, the number of calves which were assigned to putative fathers was lower than expected. These results suggest that some males which are contributing to reproduction in the western population may not utilize the primary Sakhalin feeding ground on a regular basis and highlight the need to collect genetic samples from animals recorded in other areas of the western gray whale's range. Although the relatively high proportion of calves which could not be assigned to putative fathers raises questions about the location of summer feeding areas for some males, these results provide evidence of interbreeding among animals that show fidelity to the Sakhalin feeding ground. Breeding presumably occurs while these animals are on shared migratory routes.

The Chair asked whether paternity tests had included eastern gray whales. Eastern whales had been included but no paternities were assigned to the eastern population; however, only a low proportion of eastern animals have been sampled.

SC/62/BRG5 presents the first results of genetic data obtained from the gray whales migrating along the Japanese coast to or from the breeding ground of the western population. The study examined mitochondrial DNA from gray whales from Japan (n = 6) and Russia (n = 7) to better understand the genetic characteristics of these whales at the wider geographic area. The gray whales from Japan were those either stranded or bycaught in set net from 1995 to 2007, and the Russian gray whales were those legally caught during the Chukotka aboriginal subsistence hunt in 2008. All of the mtDNA haplotypes found in the Japanese (five) and Russian (six) samples matched to some of the previously reported haplotypes. The level of genetic diversity of these samples, that is haplotype and nucleotide diversity, were surprisingly high, suggesting either gene flow between the western and eastern populations or retention of ancient polymorphisms without gene flow. No statistically significant difference in haplotype frequencies was detected between the Japanese and Russian samples possibly due to the small sample sizes. The phylogenetic analysis of the mtDNA haplotypes found in this study and the past studies detected no distinct cluster for the Japanese whales, supporting the past observation that the western and eastern gray whales were indistinguishable at the evolutionary time scale.

The sub-committee thanked the authors for providing genetic information on western gray whales during migration. These are the first samples from Japan. Other available samples are from feeding grounds, thus having samples from migratory routes will provide a valuable comparison. Some questions were asked about whether the whales sampled in Japan could have been eastern gray whales. It was unlikely because the whales were migrating south along the Japan coast. Furthermore, Brownell mentioned there was a photo match from Sakhalin with a whale from Japan.

The sub-committee **encouraged** the collection of more samples along the migration route when they are available and **recommended** a more detailed analysis of samples currently available. One suggestion was that a longer sequence was needed for the mtDNA. Another option might be to examine other markers such as microsatellites or protein coding genes. Using additional markers will be especially helpful because of the small sample size. Using additional markers will increase the possibility of detecting differences if they exist.

Larsen noted that a large proportion of the western population had been sampled and asked whether a family tree analysis had occurred. Lang responded that this approach was occurring but with the current limited number of microsatellite markers a comprehensive family tree analysis would be difficult. Additional markers will be helpful.

The review of cetacean sightings off western Kamchatka summarised in SC/62/BRG5 included six western gray whale sightings. The sightings indicated that these whales occur in the region as early as July and as late as November. This information highlights the potential for western gray whales to reoccupy parts of their former range if the currently small population expands. Given the precarious status of the western gray whale population, there is a need for directed research and monitoring of these whales relative to anthropogenic activities off western Kamchatka.

In SC/62/BRG4, data from systematic shore- and vessel-based distribution surveys conducted offshore northeast Sakhalin in the summer-to-fall seasons of 2004–09 indicated the presence of two primary gray whale feeding areas. The first, nearshore Piltun feeding area is located adjacent to Piltun Bay and extends from Ekhabi Bay in the north to Chayvo Bay in the south over a coastline stretch of about 120km length. Whales predominantly feed in this area at a distance <5 km from shore and in water depths <20m. The second, deeper offshore feeding area is located at a distance of about 35–50km from shore to the southeast of Chayvo Bay. The water depth in this area is about 35–60m.

The observations show significant variation in whale densities among years within the Piltun and offshore feeding areas. Whale densities in the Piltun area began to decrease in 2006, with lowest densities observed in 2008. This decrease reversed in 2009, when the maximum number of whales in this area seen during one survey day was 55% higher than in 2008 and comparable to 2007 levels. Increased use of the offshore feeding area was observed from 2005–2008, with the highest number of whales (since 2001) recorded in 2008. In 2009, the maximum number of whales observed on one survey day in the offshore feeding area decreased compared to 2008. This partly may be explained by the low number of offshore area surveys that were carried out in 2009 due to bad weather conditions, as well as by the fact that considerable numbers of whales were observed to the northeast of the offshore area transect lines outside the survey grid. In general, results from the 2009 distribution surveys, combined with results from 2009 photo-id surveys, indicate that the western gray whale population is stable.

Table 1 of SC/62/BRG4 presented maximum counts for each year. Some questions were raised about how those data were collected and whether time of year was accounted for. Vladimirov noted that the numbers in Table 1 were simply the highest count observed in a season, irrespective of timing. Gray whales are usually in Sakhalin in the highest numbers in September but there is some interannual variation. It was also noted that the number of whales near Piltun appeared to have decreased markedly from 2004 to 2009, with the suggestion that distribution may have shifted offshore or to another area. Vladimirov suggested that the sighting data and photo-identification data suggested that gray whales were stable in the entire Sakhalin area although there may be different dynamics occurring in the Piltun and offshore feeding areas.

SC/62/BRG9 described photo-identification studies of gray whales, which have been performed annually in the Piltun and Offshore feeding areas off northeast Sakhalin during the period 2002–09 as part of an industry sponsored monitoring programme. The intensity of use of the Piltun and Offshore feeding areas by gray whales varied from year to year. The 2002–09 catalogue of photo-identified western gray whales offshore Sakhalin Island currently includes 177 fully identified whales. The catalogue of gray whales photo-identified off southeast Kamchatka currently contains 116 fully identified whales. Sixty one of the Kamchatka whales also were seen on the Sakhalin shelf during various years, and are most likely Western gray whales. The population affiliation of the remaining 55 whales is still unclear. Out of the 117 whales identified on the northeast Sakhalin shelf in 2009, 12 gray whales were new to the Sakhalin catalogue, including four adults and eight calves.

From May 30 to June 14 of 2009, a total of eleven whales were identified off the Kamchatka Peninsula in Vestnik Bay; all of them had been registered in previous years in the Sakhalin catalogue. From 11 July to September 2009, 64 whales were observed in Olga Bay, Kamchatka of which 28 whales were registered in the Sakhalin catalogue. Since 2006, the number of identified whales in Olga Bay has grown every year. The observation season was longest and started earliest in 2009, when the largest number of whales was recorded. Since the start of the surveys in Olga Bay in 2006, researchers have identified some whales that had been registered as calves in Piltun area in the previous year. Three of the five calves identified in the Sakhalin shelf in 2008 were recorded in Olga Bay in 2009. In 2009, 138 of the 177 western gray whales from the Sakhalin catalogue were observed at both Sakhalin and/or Kamchatka combined. Eighteen whales were seen in both locations in the same season. In 2008, a mother-calf pair was registered in Olga Bay (Kamchatka) for the first time. The earlier start of the survey season in Olga Bay in 2009 compared to previous years allowed more comprehensive data to be collected about mother-calf pairs; seven pairs were identified here in 2009. Four of the mothers had been observed on the Sakhalin shelf in previous years. Two of the calves were observed later in the Piltun area. In addition, five mother-calf pairs and one calf without mother were identified only in the Piltun area. Thus, a total of ten calves with mothers in the Sakhalin catalogue were recorded in 2009. These results indicate that the Piltun area offshore Sakhalin is not the only feeding area for mother-calf pairs of the western gray whale population.

The sub-committee welcomed the new information and was especially interested in the movement of animals between Sakhalin and Kamchatka. A question was raised about whether more animals are now using the Kamchatka area because of disturbance from noise or interannual changes to prey at the Piltun feeding area. The authors did not feel that such conclusions can be drawn since the programme is not designed to compare the Kamchatka and Sakhalin feeding areas. Photo-identification surveys are again planned for 2010. Photo-identification data could provide useful information about calving interval. Some of that information has been presented to the sub-committee in the past. Movement of whales between the Sakhalin and Kamchatka areas complicates the ability to accurately determine calving rate unless studies are occurring in both areas.

Photo-identification data have been used to assess the population size of western gray whales. The most recent population assessment, using a Bayesian individually-based stage-structured model, resulted in a median 1+ (non-calf) estimate of 130 (90% Bayesian CI = 120–142; see Cooke *et al.*, 2008). The collaborative Russia-US research program on western gray whales summering off northeastern Sakhalin Island, Russia, has been ongoing since 1995 and has produced important data that has be used to determine the conservation status of this critically endangered population. SC/62/BRG6 reviews findings from 2009 research activities and combines such with data from previous years, in some cases ranging back to an opportunistic survey in 1994. Photo-identification research conducted off Sakhalin Island in 2009 resulted in the identification of 82 whales, including seven calves. This is a different effort than the photo-identification project described in SC/62/BRG9. One previously unidentified non-calf was observed. When combined with data from 1994–2008, a catalogue of 180 photo-identified individuals has been compiled. Not all of these 180 whales can be assumed to be alive, however. One new reproductive female was recorded in 2009, resulting in a minimum of 26 reproductive females being observed since 1995. In addition to a number of biological difficulties that western gray whales are facing, the large-scale offshore oil and gas development programmes near their summer feeding ground, as well as fatal net entrapments during migration, pose significant threats to the future survival of the population.

Some discussion was held about the high resighting rate of photographed whales but that the paternity tests (SC/62/BRG10) revealed only a limited number of fathers. Some of the males contributing to reproduction in the western gray whale population may not use the Sakhalin feeding ground on a regular basis, and some of the whales which demonstrate fidelity to the Sakhalin feeding ground may be migrants. Scordino asked about the high resighting rate (95%) in Sakhalin compared to a lower resighting rate of only 70% in the Pacific Northeast feeding area of eastern gray whales. This result may be due to the small size of the feeding area near Sakhalin.

Japan re-emphasised their comments from the 2009 report. The sub-committee recognised that net entrapment of western gray whales is a range-wide issue and that coastal net-fisheries outside of Japan must also be considered as potential sources of mortality, and was informed poaching was difficult to hide in Japan given the coverage of the mass media. The Government of Japan will continue to make every practicable effort to reduce anthropogenic mortality of the population of western gray whales. The sub-committee was **encouraged** by the efforts of Japan to reduce mortality, but noted that net entrapments could occur in other range states.

Brownell summarised plans for seismic surveys off Sakhalin Island in 2010. There is concern that anthropogenic sound, especially from seismic surveys, will negatively affect western gray whales in their primary feeding area. Previously, the Commission expressed concern and passed resolutions on this topic. Two seismic surveys in or near the feeding area are planned for 2010. One will start soon (i.e. June 2010) and the other is planned for July or August and September. It was noted at the recent meeting of the IUCN Western Gray Whale Advisory Panel that the company (Rosneft) planning the later survey has not followed the same procedures in regard to monitoring and mitigation as the company planning the first survey (Sakhalin Energy). As currently planned, the Rosneft survey will occur while the highest number of feeding gray whales, including cow and calves, are present. The sub-committee is **extremely concerned** about the potential impact on western gray whales and **strongly recommended** that Rosneft postpone their survey until at least June 2011. The sub-committee also **recommended** that Rosneft use monitoring and mitigation measures similar to those used by Sakhalin Energy, which have been independently reviewed by experts, and that all energy companies operating in the feeding areas of western gray whales should use comprehensive monitoring and mitigation measures to protect western gray whales.

SC/62/BRG2 compares observations of age at first reproduction (AFR) in western North Pacific gray whales to estimates of age at sexual maturity (ASM) in eastern North Pacific gray whales. AFR is a basic component of age-structured whale assessment models, but direct estimates of this parameter do not exist for either the abundant eastern or critically endangered western population of gray whales. Instead, assessments of both populations have utilised either of two recognised estimates of eastern gray whale age at sexual maturity (ASM) that are adjusted by a year to account for foetal gestation. These ASM estimates are: (1) 9 years median, 6–12 years range, and (2) 6 years median, 5–9 years range, but there are biases and discrepancies associated with these estimates. Over a decade of individual monitoring of western gray whales on their primary feeding ground off the northeastern coast of Sakhalin Island, Russia, has identified 17 female whales first sighted as calves or yearlings that were potentially sexually mature by the 2009 field season, ranging in age from 5 to 11 years. However, only two of these whales have been observed to have produced a calf, establishing the first observed values of western gray whale AFR as seven and 11 years. While limiting, that only two AFR observations were made is also informative, suggesting that until more information is available, the first eastern gray whale ASM estimate is the more appropriate to use in western gray whale assessments. Overall, eastern and western gray whale assessments would benefit from a concerted effort to collect AFR observations from each population. The data have been used to inform the recent population assessment by Cooke *et al.* (2008) and also taken into consideration in the recent eastern gray whale assessment by Punt and Wade (SC/62/AWMP2).

SC/62/O7 reported that there was no stranding, entrapment or entanglement of gray whales in Japan during the period from May 2009 to April 2010. It also noted there had not been an entrapped or entangled animal in Japan since January 2007. One juvenile gray whale was seen opportunistically in the coastal waters of Mie Prefecture, and the information on the sighting had been shared among concerned parties including national and regional governments in a timely manner in order to be prepared for possible entrapment/entanglement. Related to skeletal measurement of two gray whales entangled in the coastal waters of Miyagi Prefecture in June 2005, Japan expressed its interest in conducting a study on phrenological comparison between western and eastern stocks of North Pacific gray whale using those skeletons in collaboration with other member countries. Japan also reported that the Fisheries Agency, Ministry of Agriculture, Forestry and Fisheries, had created an educational leaflet in electronic format and had distributed it to governments of all coastal prefectures to draw fishermen's attention to the issue of western North Pacific gray whales. Japan expressed its intention to continue educational activities and other practicable measures on this issue in the future.

The sub-committee welcomed the information and was especially **encouraged** to learn about the educational efforts to inform fishers about the need to protect western gray whales.

Donovan reported on progress with the telemetry programme on western gray whales that has been recommended by the Committee (IWC, 2010). He reported that the programme is progressing and that all involved are grateful to Ilyashenko and his colleagues at IPEE for their work to try to ensure that this project happens, particularly at this stage with respect to the permit issue. An overall administrative and scientific structure has been agreed between the participating institutions and companies, the IWC and IUCN. The scientific steering group is continuing to work on finalising the protocols that will ensure that the IWC Scientific Committee safeguards and guidelines are met as it has been tasked by the Committee; the final protocols will be drawn up in co-operation with IPEE and OSU. [Paper SC/62/BRG7 had been withdrawn because e-mail communication problems meant that it was not possible to finish consultations with our Russian colleagues]. IWC, IUCN and the funding companies are also working hard on very difficult budgetary issues. This is a very expensive undertaking but it is hoped that it will be possible for the programme to take place this summer.

6.2 Conservation advice

As it had done last year, the sub-committee **acknowledged** the important work of the IUCN WGWAP and welcomed this year's update on the panel's activities (Appendix 4). Noting that the WGWAP's present contractual five year life span ends after December 2011, the sub-committee re-emphasised its view that the panel's work is important and should be continued if at all possible.

In 2009, the sub-committee welcomed the report of the IUCN range wide workshop. An important aspect of the results from that workshop was the object of developing a conservation plan for western gray whales. Therefore the sub-committee also enthused to receive a report on the draft Conservation Plan for Western North Pacific Gray Whales (SC/62/BRG24) and **commended** the authors for this important document.

The overall goal of the Western Gray Whale Conservation Plan is to manage human activities that affect western gray whales and maximise the population's chances for recovery, based on the best scientific knowledge.

The conservation plan includes eight sections, of which the first three provide background information including biology and status of the western gray whale population. Section 4 reviews actual and potential anthropogenic threats and ranks these as low, moderate or high priority. Section 5 describes mitigation measures for those threats that have been accorded moderate or high priority. These include:

- entrapment in set nets
- entanglement in other types of fishing gear
- vessel strikes
- noise in feeding areas
- direct effects of oil spills

Section 6, dealing with public awareness and education, concludes that providing range state individuals, groups, organisations, governments and societies with access to information and knowledge about the status of western gray whales is essential for meeting the conservation objectives detailed in the conservation plan.

Section 7 outlines the actions called for and includes sub-sections on monitoring, on implementation and coordination of the conservation plan, and on involvement of stakeholders. In order to be effective, the conservation plan must have a recognised, full-time Co-ordinator who is responsible for *inter alia* actively involving stakeholders, especially those whose livelihoods may be affected (e.g. fishermen). The Co-ordinator should report to a Steering Committee closely linked to appropriate authorities. The Conservation Plan will be useless without sufficient implementation funding. At the very least, sufficient funds must be made available to support the appointment and functioning of a Co-ordinator and Steering Group.

Section 8 describes in detail the high priority actions identified at this stage (see table below). They fall under the following five headings: Co-ordination, Capacity building and public awareness, Research essential for providing adequate management advice, Monitoring, and Mitigation measures. Descriptions of the high priority actions follow a common format, which consists of description of action (specific objective, rationale, target, timeline), actors (responsible for co-ordination of the action, stakeholders), action evaluation and priority (importance, feasibility).

CORD-01	Implementation of the Conservation Plan: Co-ordinator and Steering Committee.
CORD-02	Development of a web-based exchange of scientific information.
PACB-01	Development of a strategy to increase public awareness and build capacity in range states.
RES-01	Determine movements, migration routes and location of wintering ground(s) through satellite telemetry.
RES-02	Development of a GIS database on locations of set nets (both small-type and large-type) in the range of western gray whales.
RES-03	Development of a GIS database on locations of gill nets and pot/trap gear (e.g. for crabs) in the range of western gray whales.
RES-04	Identifying areas where western gray whales have a high risk of being exposed to oil spills.
MON-01	Ensure long-term monitoring of abundance and trends off Sakhalin Island through photo-identification and biopsy sampling.
MON-02	Ensure long-term monitoring of distribution, abundance and trends off southeastern Kamchatka.
MIT-01	Release of entrapped gray whales in set nets.
MIT-02	Prevention of entrapment of gray whales in set nets.

The most critical and urgent action is the implementation of the Western Gray Whale Conservation Plan (CORD-01). Funding must be found for this action at the earliest opportunity to appoint a Co-ordinator and set up the Steering Group to ensure that the Conservation Plan moves ahead in a timely fashion.

The sub-committee **recommended** that the conservation plan be broadly distributed, posted on the IWC and IUCN websites, and possibly published in the *JCRM*. This plan could provide a model for the development of other conservation plans for other populations.

6.3 Other information

Castellote described recent sightings of a gray whale in the Mediterranean Sea. It is not clear which population this whale originated from. It was first observed on 8 May 2010 off Israel (eastern Mediterranean Sea) near Herzliya Marina by Aviad Scheinin from IMMRAC (Israeli Marine Mammal Research and Assistance Center), and a second sighting occurred on 30 May 2010 in Spanish waters (Western Mediterranean Sea), in front of Barcelona harbour by Rodrigo Barahona from SUBMON (Conservación, Estudio y Divulgación del Medio Marino). Pictures of its tail fluke from both sightings did match confirming that this whale travelled more than 3,000km in 23 days (average speed of 5.4km/h for a straight line between sightings). This is the first time that a gray whale was sighted in the western basin of the Mediterranean Sea and just the second time that it is reported in the whole basin. Taking into account the relevance of this sighting, a coordinated effort was organised in Spain to re-sight the whale in an attempt to assess his health condition, reduce collision risks with vessels and obtain a biopsy sample to determine its population identity, but to date (as of 6 June 2010) the whale has not been re-sighted.

7. WORK PLAN

The following work plan was proposed for the coming year.

(1) Perform the annual review of catch information and new scientific information for B-C-B stock of bowhead whales and prepare for the 2012 *Implementation Review*.
(2) Review the stock structure and abundance in a more comprehensive manner for eastern Canada and West Greenland bowhead whales.
(3) Review scientific information on north Pacific and north Atlantic right whales. Only important or urgent matters

such as reports on the reasons for the Argentine die-off will be reviewed for Southern right whales (most papers will be referred to the subsequent Southern Right Whale Assessment Workshop).

(4) Review any new information on western gray and other stocks of bowhead whales.

(5) Review new information on eastern gray whale (not relevant to the *Implementation Review*)

8. ADOPTION OF REPORT

The report was adopted on 7 June 2010 at 18:40. The sub-committee thanked the Chair, noting that he had done an excellent job as a first time Chair for the sub-committee. The Chair expressed his thanks to the sub-committee members for their cooperation and to the rapporteurs for their hard work and diligence.

REFERENCES

Best, P.B., Reeb, D., Rew, M.B., Palsbøll, P., Schaeff, C. and Brandao, A. 2005. Biopsying southern right whales, their reactions and effects on reproduction. *J. Wild. Mgmt.* 69(3): 1171–80.

Cooke, J., Rowntree, V. and Payne, R. 2003. Analysis of inter-annual variation in reproductive success of South Atlantic right whales (*Eubalaena australis*) from photo-identification of calving females observed off Peninsula Valdes, Argentina, during 1971–2000. Paper SC/55/O23 presented to the IWC Scientific Committee, May 2003, Berlin (unpublished). 16pp. [Paper available from the Office of this Journal].

Cooke, J.G., Weller, D.W., Bradford, A.L., Burdin, A.M. and Brownell, R.L. 2008. Population assessment of western gray whales in 2008. Paper SC/60/BRG11 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 10pp. [Paper available from the Office of this Journal].

George, J.C. and Suydam, R. 2009. Preliminary report of the Spring 2009 ice-based bowhead whale census activities near Barrow, Alaska. Paper SC/61/BRG23 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 6pp. [Paper available from the Office of this Journal].

Higdon, J.W. 2010. Commercial and subsistence harvest of bowhead whales *Balaena mysticetus* in eastern Canada and West Greenland. *J. Cetacean Res. Manage.* 11(2): 185–216.

International Whaling Commission. 2010. Report of the Scientific Committee. Annex F. Report of the Sub-Committee on Bowhead, Right and Gray Whales. *J. Cetacean Res. Manage (Suppl.)* 11(2):154–79.

Koski, W.R., George, J.C. and Zeh, J.E. 2008. A calf index for monitoring reproductive success in the Bering-Chukchi-Beaufort Seas bowhead whale (*Balaena mysticetus*) population. *J. Cetacean Res. Manage.* 10(2): 99–106.

Koski, W.R., Mocklin, J., Davis, A.R., Zeh, J., Rugh, D.J., George, J.C. and Suydam, R. 2010. Abundance of Bering-Chukchi-Beaufort bowhead whales (*Balaena mysticetus*) in 2004 estimated from photo-identification data. *J. Cetacean Res. Manage.* 11(2): 89–99.

LeDuc, R.G., Weller, D.W., Hyde, J., Burdin, A.M., Rosel, P.E., Brownell, R.L., Jr., Würsig, B. and Dizon, A.E. 2002. Genetic differences between western and eastern North Pacific gray whales (*Eschrichtius robustus*). *J. Cetacean Res. Manage.*4(1): 1–5.

Patenaude, N., Portway, V., Schaeff, C., Bannister, J.L., Best, P.B., Payne, R.S., Rowntree, V., Rivarola, M. and Baker, C.S. 2007. Mitochondrial DNA diversity and population structure among southern right whales (*Eubalaena australis*). *J. Heredity* 98(2): 147–57.

Payne, R., Rowntree, V., Perkins, J.S., Cooke, J.G. and Lankester, K. 1990. Population size, trends and reproductive parameters of right whales (*Eubalaena australis*) off Peninsula Valdes, Argentina. *Rep.int.Whal.Commn (special issue)* 12: 271–78.

Pettis, H. 2009a. North Atlantic Right Whale Consortium 2009 Annual Report Card Addendum. Report to the North Atlantic North Whale Consortium, November 2009. 4pp.

Pettis, H. 2009b. North Atlantic right whale consortium annual report card (01 November 2007 – 30 April 2009). Paper SC/61/BRG11 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 7pp. [Paper available from the Office of this Journal].

Richards, R. and du Pasquier, T. 1989. Bay whaling off southern Africa, c. 1785–1805. *S.Afr. J. Mar. Sci.* 8: 231–50.

Schweder, T., Sadykova, D., Rugh, D.J. and Koski, W.R. 2010. Population estimates from aerial photographic surveys of naturally and variably marked bowhead whales. *J. Agr. Biol. Environ. Statistics* 15(1): 1–19.

Wade, P.R., Kennedy, A., LeDuc, R.G., Barlow, J., Carretta, J., Shelden, K., Perryman, W.L., Pitman, R., Robertson, K.M., Rone, B., Salinas, J.C., Zerbini, A.N., Brownell Jr, R.L. and Clapham, P.J. 2010. The world's smallest whale population? *Biology Letters* [In review]. 6pp.

Appendix 1

AGENDA

1. Opening remarks
    - 1.1 Election of Chair
    - 1.2 Appointment of rapporteurs
2. Adoption of agenda
3. Review of available documents
4. Bowhead whales
    - 4.1 Bering-Chukchi-Beaufort (B-C-B) Seas stock of bowhead whales
        - 4.1.1 New scientific information
        - 4.1.2 Catch information
        - 4.1.3 Management advice
    - 4.2. Eastern Arctic bowhead whales
        - 4.2.1 Stock structure
        - 4.2.2 Other new scientific information
        - 4.2.3 Catch information
        - 4.2.4 Management advice
    - 4.3 Other stock of bowhead whales
5. Right whales
    - 5.1 North Atlantic right whales
    - 5.2 North Pacific right whales
    - 5.3 Southern right whales
        - 5.3.1 Australian and New Zealand areas
        - 5.3.2 South America area
        - 5.3.3 South Africa area
        - 5.3.4 Plans to review Southern right whales
6. Western North Pacific gray whales
    - 6.1 New scientific information
    - 6.2 Conservation advice
    - 6.3 Other information
7. Work plan
8. Adoption of Report

Appendix 2

PROPOSAL FOR SOUTHERN OCEAN RIGHT WHALE PHOTO-IDENTIFICATION CATALOGUE

Brief description of project and why it is necessary to your sub-committee

For several decades extensive photo-id surveys have been carried out for southern right whales in the coastal waters of South America, southern Africa and Australia during winter and spring, and much valuable data on the demographics of these populations collected. Together with genetic information these data also provide the opportunity to investigate interchange and mixing between the coastal populations, but because of their geographic limitations are uninformative about the links between these populations and those found (generally at higher latitudes) in summer where extensive catches were taken in pelagic whaling, particularly in the 19th century.

This proposal seeks to address this gap by compiling images of southern right whales taken away from coastal waters of the continents, and principally south of 40°S, in a catalogue and associated database. Potential holders of images are believed to include the IWC (IDCR/SOWER), ICR (JARPA), BAS and other National Antarctic Research Programmes. Because most if not all images will be boat-based, the catalogue will be constructed so that it can be searched using any available feature (left side head, right side head, front/top of head, pigmentation/scarring, etc.) in a programme such as Big Fish. Images will all be scored for: (a) quality; and (b) distinctiveness.

Access to the images is proposed to be open to any interested researcher, but to protect intellectual property rights, access to the associated database will depend on what conditions the provider of the images has set. The holders of the Antarctic humpback whale catalogue will be consulted to implement a similar system as for their catalogue.

Compilation will be undertaken by Ingrid Peters at the MRI Whale Unit, University of Pretoria, who has experience in constructing such boat-based catalogues and databases as part of her ongoing PhD on the St. Helena Bay right whale feeding ground. Funds are sought for 6 months' work to enable her to undertake the initial sourcing, compilation and sorting of images.

Timetable

Jan.–Jun. 2011: Sourcing, compilation and sorting of available images. Production of progress report at 2011 Scientific Committee meeting.

Researchers' name

Dr Peter B. Best, MRI Whale Unit, c/o Iziko South African Museum, Box 61, Cape Town 8000, South Africa.

Estimated total cost with breakdown as needed (e.g. salary, equipment)

Salary for Ingrid Peters, MRI Whale Unit, University of Pretoria:

6 months @ R7,000 a month = R42,000 – 3,800 pounds.

Appendix 3

PROPOSAL FOR SOUTHERN RIGHT WHALE ASSESSMENT WORKSHOP

The last Scientific Committee assessment of southern right whales (SRW) was held in 1998 in Cape Town, South Africa and these results were published as an IWC Special Issue in 2001. At the 2008 Scientific Committee meeting, an intersessional correspondence group was established to develop plans on an updated assessment of southern right whales. Some members of the group met at the March 2009 SORP meeting in Sydney, Australia and again at the 2009 Scientific Committee meeting and most recently at the 2010 Scientific Committee meeting.

Objectives:

(1) the examination of current understanding of distribution and population structure in the Southern Hemisphere;
(2) the examination of current stock size and recent population trends;
(3) update and review threats to SRW populations;
(4) identification of feeding grounds and links with nursery/breeding grounds;
(5) food, feeding and links with productivity/survival;
(6) update on historical catches and estimates of original population size;
(7) future research needs and conservation plans by region; and
(8) review progress on establishment of Southern Ocean Right Whale Photo-Identification Catalogue.

Date: September 2011, 4 days.

Venue: Puerto Madryn, Argentina.

Steering committee: Brownell (convenor), Bannister*, Best*, Childerhouse, Groch*, Kitakado, and Sironi*.

IPs: Scott Baker, Anabela Brandao, Steve Burnell, Emma Carroll, Justin Cooke, Barbara Galletti, Ingrid Peters, Randy Reeves, Howard Rosenbaum, Vicky Rowntree, [Uruguay to be named], Luciano Valenzuela.

Budget: £24,000 [15 people] including steering committee marked with *.

Appendix 4

PROGRESS REPORT ON IUCN WESTERN GRAY WHALE ADVISORY PANEL WORK FROM JUNE 2009 TO JUNE 2010

R. Reeves, D. Weller, F. Larsen, G. Donovan, J. Cooke and R. Brownell, Jr.

The Western Gray Whale Advisory Panel (WGWAP), which is convened by the International Union for Conservation of Nature (IUCN), has held two formal meetings since SC/61. These were WGWAP-7 in Geneva, 11–14 December 2009, and WGWAP-8 in Geneva, 16–18 April 2010. As previously, the work of WGWAP has consisted primarily of: (a) reviewing and commenting on western gray whale field research and monitoring work sponsored by Sakhalin Energy Investment Company (also known as Sakhalin Energy); and (b) carrying out a variety of collaborative tasks with company-sponsored scientists and other outside experts within the context of task forces. Increasingly, in recognition that much oil and gas activity by other companies takes place in the region, the panel also comments on the potential additive and cumulative effects of that activity on western gray whales. Besides the two panel meetings, three task force meetings took place over the last year, all in Geneva immediately preceding the WGWAP meetings. The Photo-identification Task Force met on 8–9 December 2009 and the Seismic Survey Task Force met on 6–8 December 2009 and 13–14 April 2010.

The reports of all WGWAP and task force meetings and most of the documents considered at WGWAP meetings are available on the IUCN Western Gray Whale website (*http://www.iucn.org/wgwap/*); note that the latest WGWAP and Seismic Survey Task Force reports will be posted by the end of June 2010. Also available on this website is the cumulative list of formal recommendations made by WGWAP and its predecessors since 2004. This list includes an indication of implementation status for each recommendation. According to the WGWAP terms of reference, Sakhalin Energy is obliged to respond to relevant WGWAP recommendations by either implementing them or explaining its reasons for not doing so, and the company responses become part of the public record.

As indicated in last year's report to the Scientific Committee (IWC, 2010, p.176), the anomalous situation with regard to whale occurrence off Sakhalin in 2008 (fewer animals than in any previous year of monitoring since 2002) had prompted the WGWAP to recommend that Sakhalin Energy postpone its planned 4-D seismic survey of the Astokh oil and gas field for at least a year, and the company had agreed to do so. In the interim, the Seismic Survey Task Force continued its collaborative work with the company to develop a robust mitigation and monitoring programme for the Astokh 4-D seismic survey if and when this would take place.

According to information provided at WGWAP-7 and WGWAP-8, the numbers and distribution of gray whales off Sakhalin in the 2009 field season were similar to what had been observed in years before 2008. Given that, Sakhalin Energy has proceeded with its plans to conduct the Astokh 4-D survey, to begin as early as possible in June 2010 in the expectation that the survey will be completed before large numbers of whales arrive onto the Piltun feeding area. Although the WGWAP was generally satisfied with Sakhalin Energy's final monitoring and mitigation plan, it expressed extreme concern with another seismic survey, this one by the Russian company Rosneft Shelf – Far East, scheduled to begin soon after the Sakhalin Energy survey and expected to last on the order of two months (i.e. from late July or early August and through much of September 2010). The Rosneft survey will cover Lebedenskoie field, which underlies the northern part of the near-shore feeding area of western gray whales. The area to be surveyed directly overlaps the primary feeding area used by gray whale mothers and calves. Details of Rosneft's monitoring and mitigation plan were not available to the Panel.

The WGWAP sent letters of concern to R. Gizatulin, head of the Russian Inter-departmental Working Group on Western Gray Whale Conservation, in December 2009 and again immediately following its April 2010 meeting. Additionally, in May 2010 the Director-General of IUCN sent a letter to Prime Minister Putin urging the Russian Government to intervene and ensure that the Lebedenskoie seismic survey was postponed at least until a satisfactory monitoring and mitigation programme is in place to minimise the disturbance to whales (see *http://www.iucn.org/wgwap/wgwap/public_statements/* for full text of these and other letters).

Among other items of potential interest to this sub-committee are the following:

- One major aspect of the WGWAP's work has been to encourage and facilitate efforts by Sakhalin Energy to carry out regular beach surveys of north-eastern Sakhalin Island in order to detect and respond to stranded marine mammals. On 5 September 2009, the fresh carcase of a dead gray whale (male, 10.07m) was found near Chaivo Lagoon. From photographic evidence it was determined that this individual had been first documented as a calf off Piltun in 2005 and that it had also been photo-identified off south-eastern Kamchatka in 2008 and again in July 2009. There was no external evidence from which to infer cause of death. A biopsy was taken for genetic analyses.
- As reported previously, the Photo-id Task Force has been assessing the compatibility of the two Sakhalin photo-id catalogues with the ultimate aim of enabling a 'joint' population analysis based on the combined photo-id data sets. The population analysis using both data sets through the 2008 season was completed by Cooke and presented to the WGWAP-8 meeting. The analysis will be posted on the WGWAP website as soon as approval has been received from contributing parties. It will also be sent for external review by experts at St. Andrews University. The results indicate an estimated population size of 120–140 whales (excluding calves) in 2009 and that the population is predicted to increase if there are no additional deaths.
- The WGWAP and its convening body, the IUCN Global Marine Programme, have been working closely with the IWC Head of Science (Greg Donovan),

the donor companies (Sakhalin Energy and Exxon Neftegas Limited) and the lead scientists (Bruce Mate and Amanda Bradford) in support of the western gray whale satellite tagging initiative, for which details are reported elsewhere (see overview in SC/62/BRG7). Summaries of the satellite tagging discussions at panel meetings can be found in the reports on the WGWAP website. This is also an 'action' in the Western Gray Whale Conservation Plan discussed elsewhere (SC/62/BRG24).

The next WGWAP meeting is planned for early December 2010. It should also be noted that the 5-year contract between IUCN and Sakhalin Energy expires at the end of 2011 and it remains to be seen whether and under what terms a similar panel process will continue beyond that time.

REFERENCE

International Whaling Commission. 2010. Report of the Scientific Committee. Annex F. Report of the Sub-Committee on Bowhead, Right and Gray Whales. *J. Cetacean Res. Manage (Suppl.)* 11(2):154–79.

Annex G

Report of the Sub-Committee on In-Depth Assessments

Members: Walløe (Chair), Skaug (Co-chair), An, Baba, Bannister, Best, Brandon, Bravington, Brownell, Burt, Butterworth, Campbell, Charrassin, Childerhouse, Chilvers, Cooke, Elvarsson, Ensor, Fujise, Gales, Gallego, Gedamke, Goodman, Gunnlaugsson, Hakamada, Hammond, Hatanaka, Hedley, Holloway, Hughes, Jaramillo-Legorreta, Jérémie, Kanda, Kasuya, Kitakado, Kelly, Kock, Lauriano, Leaper, Liebschner, Lockyer, Luna, Lyrholm, Matsuoka, Miyashita, Morishita, Muller, Murase, Øien, Okada, Okamura, Palka, Pastene, Punt, Roel, Sekiguchi, Uoya, Uozumi, Williams, Yamakage, Yasokawa, Yoshida, Young.

1. ELECTION OF CHAIR AND CO-CHAIR

Walløe welcomed the participants and was elected Chair. Due to the high workload this year, Skaug was asked to co-chair the sub-committee, being mainly responsible for items related to abundance estimation of Antarctic minke whales.

2. APPOINTMENT OF RAPPORTEURS

Burt, Butterworth, Cooke and Hedley agreed to act as rapporteurs.

3. ADOPTION OF THE AGENDA

The adopted Agenda is given in Appendix 1.

4. DOCUMENTS AVAILABLE

The documents relevant to the work of the sub-committee were SC/62/IA1-15; SC/62/O15-17 and SC/62/Rep3 and Rep6.

5. ANTARCTIC MINKE WHALES

5.1 Abundance

5.1.1 Report from intersessional e-mail working group

Skaug reported on work conducted by the Abundance Estimation Intersessional Working Group. Tasks to be considered by the group were listed in Appendix 3 of Annex G (IWC, 2010), most of which were directed towards elucidating possible causes for the difference in abundance estimates for Antarctic minke whales from the IDCR/SOWER data from the recent OK (Okamura and Kitakado, 2009) and SPLINTR (Bravington and Hedley, 2009) models. In completing most of these tasks, substantial progress had been made towards this in two regards: (i) a reference dataset, which did not require any further processing for the two models to be applied, had been developed for model comparisons; and (ii) Bravington had completed a non-spatial version of the SPLINTR model (see Item 5.1.3). For (i), a number of internal inconsistencies in the 'standardised' dataset were identified, and as noted at last year's meeting, it was essential that when comparing models, the data were identical.

Due to lack of documentation on the reference dataset during the initial discussion, there were some concerns expressed that the reference dataset might not be the most appropriate for abundance estimation. However, since the purpose of this dataset is for valid comparisons between the models, it was **agreed** that this dataset was suitable for this purpose. Model developers were free to use and post-process alternative versions of the data, (such as the standardised data), for their preferred estimates of abundance from the IDCR/SOWER surveys. Because of differences in the way the data are processed by the two models, it was not likely that there would be an agreed 'best' dataset for the analysis.

Bravington indicated what changes had been made to the standard dataset to produce the reference dataset. Changes made were principally minor, but without them direct comparisons of the two models would not have been possible. The main change was to the boundary files defining the strata. In principle, it should be possible to use these boundaries to assign any effort record to a physical stratum. However, the effort and boundary datasets are often inconsistent, and in fact some effort falls outside the strata altogether. In those cases where such an inconsistency occurred, the stratum boundaries were slightly adjusted, so that each effort record fell in into the 'obvious' stratum. It was noted that these stratification changes are not changes to the data *per se*. Therefore they do not influence the spatial-SPLINTR abundance estimates at all, because that method does not use strata. They only affect the comparison between OK and stratified-SPLINTR, because the latter needs consistent strata in order to run at all. The effect of the stratification changes on OK is very small, because the revisions make very little difference to the physical area of the strata and the OK model does not use precise location data relative to stratum boundaries. The sub-committee **agreed** that it would be useful if Bravington prepared a paper intersessionally to formally document the differences between the datasets, and record apparent inconsistencies in the IDCR/SOWER data.

There was some discussion on how or whether to initiate a process to correct inconsistencies in the data stored within DESS. No conclusion was reached.

5.1.2 Results from simulated datasets

SC/62/IA14 provided results from applying the IWC 'standard' method (Branch, 2006), the OK and SPLINTR models to simulated data, focusing on the latter two. In general, both of these models performed quite well, although when bias did occur, it tended to be positive for the OK model and negative for SPLINTR. For the most complex scenarios, in which density, school size and weather gradients interacted (but excluding those for which duplicate sightings were mis-classified), estimates from SPLINTR were slightly less biased than those from the OK model. However, measurement errors caused positive bias in the SPLINTR estimates, but not in the OK estimates. Whilst non-synchronised diving positively biased the OK estimates in the most complex scenarios, its effect on the SPLINTR estimates was not totally clear; although it was not significant in the complex scenarios, it did cause significant negative bias in simpler cases. The reason for this was not known.

In relation to the patterns of surfacing, it was pointed out that there are empirical data from dive time experiments conducted on IDCR/SOWER cruises; these provide information on surfacing intervals and, for schools of size two or more, surfacing synchronicity. Despite efforts to obtain dive time data across a range of school sizes, it should be noted that there are only limited observations from schools of size 1, as singletons proved difficult to follow. A preliminary analysis of these data is in Hedley and Ensor (2006).

The sub-committee expressed its thanks to Palka for co-ordinating this extensive simulation study. It has been extremely valuable in helping to develop and refine the models, and is now enormously helpful in examining the differences between them. None of the scenarios show the level of difference between the OK and SPLINTR estimates as is currently seen in the real data analyses. This suggests either that the magnitudes of factors currently in the simulations do not cover the ranges found in the real data (either singly or in combination), or that there are additional factors not currently in the simulations that are important for modelling the real data.

Palka indicated that she was willing to continue to work on the simulation study, including providing new scenarios if necessary, but these would need to be specified without delay. At this point, suggestions for new scenarios were referred to the Abundance Estimation Intersessional Working Group, to be re-established this year (see the work plan). If the work of that Group identified specific factors that should be examined to elucidate reasons for differences in the estimates, then new scenarios could be helpful.

5.1.3 Comparison of OK and SPLINTR using the reference dataset

As noted above, different post-processing of data for use by the OK and SPLINTR models clouds investigations into the differences between their estimates. The reference set, agreed mutually by the modellers concerned, was established to compare the models on the basis that no such post-processing would be required to run the models, and hence they would use exactly the same data.

Furthermore, it would be difficult to compare the OK and SPLINTR models directly, even using the reference dataset, as it may not be clear whether any differences between the two resulted from differences in the sighting probability components of the models (the cue-based hazard probability model and the trackline conditional independence model), the school size distribution and school size error models, or differences between the stratified Horvitz-Thompson estimation and spatial modelling of school density. As a first step, it was agreed to compare the OK model with the non-spatial version of SPLINTR, using the reference dataset. A chain of comparisons depicting how this approach fits into an overall comparison of the two models as applied to their preferred data is shown in Fig. 1.

For the OK model, the preferred dataset for analysis includes some records that have been removed in the reference dataset, e.g. because of missing covariates. For the SPLINTR model, the preferred dataset slightly increases the transect effort in a way that is intended to accommodate areas searched (and sightings made within those areas) before and after breaks in effort. There are also some small adjustments in timing to ensure sightings fall into effort legs.

During a two-day pre-meeting immediately prior to this meeting and using the reference dataset, the OK and non-spatial SPLINTR output were compared. Consistency checks revealed that the basic data (numbers of sightings

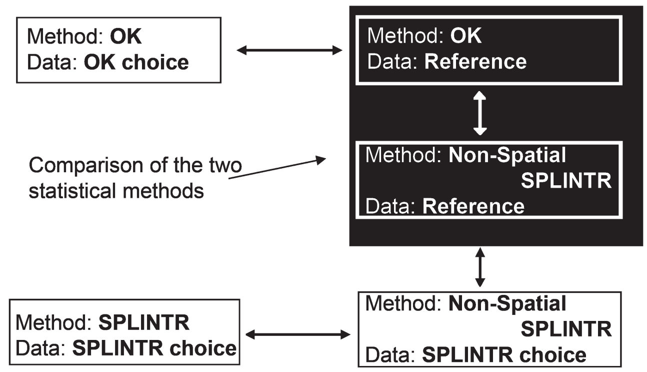


Fig. 1. Chain of comparisons needed to understand the difference between OK and SPLINTR models.

and amount of effort) were the same for each. Estimated mean school sizes (E(s)), effective strip half-widths (eshw), and encounter rates (n/L) were combined using the simple line transect formula for estimating abundance (N=n·E(s) A/2·L·eshw). The resulting estimated abundances for each model were consistent with those reported from the model. This simple check ensured that these estimated quantities from each model were being combined correctly to estimate abundance. Further diagnostic checks were as follows (all by stratum): (i) plots of E(s), eshw, and abundance estimated by OK against corresponding values estimated by SPLINTR; (ii) plots of eshw from OK against eshw from SPLINTR, separately by school size category (1, 2, 3-4, 5-9 and 10+); and (iii) observed against model-predicted number of sightings by school size category × platform combination.

The mean school size plots revealed some variation between the models, but this was not considered to be sufficient to be causing the difference in abundance estimates. However, the eshws for OK were about half of those of SPLINTR, and estimated abundances were approximately doubled, highlighting a need for further investigation. Disaggregating eshws by school size category showed some pattern. For smaller schools (of size 1, 2 and 3-4), estimated strip widths by stratum were consistently higher for SPLINTR than for OK. For schools of size category 5-9, the estimates were comparable, whilst for the largest schools, eshws for OK were higher than those for SPLINTR. In the IDCR/SOWER data, the majority of schools are of size 1 and 2, so the effects of the variation in these plots would not be expected to 'cancel out'. It was **agreed** that these plots, together with similar ones disaggregated by school size category and platform, were useful in identifying factors causing the difference in estimation from the two models.

The conclusion from these comparisons was that the difference seen in the results from the two models was not due to the data, and was probably not due to differences in mean school size. The question was: had sufficient progress been made to suggest whether further investigations would elucidate a reason for the difference? It was **agreed** that with sufficient commitment to the further work outlined in the Work Plan (Item 5.1.9), including an intersessional workshop, there was a reasonable prospect that the reasons for the differences in the estimates from the two methods would be elucidated. The sub-committee therefore **agreed** to proceed with these investigations until next year's meeting.

Contingency plans, including producing model-averaged estimates of abundance may also need to be considered in the event that it was not possible to resolve the difference in the estimates. An investigation by Skaug comparing estimates from OK, SPLINTR and a model-averaged estimate on the simulated data showed that for these data, the model-averaged estimator had smaller bias than either of the two individual models (Appendix 2). There was some discussion on the appropriateness of model-averaged estimates on the real data, but given the progress made this year, it is anticipated that a perhaps more satisfactory outcome can be achieved as a result of the planned intersessional work to resolve the reasons for the differences in estimates.

5.1.4 Results from each method using their preferred dataset

SC/62/IA3 and SC/62/IA12 presented 'survey-once' estimates (Branch and Butterworth, 2006) of abundance for the CPII and CPIII surveys from the OK and SPLINTR models respectively (Table 1).

Table 1

Comparison of 'survey-once' estimates of abundance, by *Management Area*, from the OK and SPLINTR models. Estimates shown have been extracted from the papers SC/62/IA3 and SC/62/IA12 and rounded, with CVs incorporating additional variance given in parentheses. CVs given in Table 4 of SC/62/IA12 did not incorporate additional variance but for ease of comparison, these were calculated at last year's meeting.

	Area I	Area II	Area III	Area IV	Area V	Area VI	TOTAL
CPII							
OK	209,000	261,000	187,000	104,000	635,000	90,000	1,486,000
	(0.35)	(0.38)	(0.42)	(0.37)	(0.29)	(0.39)	(0.17)
SPLINTR	117,000	141,000	87,000	61,000	282,000	59,000	747,000
	(0.38)	(0.39)	(0.55)	(0.36)	(0.34)	(0.40)	(0.19)
CPIII							
OK	65,000	93,000	126,000	79,000	244,000	105,000	712,000
	(0.34)	(0.37)	(0.33)	(0.45)	(0.33)	(0.34)	(0.17)
SPLINTR	35,000	56,000	59,000	36,000	140,000	57,000	382,000
	(0.33)	(0.35)	(0.31)	(0.33)	(0.31)	(0.33)	(0.17)

The authors of SC/62/IA3 pointed out that the model used this year was similar to that presented last year but that with slight a modification to the probability distributions for school size bias related to confirmation status. Analyses were presented which examined the sensitivity on abundance to this modification. Two further sensitivity analyses were also presented, one which examined the form of the Q function in the hazard probability model, and one which looked at different covariates affecting detectability (Sightability and Beaufort Class). The AIC best model had a truncated negative binomial model for IO mode and a truncated Poisson distribution for CL mode as a probability model of school size bias, a logistic form as a Q function, and Sightability for CPII and Beaufort Class for CPIII as a weather covariate. In addition, SC/62/IA3 investigated the effect of Platform C (Upper Bridge) on radial distance and abundance. When excluding Platform C, the authors reported that the fit of radial distances was somewhat improved and the abundance estimates decreased by 15% on average.

In discussion, it was suggested that the reduction in the abundance estimates when Platform C was removed may indicate that something is not quite right with the model. The authors agreed, noting a lack of fit at small radial distances was potentially the cause. In addition, there was some evidence of lack-of-fit in the school size distributions particularly for size 1, in CPIII. In response, the authors noted that such lack-of-fit had not been found last year, indicating that this may be due to the change in the school size bias model in relation to confirmation status. It was also commented that the general form of the model had been improved; it no longer included any *Management Area*-specific parameters.

The model presented in SC/62/IA12 did not differ from that presented at last year's meeting. At that meeting, the spatial models had generally appeared to fit the data well, but some lack-of-fit was evident in the analysis of the 2003/04 survey in Area V, where the predicted numbers of sightings were higher than those observed. In SC/62/IA12 therefore, they had adopted a different approach for modelling that year's data, fitting two separate spatial models to accommodate the spatial and temporal discontinuities evident in both survey effort and ice coverage. They reported that these models appeared to fit much better. In an effort to gain greater understanding of the effect of uneven survey coverage during the surveys, a new stratified-version of SPLINTR had been developed, which removed all elements of the spatial version of SPLINTR. SC/62/IA12 reported that the difference between the model-based and stratified SPLINTR estimates were quite small: about 10% lower for CPII and 7% lower for CPIII. By comparing results from applying stratified-SPLINTR to the reference dataset and the authors' preferred dataset (with slight lengthening of transects as mentioned in 5.1.3 above), it was concluded that such modification of the data made only a small difference (about 2-3%) in estimated abundance. Finally, the authors also pointed out that since there had been no change to the model presented last year, the lack-of-fit seen in the perpendicular distance plots, where the fits failed to capture observed spikes in the data at very small distances, would still exist.

In discussion, some concerns were raised regarding the data omitted by the authors in producing these estimates. Spatial modelling demands more precise data collection and data errors – even in validated data – are frequently discovered when applying these models. The authors responded that the tiny proportion of data excluded were such cases where the data were internally inconsistent; the small differences in estimates from the OK model using the reference dataset and the standardised dataset suggested that the omissions would also only make a small difference to the estimates for SPLINTR too. In further discussion, it was commented that the stratified SPLINTR model had proved to be a very useful halfway-house for examining differences between spatial SPLINTR and OK estimates. It was suggested that consideration be given to proceed with these comparisons, as they may also be useful for comparisons of variance estimates between the two modelling approaches.

The sub-committee expressed its thanks to both sets of authors for producing estimates and presenting a substantial amount of new work this year. Work had progressed well collaboratively by e-mail in order to get to this point. As discussed at last year's meeting, the sub-committee was now in a position where with one set of estimates alone, neither of the models' performance in the simulations and the diagnostics would raise sufficient concerns to fail to accept the estimates, but the fact that the estimates themselves were so different was problematic.

5.1.5 Difference in abundance

The comparison of results from the reference dataset had not yet revealed why the two models were yielding such different estimates. Furthermore, the estimates from the SPLINTR model were slightly lower than those from the IWC 'standard' method (Branch, 2006). This result is somewhat surprising since the expectation was that by producing estimates which did not assume $g(0)=1$, the estimates would increase. However, the IDCR/SOWER Antarctic minke whale data are complex so that the interpretation of comparisons may not be straightforward, as there are several confounding effects which affect the abundance estimators in different ways (as was illustrated to a degree in the simulation results presented in SC/62/IA14). Nonetheless, it was **agreed** that comparing not only OK and (stratified) SPLINTR results, but also results from the 'standard' method may help to understand the reasons for the differences in the estimates and to develop new diagnostics to test the models.

In the light of the results in SC/62/IA3 and SC/62/IA12 and from the reference dataset comparisons, it was thought that the differences between the estimates were probably caused by differences in estimation of the sighting probability component of the models. This represented some progress in elucidating the reasons for the differences in the estimates; results from SC/62/IA12 suggested that spatial modelling would only explain a difference of about 10% for example. The models adopt different approaches to estimating mean school size. The OK model uses a parametric form based on stratum and distance from ice, whilst SPLINTR estimates a spatial school size surface. As a result, there was some variation in the stratum-by-stratum estimates of mean school size between the two models but overall, mean school size estimation was not thought to be the root cause of the observed differences. Based on a preliminary examination of $g(0)$ estimates in the models and rough empirical estimates from the data, the sub-committee **agreed** that $g(0)$ is one key area on which to focus intersessional investigations. It was noted that the BT-NSP data collected on recent SOWER cruises were directly relevant (Burt *et al.*, 2009).

Considering the difference in estimates between the OK and SPLINTR models, there are three – not necessarily unrelated – issues: the scientific question of pursuing the work to model the data and finding reasons for the difference in the estimates; the implications, if any, for future survey programmes; and the procedural question of what the Scientific Committee should do in the interim (or if a solution to the first question proved impossible). The sub-committee has been instructed to plan for a RMP *Implementation* of Antarctic minke whales in 2015 (see 5.1.8), therefore it was important to have agreed absolute abundance estimates as well as indicators of change.

5.1.6 Reasons for differences between estimates from CPII and CPIII

Estimates from the OK, SPLINTR and standard method (Branch, 2006) were consistent in that they showed a decline from CP2 to CP3. Conclusions reached about the reasons for this change should integrate information from other sources such as changes in ice coverage during the survey periods concerned. Until recently, there was little quantitative information on the number of Antarctic minke whales that might be present within the pack ice but the sub-committee was pleased this year to receive several papers reporting on and analysing data from surveys of whales within this region.

5.1.6.1 REPORTS ON DISTRIBUTION OF SEA ICE

SC/62/IA4 investigated trends of sea ice in the period of IWC IDCR/SOWER circumpolar surveys from CPI to CPIII (1978-2004). The sea ice trends are fundamental information to understand the year-to-year sea ice variability. Trends in sea-ice-extent (sea-ice-field) in the IWC *Management Areas* were estimated by Murase and Shimada (2004) for data up until 2002. SC/62/IA4 extends the temporal coverage to also include 2003 and 2004. In addition, trends of sea-ice-area-in-the-sea-ice-field and open-sea-area-in-the-sea-ice-field are also considered. The trends in each IWC *Management Area*, western and eastern half of each IWC *Management Area* (e.g. Area I West and East) and each 10° degree longitudinal sector in January are investigated. Region-specific year-to-year sea ice variabilities were detected. The variabilities were not consistent even in the same *Management Area*. For example, differences of open-sea-area-in-the-sea-ice-field in two 10° degree longitudinal sectors in Area V (170°E-180° and 180°-170°W) between CPII and CPIII were large in comparison with the rest of Area V. These sectors correspond to the Ross Sea region where the difference in Antarctic minke whale abundance could be large. The number of Antarctic minke whales in the sea-ice-field is expected to be large if the open-sea-area-in-the-sea-ice-field is large. The difference in abundance estimates between the CPII and CPIII surveys can be partly explained by the change in open-sea-area-in-the-sea-ice-field. As recommended by Scientific Committee in the past, the authors recommend that further region-specific investigation is necessary to understand the reason why the abundance estimates are different between CPII and CPIII.

In welcoming this work, some members commented on slight difficulties interpreting the plots in SC/62/IA4, suggesting that polynyas might be included in the future. Murase noted problems defining polynyas from satellite data, and although it may be possible in areas where the vessels had surveyed in a particular year, this would not lead to a consistent series. Aside from potential measurement errors, definition of which were beyond the scope of the work undertaken, the material in SC/62/IA4 was considered valuable, and it was **agreed** that further investigations along these lines should continue.

Following the re-establishment of an intersessional Working Group on Abundance Estimates and Sea Ice Extent Changes at last year's meeting, SC/62/IA5 reported progress in preparing the sea ice data required to investigate the relationship between sea ice characteristics and Antarctic minke whale abundance estimates. The authors have made progress importing satellite sea ice data from Area II into GIS. The data include: the coastline of Antarctica; satellite sea ice data; IDCR/SOWER stratum boundaries, sighting data and effort data; days after sea ice melting; and days covered by sea ice. Imported sea ice data in Area II suggested that realisation of sea ice conditions in geographically complex regions such as the Weddell Sea in Area II and the Ross Sea in Area V is difficult because surveys proceeded following retreating ice to the south, in addition to longitudinal directions. In such cases, the authors consider that the use of average sea ice data during the survey periods is an alternative solution. They also report that the work of the intersessional Working Group established last year is now not expected to be completed until next year's meeting.

A review of papers submitted to the Scientific Committee since 2001 relating minke whale densities to sea ice characteristics included in SC/62/IA5 was welcomed. The sub-committee **recommended** that the important exercise of ice data preparation be continued in time for next year's meeting. The exact nature of any models relating minke whales densities in open water to those in the ice was not discussed, but it was **agreed** that investigation of the relationships between whale density and ice characteristics was an area worth pursuing.

5.1.6.2 REPORTS AND ANALYSES FROM AERIAL SURVEYS

This year, the sub-committee was pleased to receive reports (SC/62/IA8 and SC/62/O15) from two aerial survey programmes: the Australian East Antarctic programme (which co-ordinated in 2009/10 with the SOWER survey) using a fixed wing plane; and the German programme surveying the area in the Weddell Sea from a helicopter launched from the ice breaker vessel, the *Polarstern* (which was also used as a platform of opportunity for cetacean sightings). These programmes are some of the first attempts to gather quantitative data to estimate densities of minke whales in the pack ice. Preliminary analyses from each programme are also now available (SC/62/IA9 and SC/62/IA13).

SC/62/IA8 detailed a full-scale, double-platform aerial survey for Antarctic minke whales which was conducted in East Antarctica in the 2009/10 austral summer. The survey targeted polynyas within pack-ice between 93° and 113°E between mid-December, 2009 and early February, 2010. The aim of the aerial survey was to collaborate with a concurrent IWC-SOWER voyage surveying north of the ice edge, and to collect environmental information to study the distribution of minke whales within pack-ice environments. The 2009/10 aerial survey was conducted in three phases: the first phase repeated a survey design from the previous summer period, based in and around Vincennes Bay; the second phase moved survey effort over to the Shackleton Ice Shelf and the Davis Sea; and the final phase repeated the Vincennes Bay survey, but also extended transects around 40n.miles north of the sea ice boundary. In total, 4,923n.miles of effort was achieved, covering around 55,559n.mile^2 of survey area. Across the entire survey period there were 24 on-effort sightings (34 individuals) of minke whales; 5 sightings (5 individuals) of 'like' minke whales; and 5 sightings (5 individuals) of minke whales observed off-effort. Other species sighted were killer whales, southern right whales, sperm whales, southern bottlenose whales and a number of sightings of unknown species. Of note was the absence of humpback whale sightings north of the sea ice edge, despite the concurrent IWC-SOWER voyage (SC/62/IA1) counting many such whales. Given humpback whales are generally conspicuous from the air, it is likely that such animals were not missed, but that there were not present on the dates the aerial survey targeted areas north of the sea ice edge. Although no direct overlap in space and time was achieved between the aerial survey and the IWC-SOWER voyage, there was around 11,900n.mile^2 overlap where both programmes surveyed within 14 days of each other.

Although no synoptic coverage with the SOWER vessel had been achieved, Bravington commended the fact that the aerial and shipboard surveys had surveyed part of the same area within a short period of time, during two weeks when the ice conditions did not change substantially. The sub-committee **agreed** that the collaboration had been highly successful, both in collection of data, and in regular communications and data exchanges during the surveys.

A preliminary analysis of data collected during the 2009/10 aerial survey in east Antarctica (SC/62/IA8) was presented in SC/62/IA9. This analysis also included minke whale sighting data from a smaller-scale aerial survey undertaken in the austral summer of 2008/09 (Kelly *et al.*, 2009b). A basic MRDS analysis yielded estimates of relative densities for areas within both aerial surveys. A proper left-truncation of the sighting data was not applied in this preliminary analysis due to software limitations; the authors intend to investigate alternative truncation options in future analyses. In the Vincennes Bay area, relative density of minke whales in December 2008 was around 10 times that of densities observed in December 2009. There was also an intra-season increase in relative density of minke whales in Vincennes Bay: estimated relative density of minke whales in the Vincennes Bay in late January-early February 2010 was 2-4 times higher than in December 2009 (based on point estimates). Densities of minke whales were higher in the north of the Davis Sea as compared to the south. It may be that pack-ice dynamics and the relative position of the shelf-break (krill habitat) are influencing inter- and intra-summer densities of minke whales across the aerial survey study area; as these analyses are preliminary, such inferences are highly speculative at this time.

Although preliminary in nature, the authors also commented that the figures shown in SC/62/IA9 suggested a fairly high and consistent 'recapture' probability out to 600m. They anticipated that the data would therefore provide a good idea of the proportion of whales available to be seen but were in fact missed. The sub-committee welcomed this work and looked forward to receiving an updated analysis next year.

A brief discussion was held concerning the plans for future analyses of minke whale sightings from the aerial survey described in SC/62/IA8. The basic research question upon which these analyses will be based is whether, using such aerial survey data, a number of minke whales can be found in pack-ice in Area IV-East that is able to account for decreases in numbers estimated by either SPLINTR (SC/62/IA12) or OK (SC/62/IA3) abundance estimation methods. Presently, there is no satisfactory data to estimate availability of Antarctic minke whales for an aerial survey, but some estimates do exist for common minke whales that could, at least, provide a lower bound. A more informal or indirect way of estimating availability would be to compare the uncorrected estimates of abundance from the aerial survey data to IWC-SOWER abundance estimates from the same region. The aerial survey data will be analysed within a MRDS framework and combined with the rough estimates of availability. This distance analysis will then form the foundation of a spatial model of minke whale density based on geographical and sea ice variables. It is hoped such a model will aid in model-based abundance estimates of minke whales in pack-ice in East Antarctica.

SC/62/O15 reported on two helicopter and shipboard cetacean surveys conducted in the Weddell Sea from the German research vessel *Polarstern*, in 2006/07 and 2008/09. Helicopter tracklines covered a total of 13,124km and 13,417km in 2006 and 2008 respectively, while the ship survey covered 1,171km and 2,011km respectively. Minke whales were primarily observed in the ice. Killer and southern bottlenose whales were also seen in the ice while all baleen whales (other than minke whales and sperm whales) were only observed in open water. Humpback whales were the most frequently sighted species on the shipboard survey in 2006/07 and the helicopter survey in 2008/09. Environmental information, including the proportion of ice coverage, was collected continuously. One striking finding was a much higher encounter rate for all cetaceans from the ship than from the helicopter. The authors consider two possible explanations for this difference: (1) observers on the helicopter missed more animals on the trackline than those from the ship (i.e. $g(0) < 1$); and (2) whales were drawn to leads created while *Polarstern* broke the ice.

SC/62/IA13 reported preliminary results from helicopter surveys for Antarctic minke whales and sea ice, conducted from *Polarstern* in 2006/07 and 2008/09. The cruise plan (described in SC/62/O15) was designed to achieve other research and logistical objectives in conjunction with reprovisioning the German Antarctic base at Neumayer; therefore placement of helicopter tracklines around the ship's cruise track was designed to sample across as wide a range of ice conditions as possible. In the first year of the study, the survey covered the ice edge in the Weddell Sea, the areas formerly occupied by Larsen A and B, and western Antarctic Peninsula, and only a line from Cape Town to Neumayer in the second. The survey design was further constrained by a maximum flight time of 2 hours at 80 knots, and the majority of surveys were therefore squares of 40n.miles (74km) on a side and placed on a diagonal to sample as far as possible from this ship's track. The resulting survey yielded over 13,000km of dedicated trackline effort from each of two years, and 94 on-effort sightings of Antarctic minke whales in the two years combined. The helicopter served as an excellent, highly manoeuvrable platform, which allowed observers to hover immediately after each sighting to confirm species identity, take photographs, and to confirm school size. Only single platform data collection are available, so data were analysed assuming $g(0)=1$. Available environmental covariates included ice concentration (observed visually along the trackline, and inferred from satellite imagery) and distance to ice edge (defined as a smooth line joining all grid cells in which ice concentration was greater than or equal to 15%). Ice covariate data were calculated for each segment and each sighting on the corresponding day of the survey. A classification tree indicated that the first split occurred in the data at 143km from the ice edge: i.e. most whales that were seen farther from the ice edge than this were humpback and fin whales. The second split occurred at 5% ice concentration (as observed along the trackline): almost all whales seen in ice concentrations >5% were Antarctic minke whales. A tentative analysis was reported that used the Density Surface Modelling engine in Distance (Thomas *et al.*, 2010) using the 'count' method (Hedley *et al.*, 1999). The density surface model was used to predict animal density throughout the study area based on ice concentrations on three days representing the beginning, middle and end of the two survey periods. The model showed highest density of minke whales in a narrow band of modest ice concentration (approximately 5-20%), but reanalysis is required to put robust bounds on this band to infer habitat preference. Next steps include plans to reanalyse the data using soap-film smoothers (Wood *et al.*, 2007), error distributions that are robust to unmodelled overdispersion in the data, and new methods developed by Hedley and Bravington to propagate the variance from the model through to the resulting abundance estimate (Hedley *et al.*, in press). The authors emphasised that they invite collaboration with their Australian colleagues doing aerial survey work.

Kelly agreed that these data, in combination with those from the Australian aerial survey, would help to make useful inroads into questions related to densities of minke whales in the ice, expressing interest in collaborative analyses. The sub-committee thanked all the authors for their work, and extended their appreciation to the governments of Australia, Germany and the Netherlands for supporting this research.

5.1.7 Planning for a RMP Implementation *as proposed in the SAG report*

The sub-committee Chair appointed a small group under Butterworth to consider this item. Members were Bravington, Cooke, Hakamada, Hatanaka, Kelly, Pastene and Walløe (Observer). As there was no time for the group to meet during the sub-committee period, it was **agreed** that they would report their conclusions during the Scientific Committee Plenary.

After some discussion of the relative priorities of In-depth and *pre-Implementation assessments* of North Pacific sei whale and of Antarctic minke whales, the timeline given in the SAG report was **agreed**.

5.1.8 Work plan

The sub-committee proposed that the following work be completed intersessionally:

(1) continue the work to evaluate the reasons for difference in estimates from the OK and SPLINTR models; and
(2) continue to address reasons for the differences between CPII and CPIII Antarctic minke whale estimates, by investigating:
  (a) the relationship between whale density and days after sea-ice melt; and
  (b) the relationship between estimates of abundance and sea ice characteristics.

The Intersessional Working Group on Abundance Estimates was re-established in order to make progress with item (1) above. The sub-committee **recommended** that the programme of work detailed in Appendix 3 be completed. Last year, plans had been made to hold an intersessional workshop to expedite progress on this item; in the event, a suitable date for the workshop could not be agreed and so work was carried forward to a pre-meeting at SC/62. Both sets of modellers have committed to the timeline set out in Appendix 3; note that a workshop, to be held by February 2011 at the latest, is considered to be essential for satisfactory completion of item (1). For comparative purposes, it was also **agreed** that estimates – and as applicable, diagnostics – from the IWC 'standard' method should be included in the model evaluations. The simpler formulation of this method made its behaviour easier to understand; this was expected to be useful when considering the model output from OK and SPLINTR.

With regard to putative relationships between minke whale density and sea ice, the sub-committee has received several papers over the course of the past decade. The work identified in item (2) above represents exploratory work to examine these relationships in a quantitative framework. It requires the preparation of sea ice and other environmental data for model input, as well as estimates of minke whale abundance by 10° longitudinal slice. Bravington undertook to provide the latter using the SPLINTR estimates (since SPLINTR is a spatial model, it can more readily provide estimates by sub-area than stratified models). The data preparation and exploratory investigations would be carried out by Murase and Kitakado (see section 8 below). The sub-committee noted that there appeared to be some value in continuing to discuss the details of satellite sea ice data processing. Kelly agreed to cooperate with this.

5.2 Catch-at-age analyses

5.2.1 Report from the intersessional working group

SC/62/IA7 reported on activities during the past year. These are elaborated in the documents summarised in sections 5.2.2 and 5.2.3 below.

5.2.2 Age estimation

Lockyer enlarged on the Antarctic minke whale ageing exercise (SC/62/IA11) which she had carried out during the intersessional period in terms of the experimental design agreed by the Scientific Committee (IWC, 2009, p.209). This had involved readings of ear plugs from minke whales taken in the period 1974/75-2005/06, including both Antarctic commercial and JARPA samples. The primary aim of the work was to determine whether evidence exists of a drift in reader performance, and, if so, to quantify it. A secondary aim was to quantify age-reading error variability. Left ear plugs were selected only from females, and only from samples where a useable age had been achieved by

Japanese researchers. The experimental sample comprised 50 randomly taken ear plugs from each of 5 sub-sets totalling 250 ear plugs in all. The sub-sets were taken from Area IV in the periods 1974/75-1976/77, 1982/83-1984/85, 1989/90-1991/92, 1997/98-1999/2000 and 2003/04-2005/06, thus encompassing a 25-year time span. The ear plugs were selected by staff from the laboratory at the Tokyo University of Marine Science and Technology, under the supervision of Kitakado. The sample was numbered independently of all existing identifying marks for the first reading. The numbering was random for the entire set of 250 plugs, but the plugs were read in numerical order from 1-250. After completion of the first reading, the sample was reassigned new identifying numbers and re-ordered randomly. The ear plugs were then read again in numerical order 1-250. After the second reading was completed, a sub-set was randomly selected from the 250 set, but this time choosing 10 plugs from each time period, totalling 50 plugs in all. These were then read again.

During the reading procedure, the reader had no input or access to actual data pertaining to the sample, i.e. the plugs were read 'blind'.

The readings were undertaken within a three week period with approximately 50 ear plugs read daily using a Nikon binocular microscope to examine all ear plugs with an eye objective 10×B22 and zoom magnification ×0.8-×8 facility. A break period of two days was scheduled between the first and second, and then second and third readings, to minimise possible recognition of certain samples. The oldest whale examined was >60 GLGs and the youngest had no GLG visible (young of year). The impression was that ear plug size in general was very variable, and not always correlated with age. In addition, the early-forming GLGs were the most problematic to interpret, the pattern of deposition frequently appearing distorted and irregular, especially in old animals. For this reason, the source of error in ageing in old animals was thought likely to be mainly due to problems in the early GLGs. The late-forming GLGs were much easier to interpret, despite becoming more narrowly packed together, because they were usually regular in form. In addition, accessory laminae were sometimes present and confusing in young ear plugs. For this reason occasionally two possible alternative readings were provided because the reader could not be certain which to choose. Normally – though not in an experimental situation such as this – readers might refer to biological data to help resolve such issues.

Age readings were recorded in Excel data format, and the following data were recorded for each ear plug specimen at each of the three reading sessions to facilitate the subsequent analysis of the data: sequential specimen number, age readings including both weighted and simple mean ages of 5-10 counts, comments including whether the ear plug was intact, whether the neonatal line was present, whether the plug was cut centrally, colour and general size and appearance, and a readability rating from excellent, good, poor to unreadable when the age reported should be disregarded.

In discussion appreciation was expressed at the manner in which the experiment had been carried out to maintain independence of and a blind approach to readings as specified in the protocol; thanks were also expressed to Japanese graduate students who had assisted in the conduct of the experiment.

A recommendation by Lockyer that a standard reference set of minke earplugs be maintained for age-reading training purposes received support.

SC/62/IA2 explored the impact of period/reader on age-determination by three Japanese readers by comparing age-estimates from earplugs from a control reader (Lockyer) with age-estimates by the Japanese readers (Masaki, Kato and Zenitani). A total of 250 plugs selected according to the predetermined protocol (IWC, 2009) were used in the analyses (see SC/62/IA11 for details). A conditional distribution of an observed age given a true age was defined to estimate the extent of ageing error for two groups of readers. Parameters determining ageing error matrices were estimated using a maximum likelihood method under several scenarios regarding the bias of the control reader. The analysis showed that incorporating a reader effect into the variance component to quantify the extent of random age-reading error improved the goodness of fit substantially (in terms of model selection criteria) compared to incorporating these effects into the mean structure. A model with reader effects in both the mean and variance structures provided the most parsimonious fit to the data among the models investigated. The period effect models tended not to fit the data as well as expected because of two readers within one period.

Overall, the results demonstrated that the Japanese readers and the control reader differed in terms of both expected age given a true age and variance in age-estimates. The results also suggested that the expected age and random uncertainty in age-estimates differed among the Japanese readers although the differences were not severe. This work could contribute to how catch-at-age data are used in the statistical catch-at-age analyses and in future virtual population analyses. The authors of SC/62/IA2 expressed their appreciation to Japanese scientists for allowing them to access past Japanese age-estimates through Procedure B.

This study was welcomed by members and seen as an important step forward. The comparisons indicated a few outliers at large ages, but it was noted that the models fitted assumed variance to increase with age so that such instances would not impact estimates of inter-reader bias greatly, and further that in practice age readings also took account of auxiliary information about the animals which would tend to diminish the proportion of such outliers. It was noted that Lockyer tended to report greater ages than the Japanese readers, but that differences amongst the Japanese readers was slight, and that there was no indication of a trend in bias in Japanese readings over the period from the commencement of commercial takes of Antarctic minke whales to recent years of whaling under research permit.

It was pointed out that while SC/62/IA11 makes a valuable contribution, it does not provide any information about the accuracy of the age readings in absolute terms, given that none of the ear plugs come from known-aged individuals. In response, comments were made that the absence of known-aged individuals was the norm for fish populations generally. However, for a number of fish populations there were indications from seasonal studies that layers were seasonal. Similarly, studies of fin whales, as well as corpora counts and animals with known histories indicated that the growth layers counted to age whales were laid down annually. Best pointed out that in the absence of known-aged individuals, the use of corpora counts from the same whales would provide an independent estimate of relative age, from which possible age-related biases in ear plug reading could be investigated.

It was **recommended** that guidelines for dealing with stranded animals include encouragement to obtain samples which could provide information on the animal's age.

5.2.3 Analyses using modified catch-at-age data

In SC/62/IA6, Punt examined the impact of allowing for ageing error based on the analyses of the age-reading experiment (SC/62/IA2) when conducting assessments for Antarctic minke whales in Areas III-E, IV, V and V-W using statistical catch-at-age analysis (SCAA) by means of sensitivity tests. These sensitivity tests explored three scenarios: (a) no ageing error; (b) ageing error is modelled as in previous base-models; and (c) ageing error is based on the results from SC/62/IA2. Time-trajectories of total (1+) population size and recruitment were qualitatively the same, irrespective of how age-reading error was modelled.

In discussion it was noted that while estimates of recruitment and abundance for the three different assessments were close over recent years, absolute values showed relatively large differences over the 1930s and 1940s, though also noted that estimation variance would be expected to be much higher over this period.

The question was raised of whether the issue of age estimation error had now been adequately addressed, or rather more investigation was needed through further analyses of readings made by a group of readers during the 1983 minke whale ageing workshop. The sub-committee noted comments that the experimental reading exercise conducted recently by Lockyer was far more rigorous and reliable than the 1983 comparisons, and further that introducing age-reading error into the SCAA evaluation did not change population trends qualitatively. It consequently **decided** that no further experiments or analyses on age reading errors were necessary to resolve problems raised in the JARPA review.

This decision did not however imply that other issues associated with the data and analyses, such as reasons for the different length distributions at age for younger-aged commercial and JARPA catches, had been resolved. Further work needed is discussed in the following section.

5.2.4 Work plan

The following issues were identified as requiring attention before investigation of catch-at-age based assessments of Antarctic minke whales using SCAA might be considered to have been completed.

(1) Confirm satisfactory convergence of the SCAA estimator with the inclusion of the ageing error matrix now developed.
(2) Check whether the SCAA model together with its various estimated selectivity functions can account satisfactorily for the different length-at-age distributions for younger animals in the commercial and JARPA catches.
(3) Check the impact of possible misreporting of the length distribution by the USSR commercial fleet on the SCAA results, possibly by assuming these catches to have the same length distribution as contemporaneous Japanese commercial catches.
(4) Investigate the effect of alternative assumptions in regard to Lockyer's possible bias in the age reading experiment.
(5) Explore how useful it would be for the models to have independent age estimates from corpora counts, to investigate possible age-related biases.

It was noted that these investigations would require an extension of permission from Japan for use of their minke whale catch-at-age data, and also that the investigations would be improved if data from the most recent JARPA cruises could also be made available. The sub-committee **recommended** that such an approach be made to Japan under Procedure B. Kato indicated that corpora count data were available, and that these data would be provided if necessary.

The following intersessional steering group was nominated to co-ordinate this data application and also to oversee progress on the outstanding analysis issues identified above: Punt (convenor); Butterworth, Kitakado and Polacheck.

6. CRUISES

6.1 Results from the 2009/10 IDCR/SOWER field studies

The planning meeting for the 2009/10 IDCR/SOWER cruise was held in Tokyo, Japan in September 2009 (SC/62/Rep6). The meeting reviewed the Scientific Committee discussions at last year's meeting and noted that highest priority had been assigned to collaboration with the proposed Australian aerial survey (Kelly *et al.*, 2009a) and, in case the aerial survey could not continue as planned, priority should be given to humpback whale biopsy sampling and photo-id image collection. At the meeting the Australian Antarctic Division confirmed that the aerial survey was to continue as planned. The meeting welcomed this information and agreed the SOWER survey should be synchronised with the aerial survey and so the region between 100°E-115°E was selected as the research area for SOWER. This research area was similar to the two most recent IDCR/SOWER cruises. The meeting agreed that, as a contingency plan, humpback whale photo-id and biopsy work should take place in the southern stratum between 120°E-135°E.

The 2009/10 SOWER cruise was conducted in Area IV, aboard the Japanese research vessel *Kaiko Maru* (SC/62/IA1) and had two main objectives: to undertake a sightings survey in collaboration with an Australian Antarctic Division aerial survey, and to continue research on the priority species (southern right, blue, fin, and humpback whales) including biopsy/photo-id as well as identification of sub-species for blue whales. A total of 1,072n.miles were covered during two repeat surveys of the region (100°E-115°E and extending from the pack ice to 60n.miles north of the ice edge) and in two survey modes (SS-II and BT-Option II). A further 92n.miles of SS-II and BT-Option II effort was conducted between 100°E-102°E and then the vessel continued eastwards along the ice edge in BB mode.

The total number of minke whales sighted during the entire coverage of the research area was 83 groups, comprising 152 animals. Two concentrations of minke whales were encountered along the ice edge during BB mode. Humpback whales were the most frequently sighted species in the research area (174 groups comprising 322 animals). Biopsy samples and individual identification photographs were taken from 21 and 45 humpback whales, respectively. No blue whales were observed but five fin whales in three groups were sighted, two of these groups near the ice edge. Twenty-eight groups of southern right whales were sighted (comprising 38 animals) with biopsy samples from 22 animals and identification photos of 26 individuals. One mixed-species group, consisting of one southern right whale and one humpback whale, was photographed and biopsy samples were taken. Nine groups of killer whales (78 animals) were sighted, however, most groups did not show strong characteristics for any type, except one group of 20 animals that were identified as Type A. Experiments using a photogrammetric system, to measure angle and sighting distances, were planned but, due to missing equipment, were not performed.

Collaboration with the Australian Antarctic Division aerial survey had the highest priority for the survey. Some flights were carried out during the SOWER survey but the plane was never seen in the vicinity of the SOWER vessel. The weather was poor for most of the survey period and the SOWER vessel had 68% and 56% of off-effort time during the two repeat surveys.

The *Kaiko Maru* had not been used on SOWER cruises before and the bowdeck was lower and smaller, and the vessel sides were higher than the *Shonan-Maru No.2* which had been used in recent years. However, no difficulties were encountered when taking biopsy samples or identification photos of the target species (humpbacks and right whales). The Cruise Leader expressed her appreciation to the Captain and the crew of the *Kaiko Maru* for their cooperation throughout the survey.

The sub-committee thanked the Government of Japan for generously providing the vessel and crew for this survey, and also thanked the Cruise Leader for her efforts. Noting that this was the last IDCR/SOWER cruise, the sub-committee also extended its appreciation to all member nations who had contributed to this extensive programme, and particularly to the governments of Japan and the former Soviet Union, for providing the survey vessels. Furthermore, the sub-committee thanked all those who had been involved with the cruises, including the Steering Group, the Cruise Leaders, the researchers and the crews. The data collected during the program were an unparalleled source of information on Antarctic cetaceans. The experience gained from these surveys would also continue to be of use in planning future studies, in the Southern Ocean and elsewhere.

At the Scientific Committee meeting in Santiago in 2008, a Steering Group was formed to consider creating a Special Issue of the *Journal of Cetacean Research and Management* on the IDCR/SOWER surveys. No work has been reported from this Group to date; the sub-committee **agreed** that such a volume is still merited; Best agreed to discuss this with the Head of Science.

6.2 Plans for cetacean sighting surveys in the Antarctic in the 2010/11 season

SC/62/O17 described a dedicated, systematic cetacean sighting survey which was being planned to take place from December 2010 to February 2011 in order to obtain estimates of abundance for use in the RMP. The research area will be south of 60°S in Area V and the western part of Area VI (130°E-145°W), including the Ross Sea. This survey will be conducted in relation with the Japanese Whale Research Program under special permit in the Antarctic (JARPA II). Two dedicated, sighting survey vessels, *Shonan-Maru No.2* and *Yushin-Maru No.3*, will be used and the survey procedures are planned to be based on the standard SOWER search modes; closing (NSC) mode and passing with the independent observer (IO) mode. Distance and angle estimation training, as well as some experiments, will be conducted. Abundance of Antarctic minke whales will be estimated using analysis methods being developed by members of the sub-committee. Biopsy skin sampling of blue, fin, humpback, southern right, and sperm whales will be opportunistically collected for assessing stock structure. Photographs for identification studies of large cetaceans, such as blue, southern right and humpback whales, will also be taken. Researchers will record the data (weather, effort, sighting and experiments data) using the on-board computer during the survey. These data will be validated at the Institute of Cetacean Research and submitted to the IWC Secretariat based on the IWC Scientific Committee Guidelines. A planning report will be prepared by Japan and a Cruise Report, prepared by the Japanese researchers, will be submitted to next year's meeting.

During discussions, the sub-committee reflected on its current difficulties interpreting estimates of Antarctic minke whale abundance from the IDCR/SOWER surveys, and that as far as possible, the lessons learned from those surveys – and their ongoing analyses – should be used to improve surveys and data analyses in the future. The Ross Sea is a particularly difficult region to survey, since it is large in area and has a complex and rapidly changing ice configuration. Two potential issues relevant to surveys in this Area relate to the spatial and temporal coverage in the region. In terms of the spatial coverage, it is important to attempt to design tracklines which give approximately even probability of coverage within a stratum, particularly if the intent of the analysis is design-based rather than model-based. It was suggested that historical and predictive sea ice maps may be useful indicators of what the survey area might be in 2010/11, and furthermore, that the 'survey design' component of the *Distance* software could be used to examine different trackline placements and survey region definitions. In terms of the temporal coverage, the concern is that if this is not considered carefully then any resulting estimates from the survey would be subject to the criticism that whales may have been double-counted. To avoid this, it is important to either survey the whole area 'synoptically' (i.e. over a sufficiently short period of time that whale movement and changing ice conditions are not significant), or to survey the relevant strata multiple times.

Based on its utility in the analyses of the IDCR/SOWER data, the sub-committee also **recommended** that instead of normal Closing Mode, SSII mode (closing-when-abeam) be adopted on this cruise. Other considerations for change in data collection from SOWER were also made. These included the collection of data to allow duplicate identification algorithms and measurement error models to be applied. Accurate sighting times and independent estimates of group size may be helpful in this regard.

In order to minimise difficulties associated with survey design, an intersessional Working Group was established under Matsuoka (also comprising Bravington, Ensor, Hedley and Kitakado). Matsuoka would prepare an intersessional report from this group which would also form a planning report as no planning meeting was scheduled.

The sub-committee **agreed** that Matsuoka would be responsible for IWC oversight.

6.3 Plans for cetacean sighting surveys in the North Pacific

6.3.1 IWC organised sighting surveys

During the last year's Scientific Committee meeting, Japan presented a proposal for a medium- to long-term research programme involving sighting surveys to provide information for cetacean stock management in the North Pacific. The Scientific Committee welcomed the initiative and agreed the value of a large-scale, medium-long term integrated research programme in the North Pacific and encouraged this in the context of international collaboration under IWC auspices. The Scientific Committee recommended that the planning process should start with a review of the current discussions on North Pacific issues within the Committee and a careful examination of available information and identification of gaps in knowledge.

A meeting to discuss the North Pacific survey programme was held in Japan in September, 2009 (SC/62/Rep3). The meeting noted four terms of reference:

(1) review the Scientific Committee's issues in the North Pacific and circulate a paper before SC/62;
(2) review the past and ongoing survey activities and available data in range states from completed *pro formas*;
(3) consider possible line transect survey plans and additional data collection (e.g. photo-id and biopsy) for the 2010 season; and
(4) prepare a proposal for an intersessional Workshop (to be held between SC/62 and SC/63) on future surveys beyond 2011.

The meeting reviewed previous Scientific Committee discussions regarding the proposal for a research programme in the North Pacific to provide information for stock management. The meeting agreed the priorities and cruise plan of the survey to be held in 2010, as well as considering the medium- to long-term objectives of such a programme.

SC/62/IA15 was provided in response to the first term of reference from the meeting and provided a summary of the Scientific Committee issues relating to North Pacific sei, common minke, Bryde's, right and blue whales. The distributions of these whale species were described and requirements for further surveys, in order to estimate abundance and investigate stock structure, were considered.

SC/62/IA10 presented the research plan for an IWC/Japan whale sighting survey taking place in summer 2010. The plan had been drawn up following guidelines agreed at the North Pacific programme intersessional meeting. The research area (170°E-170°W) had been chosen because for some species it spans proposed stock boundaries and has been poorly covered by previous surveys, representing an important information gap for several large whale species. The cruise will collect line transect data, to estimate abundance, and biopsy/photo-id data contributing to the work of the Scientific Committee on the management and conservation of populations of large whales in the North Pacific. It will provide:

(1) information for the proposed future in-depth assessment of sei whales in terms of both abundance and stock structure;
(2) information relevant to *Implementation Reviews* of whales (e.g. common minke whales) in terms of both abundance and stock structure;
(3) baseline information on distribution and abundance for a poorly known area for several large whale species/populations, including those that were known to have been depleted in the past but whose status is unclear; and
(4) biopsy samples and photo-id images to contribute to discussions of stock structure for several large whale species/populations, including those that were known to have been depleted in the past but whose status is unclear.

The cruise will last a total of about 60 days (including transit time) between July and August. In order to adequately cover the longitudinal range, the latitudinal range is restricted between a southern boundary at 40°N and a northern boundary at the Aleutian Islands chain. This region will allow for sufficient coverage and be expected to incorporate the latitudinal range of sei whales at that time of the year. Based on experience elsewhere in the North Pacific, allowing for poor conditions and time for photo-id and biopsy sampling work, an average of 65n.miles is expected to be covered per day in primary searching effort (12 research hours per day). The research vessel *Kaiko Maru* will be used and is equipped with a top barrel platform, IO platform and upper bridge. Biopsy sampling/photo-id work will be undertaken on priority species (North Pacific sei, common minke, right, blue, humpback and fin whales, with higher priority to the first two species). The Institute of Cetacean Research (ICR) data recording system will be used along with the data forms used on the SOWER cruise. The rules for data availability, shipping and storage will be as for the present SOWER cruise and IWC equipment will be used, if required. Copies of data, photographs etc. will be sent by ICR to the IWC Secretariat upon completion of the cruise. Records of all the data taken in US waters will be made available for unrestricted scientific research, including photographs and one-third of the sample from each biopsy sample collected in US waters. Four researchers can be accommodated on this cruise and US and Korean scientists will participate. The cruise will follow the requirements for reports and documentation developed for cruises that could provide data for use under the RMP and will be the responsibility of the Japanese scientists.

The sub-committee thanked the Government of Japan for its generous offer of a vessel for this survey. It was noted that the start and end points of the cruise track in the northern strata coincided with the US EEZ but it was confirmed that the start point of the trackline had been randomly generated and this was a coincidence. It was also noted that although 350 biopsy sample permits had been applied for, it was anticipated that this number would not be collected. Matsuoka was confirmed as cruise leader and assigned responsibility for IWC oversight.

The sub-committee **recommended** that the research objectives stated in SC/62/IA10, and listed as items (1)-(4) above, form the basis for planning a North Pacific survey in 2011. A working group under Kato was formed to discuss logistical details of this survey. The sub-committee endorsed the working group's report (given as Appendix 4), and **recommended** that the investigations regarding the use of Institutional permits to exchange biopsy samples proceed as soon as possible, with the results of the investigations being reported to the Planning Meeting (scheduled for October 2010).

Furthermore, the sub-committee **recommended** that the research objectives for the 2011 survey be taken forward and a coherent multi-year plan be developed for the survey programme. A Steering Group to oversee the IWC North Pacific surveys was established, convened by Kato, with the following members: An, Brownell, Clapham, Donovan, Ensor, Matsuoka, Miyashita, Murase, Pastene and Wade. It was proposed that a meeting of the Steering Group should be scheduled immediately prior to the Planning Meeting for the 2011 cruise, in order to develop the programme of research to be undertaken over the next few years.

6.3.2 Japanese sighting surveys

SC/62/O16 described two sighting surveys for cetaceans, taking place in the North Pacific in 2010, to examine the distribution of sei, Bryde's and minke whales and to estimate abundance. Both surveys are in the middle part of the western North Pacific. The first survey will take place from June to July in the region 35°N-40°N and 157°E-170°W, and the second survey will take place from July to August in the region 32°N-37°N and 145°E-180°. The main target species are sei and minke whales for the first survey and Bryde's whale for the second survey. The research vessel *Yushin-maru No.3* will be used for each cruise. Distance and angle estimation training and experiments will be conducted for abundance estimation. Sighting data will be analysed to obtain estimates of abundance for use in the RMP. Biopsy skin samples from large whales, such as blue, fin, sei, Bryde's, minke, humpback, right and sperm whales, will be opportunistically collected for assessing stock structure. Photo-id of large cetaceans, such as blue, right and humpback whales, will be also conducted. The cruise report will be submitted to next year's meeting.

During discussion it was confirmed that there were no plans to estimate the probability of detection on the trackline ($g(0)$) as the main focus of the survey were sei and Bryde's whales and so $g(0)$ would be expected to be close to one.

The sub-committee assigned responsibility to Matsuoka for IWC oversight.

7. PROGRESS TOWARDS AN IN-DEPTH ASSESSMENT OF NORTH PACIFIC SEI WHALES

7.1 Review of information

The available information was summarised in last year's report (IWC, 2010, pp.196-97). There is no new processed information available this year, but field work has continued: scientific catches (100 sei whales sampled out of 386 sighted) and associated sighting vessels (120 sei whales sighted) under JARPN II; and sightings surveys conducted independently by NRIFSF/Japan, resulting in effort with no sightings (SC/62/ProgRepJapan).

The sub-committee reviewed the available information with a view to assessing the likely amount of work involved in the In-depth Assessment and subsequent *pre-Implementation assessment*.

7.1.1 Stock structure

Analyses of 489 genetic samples from JARPN II catches and 301 samples from former Japanese commercial pelagic catches indicate no evidence for stock structure over the areas sampled (Kanda *et al.*, 2009). The eastern boundary of the JARPN II area is 170°E, but the commercial samples extend across the northern North Pacific to 135°W. If this result is confirmed, the area that has been genetically sampled would be regarded as containing a single stock, but the possibly of additional stocks in other areas cannot be excluded. The precautionary approach would be to entertain both hypotheses:

(1) whales in unsampled areas are from the same stock as the sampled area; and
(2) whales in unsampled areas are from different stocks to the sampled area.

The simplest way to cover both eventualities would be to designate the area with information as a single *Small Area*, but to apply catch capping at the *Medium Area* level. With the current state of knowledge, the entire North Pacific region would be a *Medium Area*, but if evidence of stock segregation is found in other areas later, the latter areas would be excluded from the *Medium Area*. Areas with no genetic information would be designated as *Residual Areas*.

7.1.2 Catch history

The sub-committee agreed last year to use the same division of past catches between sei and Bryde's whales as has been used for the western North Pacific Bryde's whale assessment. Allison reported that work is continuing on Soviet catch data in the North Pacific, and that the catch history should remain open until this work is completed.

7.1.3 Abundance estimates

In order to avoid potential double-counting arising from migrations, abundance estimates across the region should refer to a specific time of year. The sub-committee agreed that estimates should be prepared for two time periods: (i) May-June; and (ii) July-September, and that the decision as to which period to use for the primary abundance estimates would be taken later. Currently, abundance estimates are only available for the JARPN II area (North Pacific north of 35°N and west of 170°E). As noted last year, older abundance data are available for pelagic areas to the east of 170°E, but these would probably not be suitable for use in the RMP. The US and Canadian surveys conducted in the Aleutians and Alaskan waters, along the western coasts of Canada and the USA and in the ETP have yielded very few sei whale sightings. As discussed under item 6.3, new sightings surveys to be conducted in the North Pacific in 2010, and IWC-coordinated sightings surveys planned from 2011, may extend the area for abundance estimation into the offshore region east of 170°E over the next few years.

7.2 Plans for the assessment

The sub-committee agreed that unless new information obtained in the near future indicates a more complex picture, the options for RMP *Implementation* will remain relatively simple as outlined above, and that it is unlikely that *Implementation Simulation Trials* will be required. The sub-committee therefore agreed that the In-depth Assessment (IDA) and the *pre-Implementation assessment* (PIA) should be combined into a single exercise.

The timetable proposed in the SAG report and the Chair's proposal (IWC/62/7rev) envisaged an IDA in 2011 followed by a PIA in 2013 and an RMP *Implementation* in 2015, but this timetable was primarily motivated by the need to spread the workload in the event that the Assessment and *Implementation* involved substantial extra work such as *Implementation Simulation Trials*.

In light of the more modest workload now envisaged, a range of views were expressed regarding the timing of the combined Assessment. Cooke and others noted that the combined Assessment and *Implementation* could be carried out with current information with relatively little additional work, and could be accomplished in 2011 or 2012. The new data to be gathered over the next few years would be considered in an *Implementation Review* to be scheduled a few years after the initial combined assessment. Hatanaka and others expressed a preference for the assessment to be conducted at a later date, when more abundance data covering a wider area are available.

After some discussion, the sub-committee recommended that the combined IDA/PIA be scheduled for 2013. If no *Implementation Simulation Trials* are required, the RMP *Implementation* could be completed the following year.

8. WORK PLAN AND BUDGET REQUESTS

The sub-committee agreed that completing the In-depth Assessment of Antarctic minke whales was its primary objective. It identified the following priority topics for next year's meeting:

(1) to resolve the reasons for the differences between estimates of abundance of Antarctic minke whales between the OK and SPLINTR models, and thus provide agreed estimates of abundance at next year's meeting;

Table 2

Intersessional Working and Steering Groups, and their membership.

Group	Terms of reference	Membership
Abundance estimation methods (WG)	(i) Run sensitivity tests on modified real datasets to understand differences between OK and SPLINTR (e.g. in terms of ESW, *g*(0), MSS, and the underlying sighting parameters). (ii) As above, to understand differences between OK/SPLINTR and Standard. (iii) Following identification of the underlying statistics/parameters where big differences occur, develop ways to cross-check against empirical data. (iv) If necessary, design further simulation trials to test robustness.	Walløe (Convenor), Branch, Bravington, Butterworth, Cooke, Hedley, Kitakado, Okamura, Palka, Skaug, Wade.
Catch-at-age analyses (WG)	(i) Confirm satisfactory convergence of the SCAA estimator with the inclusion of the ageing error matrix. (ii) Check whether the SCAA model together with its various estimated selectivity functions can account satisfactorily for the different length-at-age distributions for younger animals in the commercial and JARPA catches. (iii) Check the impact of possible misreporting of the length distribution by the USSR commercial fleet on the SCAA results, possibly by assuming these catches to have the same length distribution as contemporaneous Japanese commercial catches. (iv) Investigate the effect of alternative assumptions in regard to Lockyer's possible bias in the age reading experiment. (v) Request permission from Japan for continued use of the catch-at-age data, and for permission to use similar data from the most recent JARPA surveys. (vi) Explore how useful it would be for the models to have independent age estimates from corpora counts, to investigate possible age-related biases.	Punt (Convenor), Butterworth, Kitakado, Polacheck.
IWC North Pacific Survey Planning (SG)	(i) Identify medium and long term research objectives for the IWC-Japanese North Pacific surveys. (ii) Develop a (multi-year) research plan to achieve these objectives.	Kato (Convenor), An, Brownell, Clapham, Donovan, Ensor, Matsuoka, Miyashita, Murase, Pastene, Wade.
Survey design for 2010/11 Antarctic minke whale survey (WG)	(i) Consider survey design with respect to spatial and temporal coverage, and ice extent, to reduce ambiguities in interpretation of abundance estimates. (ii) Evaluate and consider adapting survey protocols to facilitate flexible and improved analyses.	Matsuoka (Convenor), Bravington, Ensor, Hedley, Kitakado.

(2) to continue the development of the catch-at-age models of the Antarctic minke whales, including sensitivity tests to examine various assumptions regarding ageing errors and age-length keys; and
(3) to continue the examination of the differences between minke abundance estimated from CPII and CPIII, by further investigation of the relationship between sea ice and minke whale abundance.

Since the highest priority next year will be given to obtaining the abundance estimates of Antarctic minke whales using the IDCR/SOWER survey data, the sub-committee **recommended** that IWC funds be granted to support the work identified in (1) above (see also section 5.1.8; details are provided in Appendix 3). It was noted due to that the intersessional workshop planned for last year had not taken place, and that this had – to some extent – limited the progress that had been made. This year, no outstanding tasks were foreseen that would restrict progress in the same way, and it was expected that the proposed workplan represented the best possible solution for resolving the Antarctic minke whale abundance estimation issues by next year's meeting.

Considerable progress has been made intersessionally on analysing ageing errors with regard to the statistical catch-at-age modelling. The sub-committee **recommended** that the modelling work identified in item (2) continues (see also section 5.2.4), and proposed that the relatively small budget request for this be granted.

The sub-committee has received preliminary investigations suggesting that the apparent decline in Antarctic minke whale abundance from CPII to CPIII may be attributed, at least in part, to changes in sea ice conditions. Further work on this is planned in task (3) above. This work requires a substantial amount of data preparation before any analyses can proceed. The sub-committee supported the funding request for preparing these data, and **recommended** that the analyses outlined be conducted.

As for the preceding SOWER surveys, the sub-committee also **recommended** that funding be provided to enable the 2009/10 IDCR/SOWER survey data to be imported into DESS.

This year, the sub-committee received plans for an IWC-Japanese collaborative North Pacific survey, to form part of a multi-year programme in this region. The sub-committee **recommended** that the funds requested to support this survey be granted, as the survey will, *inter alia*: (i) aim to provide abundance estimates of, and collect genetic samples from, sei whales, which would inform the proposed In-depth Assessment; and (ii) collect data on North Pacific right whales in an area of known historical depletion.

Table 2 shows the intersessional Working and Steering Groups established by the sub-committee.

9. ADOPTION OF REPORT

On behalf of the sub-committee, Kato thanked the Chair and co-Chair for their faithful, thoughtful and calm chairmanship. The Chair expressed his thanks to the sub-committee members for their cooperation and to the rapporteurs for their efforts. The report was adopted at 12:00 on 7 June 2010.

REFERENCES

Branch, T.A. 2006. Abundance estimates for Antarctic minke whales from three completed sets of circumpolar surveys. Paper SC/58/IA18 presented to the IWC Scientific Committee, May 2006, St. Kitts and Nevis, West Indies (unpublished). 28pp. [Paper available from the Office of this Journal].

Branch, T.A. and Butterworth, D.S. 2006. Suggested options for the analysis of IDCR/SOWER minke whale data. Paper SC/58/IA19 presented to the IWC Scientific Committee, St. Kitts and Nevis, June 2006 (unpublished). 10pp. [Paper available from the Office of this Journal].

Bravington, M.V. and Hedley, S.L. 2009. Antarctic minke whale abundance estimates from the second and third circumpolar IDCR/SOWER surveys using the SPLINTR model. Paper SC/61/IA14 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 25pp. [Paper available from the Office of this Journal].

Burt, M.L., Ensor, P. and Borchers, D.L. 2009. Detection probability of Antarctic minke whales: analyses of the BT mode experiments conducted on the IWC-SOWER cruises 2005/06-2007/08. Paper SC/61/IA18 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 14pp. [Paper available from the Office of this Journal].

Hedley, S., Buckland, S.T. and Borchers, D.L. 1999. Spatial modelling from line transect data. *J. Cetacean Res. Manage.* 1(3): 255-64.

Hedley, S. and Ensor, P.H. 2006. A preliminary look at minke whale dive time data from the 2004/2005 IWC-SOWER survey. Paper SC/58/IA21 presented to the IWC Scientific Committee, May 2006, St, Kitts and Nevis, West Indies (unpublished). 7pp. [Paper available from the Office of this Journal].

Hedley, S.L., Bannister, J.L. and Dunlop, R.A. In review. Abundance estimates of Breeding Stock 'D' humpback whales from aerial and land-based surveys off Shark Bay, Western Australia, 2008. *J. Cetacean Res. Manage. (special issue)*.

IWC. 2009. Report of the Scientific Committee. Annex G. Report of the Sub-committee on In-depth Assessment (IA). *J. Cetacean Res. Manage. (Suppl.)* 11: 193-211.

International Whaling Commission. 2010. Report of the Scientific Committee. Annex G. Report of the Sub-Committee on In-Depth Assessments. *J. Cetacean Res. Manage (Suppl.)* 11(2):180-97.

Kanda, N., Goto, M., Yoshida, H. and Pastene, L.A. 2009. Stock structure of sei whales in the North Pacific as revealed by microsatellite and mitochondrial DNA analyses. Paper SC/J09/JR32 presented to the Expert Workshop to Review Results of JARPN II, 26-30 January 2009, Tokyo, Japan (unpublished). 14pp. [Paper available from the Office of this Journal].

Kelly, N., Peel, D., Bravington, M.V. and Gales, N. 2009a. A planned aerial survey for minke whales in east Antarctica during summer 2009/10. Paper SC/61/IA4 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 5pp. [Paper available from the Office of this Journal].

Kelly, N., Peel, D., Pike, D., Bravington, M.V. and Gales, N. 2009b. An aerial survey for Antarctic minke whales in sea ice off east Antarctica: a pilot study. Paper SC/61/IA3 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 14pp. [Paper available from the Office of this Journal].

Murase, H. and Shimada, H. 2004. Possible impact due to variability of sea ice condition on minke whale abundance estimation in the Antarctic, in 1978 to 2004. Paper SC/56/IA10 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 15pp. [Paper available from the Office of this Journal].

Okamura, H. and Kitakado, T. 2009. Abundance estimates and diagnostics of Antarctic minke whales from the historical IDCR/SOWER survey data using the OK method. Paper SC/61/IA6 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 58pp. [Paper available from the Office of this Journal].

Thomas, L., Buckland, S.T., Rexstad, E.A., Laake, J.L., Strindberg, S., Hedley, S.L., Bishop, J.R.B., Marques, T.A. and Burnham, K.P. 2010. Distance software design and analysis of distance sampling surveys for estimating population size. *J. Appl. Ecol.* 47: 5-14.

Wood, S.N., Bravington, M.V. and Hedley, S.L. 2007. Soap film smoothing. *J. Roy. Stat. Soc.* 70: 931-55.

Appendix 1

AGENDA

1. Election of Chair and co-Chair
2. Appointment of rapporteurs
3. Adoption of Agenda
4. Documents available
5. Antarctic minke whales
   - 5.1 Abundance
     - 5.1.1 Report from the intersessional e-mail Working Group
     - 5.1.2 Results from simulated datasets
     - 5.1.3 Comparison of OK and SPLINTR using the reference dataset
     - 5.1.4 Results from each method using their preferred dataset
     - 5.1.5 Abundance
     - 5.1.6 Reasons for differences between estimates from CPII and CPIII
       - 5.1.6.1 Reports on distribution of sea ice
       - 5.1.6.2 Reports from aerial surveys
     - 5.1.7 Planning for a RMP *Implementation* as proposed in SAG report
     - 5.1.8 Work plan
   - 5.2 Catch-at-age analyses
     - 5.2.1 Report from the intersessional working group
     - 5.2.2 Age estimation
     - 5.2.3 Analyses using modified catch-at-age data
     - 5.2.4 Work plan
6. Cruises
   - 6.1 Results from the 2009/10 IDCR/SOWER field studies
   - 6.2 Plans for cetacean sighting surveys in the Antarctic in the 2010/11 season
   - 6.3 Plans for cetacean sighting surveys in the North Pacific
     - 6.3.1 IWC organised sighting surveys
     - 6.3.2 Japanese sighting survey
7. Progress towards an In-depth Assessment on North Pacific sei whales
8. Work plan and budget requests
9. Adoption of Report

Appendix 2

STANDING ON THE SHOULDERS OF GIANTS - THE COMBINED OK-SPLINTR ESTIMATOR

Hans J. Skaug

Summary: It is shown that the average of OK and SPLINTR performs better on the simulated data than any of the estimators individually.

Introduction

At the current Scientific Committee meeting we are considering OK and SPLINTR as competing estimators of Antarctic minke whale abundance. Both estimators account for a large number of features of the IDCR/SOWER data, but nevertheless they give very different results.

Both methods have been subject to extensive simulation testing (SC/62/IA14), and it was found that there is much random variation between the estimators on individual simulation replica, in addition to some systematic difference. This suggests that averaging the two estimators may yield improved statistical properties.

Methods and results

The OK and SPLINTR results for the simulated datasets (school density, 100 replica of each of 54 simulation scenarios) were obtained from the author of SC/62/IA14. Let $d_{ij}^{(OK)}$ and $d_{ij}^{(SPL)}$ be the estimated school density for OK and SPLINTR, respectively, in simulation replica *j* of scenario *i*. Fig. 1 shows the within-scenario correlation r_i between $d_{ij}^{(OK)}$ and $d_{ij}^{(SPL)}$. The correlations range from 0.2 to 0.9 with a mean correlation of 0.6. The fact that the correlation is substantially less than 1 suggests that something can be gained by taking the average of the two estimators. I thus propose a new estimator of school size density (or equivalently whale abundance since OK and SPLINTR agrees on mean school size):

$$d^{(os)} = \frac{d^{(OK)} + d^{(SPL)}}{2}$$

The performance of $d^{(OS)}$ was compared to that of $d^{(OK)}$ and $d^{(SPL)}$ using the mean square error as the criterion:

$$mse(d) = \sqrt{\frac{1}{100}\sum_{j=1}^{100}\left(\frac{d_j - d_{true}}{d_{true}}\right)^2}$$

The main result of this working paper is that $mse_{(OS)}$ = 1.37, $mse_{(OK)}$ = 1.38 and $mse_{(OS)}$ = 1.78, i.e. $d^{(OS)}$ beats both estimators. Fig. 1 shows the results split into scenario.

Discussion and conclusion

Because MSE is a standard measure of performance of statistical estimators, the finding that OS has the lowest MSE suggests that averaging OK and SPLINTR is scientifically defendable. The reason that it is possible to improve on both estimators may be that OK and SPLINTR use different aspects of the IDCR/SOWER data (in some complicated way). The correlations in Fig. 1 support this. The combined estimator makes use of all aspects of data, and is thus to be preferred.

R code

```
d=read.csv("tohans.csv")
mse=function(x) sqrt(sum(x^2))
ind=(!is.na(d$ds.ok))&(!is.na(d$ds.spl))
d = d[ind,]                                             # Remove NA's
d$ds.os=0.5*(d$ds.ok+d$ds.spl)

d$spl=(d$ds.spl-d$ds.km2.act)/d$ds.km2.act
d$ok=(d$ds.ok-d$ds.km2.act)/d$ds.km2.act
d$os=(d$ds.os-d$ds.km2.act)/d$ds.km2.act

plot(tapply(d$os,d$scenario.factor,mse),
     tapply(d$ok,d$scenario.factor,mse))
plot(tapply(d$os,d$scenario.factor,mse),
     tapply(d$spl,d$scenario.factor,mse))
```

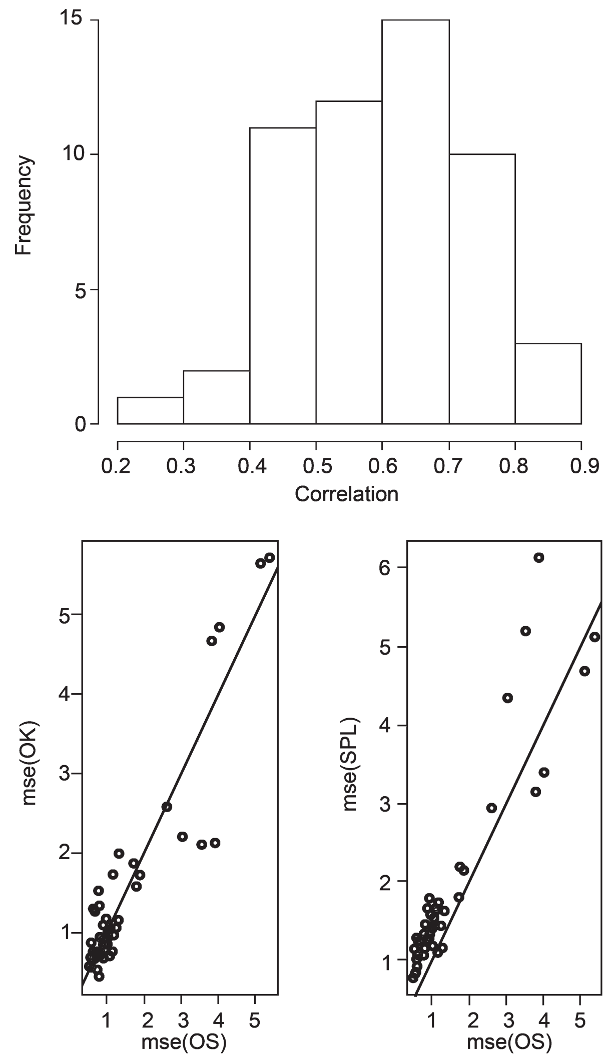


Fig 1. Correlation between OK and SPLINTR within each of 54 simulation scenarios.

Appendix 3

INTERSESSIONAL PROCESS FOR RESOLVING DIFFERENCES IN MINKE WHALE ABUNDANCE

Mark Bravington, Sharon Hedley, Toshihide Kitakado, Hiroshi Okamura and Hans Skaug

Over the past two years, OK and SPLINTR have presented estimates of Antarctic minke whale abundance from the CPII and CPIII IDCR/SOWER cruise data. There are big differences between the estimates, by almost a factor of 2. Such differences are much bigger than the statistical uncertainty, and much bigger than generally seen in the simulated datasets. The extent of differences between each method and the 'Standard' estimates are also perhaps unexpected.

As yet there is no clear explanation for the differences; there is no glaringly obvious deficiency for either OK or SPLINTR in the goodness-of-fit diagnostics considered *so far*. However, the fact is that the estimates are currently incompatible, and there must be some reason. It is important to continue the investigations, not just for understanding the historical abundance and adopting a 'current' abundance estimate, but also for analysing further Antarctic abundance estimates produced by similar survey protocols (e.g. paper SC/62/O16 submitted this year).

Our intersessional work during 2010 has helped to eliminate several possible sources of difference, but has not solved the mystery. We believe that it is important and feasible to continue the investigations, and that there is a reasonable prospect of a timely resolution; the investigations so far have helped focus attention on what the next steps should be, so fewer diagnostics will probably be needed, and the tedious dataset issues which dominated last year's intersessional work have been resolved. This Appendix proposes an intersessional work plan for further investigation, with the expectation of resolving matters for the 2011 meeting.

We will establish an intersessional Group containing the developers, plus other experts in complex abundance estimation problems. The role of the other experts will be to suggest investigations and examine diagnostics. We have proposed a sequence of checks (see below), but the process will be iterative: depending on the results from each check, we may either decide to change what is studied next, or to continue with the next planned check, or to stop because we have worked out the answer.

A timeline is proposed (Table 1). One intersessional Workshop will be required, and there will be email correspondence before and probably after the Workshop. The Workshop should take place preferably this calendar year, and in any case no later than February 2011. Assistance will be required to run some Standard-method analyses on modified datasets. Some further work on Palka's simulated datasets may be required.

Composition

Walløe (Chair), [Branch] Butterworth, Cooke, Palka, Skaug, Wade (advisory experts), Bravington, Hedley, Kitakado and Okamura (developers).

Terms of reference

- Run sensitivity tests on modified real datasets to understand differences between OK and SPLINTR (e.g. in terms of ESW, $g(0)$, MSS, and the underlying sighting parameters).
- Run tests as above to understand differences between OK/SPLINTR and Standard.
- Once we have identified the underlying statistics/parameters where big differences occur, develop ways to cross-check against empirical data.
- If necessary, design further simulation trials to test robustness.

Statistics/diagnostics to be looked at as soon as possible

Investigations during this meeting suggested that estimates of $g(0)$ at size 1 are very different between the methods, and may be a big contributor to the difference in abundance estimates. There are at least two ways that the estimates might be ground-truthed: by using empirical summaries of duplicate frequency in the real data (but some care is needed to select appropriate subsets of the data), and consideration of SOWER BT-NSP results from recent years. This work should be done as soon as possible, since it may redirect our subsequent investigation.

Statistics to focus on

- Empirical perpendicular dist in CL mode (where school size is known), combined with empirical $g(0)$ from recent BT trials.

Sensitivity runs for all 3 methods on real data

These tests have been chosen to be feasible for all methods (except where stated) without major modifications to the *code*, so that we are testing the same model used for the full data; the plan is rather to modify the *data* used. For all of these, the Standard method should be run *without* using encounter rates from Closing mode, for compatibility with OK and SPLINTR. These suggestions are intended to be run in the order given: results from the earlier runs may make the later runs unnecessary. Further tests may be added if necessary.

(1) SPLINTR-like confirmation treatment: set Conf=Yes for all CL. Set Conf = No for all IO.
  - Aim: confirmation has subtle implications for school size issues. Can't change in SPLINTR. Can change in other methods.
  - Feasibility: do-able for all 3 methods.

(2) No SS error
  - Aim: SS error makes diagnosis very confusing.
  - Feasibility: Do-able for all 3. OK just set Conf=Yes for all sightings. SPLINTR: create artificial SSX data with all SSobs=SStrue.

(3) Fix SchoolSize = 1
  - Aim: investigate impact of SS effects (as opposed to $g(0)$/ESW effects).
  - Feasibility: Do-able for all 3 methods.

(4) SPLINTR without Platform C
- Aim: already done for OK, where it had a moderate but unexpected effect on the abundance estimate. Worth checking whether SPLINTR responds similarly.
- Feasibility: do-able for SPLINTR, done already for OK, not so relevant for Standard.

(5) Fix $g(0)=1$ for SPLINTR
- Aim: for comparison with Standard method.
- Feasibility: probably do-able (set all sightings to AB duplicate).

Table 1
Timeline.

Date		Task
01/08/10	(1)	Revised specification of statistics for empirical checks of $g(0)$/esw using SOWER data.
	(2)	Specification of what to report from sensitivity runs (e.g. abundance by stratum; school size frequency by weather…).
	(3)	Specification of any tedious details of sensitivity runs.
01/11/10	(4)	Circulation of results (and developers' comments on them).
By 02/11*	(5)	Intersessional Workshop, with specifications for any further work. (*preferably earlier than February).
15/04/11	(6)	Circulation of results from item (5).

Further work on simulated data

As yet, we have not identified any specific factors that need further testing through simulation. However, if our sequence of checks does identify factors in the real data that have not been tested severely enough in the simulation trials, then a few further trials may be necessary to assess robustness against those factors.

In addition, we have not yet tested the variance-estimation aspects of either method; these will subsequently be of importance to the Scientific Committee regardless of which estimates are ultimately used. This can be done using a single set of 100 scenarios. For purposes of checking variance estimates, it is probably not of critical importance which scenario is used, but the scenario should be complex enough to test all the aspects of the models that can contribute to estimation uncertainty. None of the scenarios tested so far simultaneously include *all* of what we currently consider to be important factors, so one further scenario should be developed that includes all important factors.

Further, it is desirable to have the simulated datasets presented in the same format as the SOWER data itself. The datasets are inevitably complex, and the formats of real and simulated data are currently very different. Using the same format would provide a guard against any differences between performance on real and simulated data that might arise through differences in the reading-in process.

Finally, in the light of our intersessional checks on the real data, it may be necessary to re-process some of the simulation output in order to report other statistics that we discover to be of significance.

Appendix 4

REPORT OF THE SMALL GROUP PLANNING THE 2011 IWC/JAPAN NORTH PACIFIC CRUISE

Members: Kato (Chair), An, Borodin, Brownell, Clapham, Donovan, Ensor, Matsuoka, Miyashita, Murase, Okada, Pastene, Saramillo (Interpreter), Sekiguchi, Yasokawa (Interpreter) and Uoya.

1. CHAIR'S OPENING REMARKS AND APPOINTMENT OF RAPPORTEUR

Kato was appointed as Chair. Ensor acted as rapporteur.

2. TERMS OF REFERENCE

The terms of reference for the group were to undertake preliminary logistic planning for the 2011 cruise. The research objectives were as follows:

(1) to collect data relevant to the proposed future In-depth Assessment of sei whales in terms of both abundance and stock structure;
(2) to collect data relevant to *Implementation Reviews* of whales (e.g. common minke whales) in terms of both abundance and stock structure; and
(3) to collect baseline distribution and abundance data, biopsy samples and photo-id images, for several large whale species/populations, including those that were known to have been depleted in the past but whose status is unclear, in a poorly known area.

These terms of reference do not include the identification of mid- and long-term research objectives for the IWC-Japan North Pacific cruise series. These longer-term objectives would be clearly formulated as part of a coherent multi-year plan developed intersessionally. If possible this could be undertaken at a Steering Group Meeting scheduled immediately prior to the Planning Meeting for the 2011 cruise (see agenda Item 5)

3. ADOPTION OF AGENDA

The agenda was adopted, and forms the basis of this report.

4. CRUISE LOGISTICS

4.1 Availability of vessel

The meeting was informed that the Government of Japan had made the generous offer of a research vessel and crew for the cruise. The actual vessel to be used has not yet been determined but it may be a vessel previously used in the IDCR/SOWER programme; the vessel will certainly have suitable characteristics to be able to undertake the plans outlined in this report and will have space for three or four researchers. Details were also uncertain of the Certification status of the vessel: Japanese domestic vessel or International

Table 1

Preliminary cruise budget for 2011. Figures in UK £ sterling.

Item	Grant	Travel	Insurance	Shipboard	Shore	Bank charges	Total
Cruise							
Cruise Leader	10,310	1,700	100	831	550	30	13,521
Scientist 1	6,200	1,700	100	831	550	30	9,411
Scientist 2	6,200	1,700	100	831	550	30	9,411
Japan	6,200	1,700	100	831	550	30	9,411
Sub-total							41,754
Equipment/communications							
Sighting							
Modification of ICR data logging system							3,000
Biopsy							
Repairs/maintenance Larsen guns							3,000
Darts x 50 @ 31 each							
Plugs x 1,000 @ 1.4 each							
Ammunition x 500							
Photo-id							
Repair/maintenance/transportation IWC cameras							200
Camera batteries (3)							300
External hard drive (2)							300
Communications: Inmarsat time for reception of visibility forecast and sea temperature data and communication with steering group							500
Transportation of IWC equipment and data							1,400
Planning meeting for 2011(2 days)							
Travel and subsistence for 3 participants: 3 x 1,500							4,500
Annual Meeting							
Cruise Leader travel and subsistence							2,500
Total							**57,454**

vessel. The latter could be advantageous to enable the vessel to enter a US port if such a situation arose.

4.2 Length of cruise
The cruise is scheduled for July and August 2011. The total duration of the cruise will be approximately 60 days, comprising approximately 46 days of research time and 14 days of transit between the homeport in Japan and the research area.

4.3 Number of participants
The vessel will have accommodation for a total of three or four researchers. The researchers will include appropriately qualified personnel from the US and Japan.

4.4 Cruise track design and research mode
The research area for the 2011 cruise was defined as the area bounded by longitudes 170°W and 150°W, and extending north from latitude 40°N to the Aleutian Island chain. It was noted that a survey in this area in particular, represented a valuable opportunity to gain information on the status of right whales, as there had been little recent systematic research in this region. Furthermore, the research area included the region where there had been substantial Soviet catches of right whales in the early 1960s.

A preliminary cruise track with a zigzag design was proposed, and a survey protocol using established IWC-SOWER survey methods. Precise details of stratification of the research area, cruisetrack design and survey methods will be finalised at the Planning Meeting.

Given the fundamental importance of accurate distance and angle data, an estimated angle and distance training exercise and associated experiment will be undertaken during the cruise.

4.5 Experiments other than sightings
Biopsy sampling is planned for the cruise and target species will include North Pacific sei, common minke, right, blue, humpback, grey, bowhead and fin whales. Priority species for biopsy sampling will include right whales, North Pacific sei and common minke whales (in regard to potential targets for biopsy sampling, it was noted that detections of Bryde's whales were not expected due to their distribution south of the southern boundary of the research area (on latitude 40°N)). Biopsy of other species, including killer and sperm whales will be attempted on an opportunistic basis.

Photo-id studies and/or video recording of right, blue and humpback whales will be undertaken.

Details of other experiments would be discussed at the Planning Meeting.

4.6 Other
It was noted that difficulties with CITES issues between Japan and Russia had been experienced last year when biopsy samples had been collected by a Japanese vessel inside the Russian 200n.mile EEZ. Furthermore, any IWC-Japan North Pacific cruise that operates in the US EEZ will encounter the same types of CITES problems.

It was **recommended** that to avoid this regrettable situation, CITES permit issues should be resolved as soon as possible and on a long-term basis rather than on an annual basis. It was also **recommended** that the CITES solution would be the establishment of an Institutional permit (for example on behalf of the Institute of Cetacean Research or The National Research Institute of Far Seas Fisheries). Institutional permits were frequently used for transfer of samples between the US and other countries. This would greatly facilitate import/export and future exchange of cetacean samples between institutions in Japan and the US. It was noted that analysis of samples at sea (thus avoiding

CITES issues) was not a valid scientific option as archival of biopsy samples was essential due to the rapid development of the scope of analyses, notwithstanding the difficulties in collection of samples. The Government of Japan **agreed** to investigate the option of establishing an Institutional permit, and would report the results of its investigations to the Planning Meeting later this year (see Item 5).

Regarding the intersessional development of mid- to long-term objectives for the IWC-Japan North Pacific cruises it was noted that Matsuoka, Miyashita and Clapham will provide an updated summary of North Pacific sighting survey data from US and Japanese cruises to the Long-term Planning Meeting (proposed to precede the cruise Planning Meeting).

5. PLANNING MEETING

It was proposed that a Planning Meeting for the 2011 cruise be held during two days in early October 2010. The Planning Meeting will be held in Tokyo, and Kato agreed to be convenor. Participants will include 2 or 3 non-Japanese participants (including Donovan). It was noted that convening a Steering Group meeting to decide on mid- long-term research objectives and formulate a multi-year work plan was vital and it was **recommended** (to help minimise costs) this could occur in conjunction with the Planning Meeting. Three days were suggested for this meeting of the Steering Group and participants would include 3-4 non-Japanese participants (including Brownell, who it was noted would be able to contribute funds for his participation).

6. BUDGET

The plans given above assume the availability of the same level of Japanese funding as for the 2009/2010 IWC-SOWER Antarctic cruise and the 2010 IWC-Japan North Pacific cruise. A budget request to the IWC of £57,454 is requested (Table 1). Brownell expressed his view that Scientist/Cruise Leader grants should not be provided to researchers who have a normal/full-time salary.

Annex H

Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks

Members: Zerbini (Convenor), Robbins (co-Convenor), Allison, Amaral, Baba, Baker, Baldwin, Bannister, Barendse, Best, Borodin, Brandão, Brockington, Brownell, Burt, Butterworth, Campbell, Carlson, Carvalho, Cerchio, Charrassin, Childerhouse, Chilvers, Clapham, Collins, Deimer-Schüette, Donoghue, Ensor, Fleming, Florés, Fujise, Gales, Galletti, Gedamke, Goodman, Hakamada, Hammond, Hatanaka, Hedley, Holloway, Iñíguez, Ivashchenko, Jackson, Jérémie, Kaufman, Kock, Lang, Liebschner, Luna, Lyrholm, Marcondes, Mate, Matsuoka, Mattila, Miyashita, Muller, Murase, Øien, Okada, Okamura, Palka, Pastene, Punt, Roel, Rosenbaum, Sekiguchi, Simmonds, Suydam, Uoya, Uozumi, Urban, Vély, Weinrich, Werner, Williams, Yamakage, Yasokawa, Yoshida, Young.

1. INTRODUCTORY ITEMS

1.1 Opening remarks
Zerbini welcomed the participants.

1.2 Election of Chair
Zerbini was elected Chair and informed the meeting that Robbins would act as co-Chair during the sub-committee's sessions.

1.3 Appointment of rapporteurs
Fleming and Jackson undertook the duties of rapporteuring.

1.4 Adoption of Agenda
The adopted agenda is given in Appendix 1.

1.5 Documents available
Documents identified as containing information relevant to the sub-committee were: SC/62/SH2, SH3, SH5-12, SH14-31, SH33, O2, O12, Bamy *et al.* (2010), Barendse *et al.* (2010), Carvalho *et al.* (In review), Gedamke and Robinson (2010), Murphy *et al.* (1997), Picanço *et al.* (2009), Ritter (2010), Rosenbaum *et al.* (2009), Weir (2007; 2010) and Zerbini *et al.* (2010).

2. ASSESSMENT OF SOUTHERN HEMISPHERE HUMPBACK WHALES

The IWC Scientific Committee currently recognises seven humpback whale breeding stocks (BS) in the Southern Hemisphere labelled A to G (IWC, 1998), which are connected to feeding grounds in the Antarctic. The assessments of BSA (western South Atlantic), BSD (eastern Indian Ocean) and BSG (eastern South Pacific) were completed in 2006 (IWC, 2007a) and BSC (western Indian Ocean) was completed in 2009 (IWC, 2010).

At last year's meeting, the sub-committee identified that completion of the assessment of BSB (eastern South Atlantic) was considered a priority (e.g. IWC, 2010, p.234).

2.1 Breeding Stock B
2.1.1 Distribution
The sub-committee received several papers addressing the distribution, new records or habitat use of humpback whales along the central and northern Atlantic coast of Africa (Bamy *et al.*, 2010; Carvalho *et al.*, In review; Picanço *et al.*, 2009; Weir, 2010). Available evidence continues to suggest that the breeding range of BSB humpback whales (Fig. 1) includes the coastal regions of northern Angola, Congo, Togo, Gabon, Benin, offshore islands (Príncipe and São Tomé), Pagalu and other coastal countries within the Gulf of Guinea. The northernmost authenticated record of humpback whales in this region during the austral winter comes from one sighting and two strandings off the coast of Guinea (Bamy *et al.*, 2010).

2.1.2 Population structure
It has been hypothesised that there may be two humpback whale breeding sub-stocks in the eastern South Atlantic. Breeding sub-stock (BS) B1 winters along the central West African coast and around the northern islands of the Gulf of Guinea. BSB2 has been sampled off the west coast of South Africa (WSA), in an area which appears to serve as a feeding site or possibly a migratory corridor. The actual breeding site of BSB2 is unknown. A boundary between these two sub-stocks has been tentatively placed in the vicinity of 18°S, where the Walvis Ridge meets the African coast and the Angola Current/Benguela Current Front (IWC, 2007b). In this meeting, the sub-committee further evaluated the evidence for BSB sub-structure, in light of new information.

SC/62/SH8 described temporal population structure in humpback whales on the west coast of Africa using maternally (mitochondrial DNA control region) and bi-parentally (10 microsatellites) inherited markers. A total of 2,018 samples were amplified, sexed, genotyped and sequenced from BSB1 (Gabon, Angola, São Tomé) and BSB2 (WSA). The results showed significant differentiation based on haplotype frequencies (FST) and molecular distances (ΦST). Similar results were obtained with the microsatellite data; however very low gene flow was detected between the two regions. Haplotype frequency statistics (FST) suggested seasonal differences between WSA and Gabon. When the samples were stratified by sex, significant differentiation at the haplotype level was found for both sexes and at the nucleotide level only for females. The direct detection of movements by genetically identified individuals, females and males, suggested that interchange occurs between regions. However, all movements detectable to date were from north to south. Overall, these results indicated spatial and temporal population substructure among BSB humpback whales.

In discussion of this paper, it was noted that the results confirm the significant genetic differentiation previously reported between Gabon and WSA, provide additional evidence of very low migration rates between the two areas, and a greater degree of gene flow from WSA to Gabon than

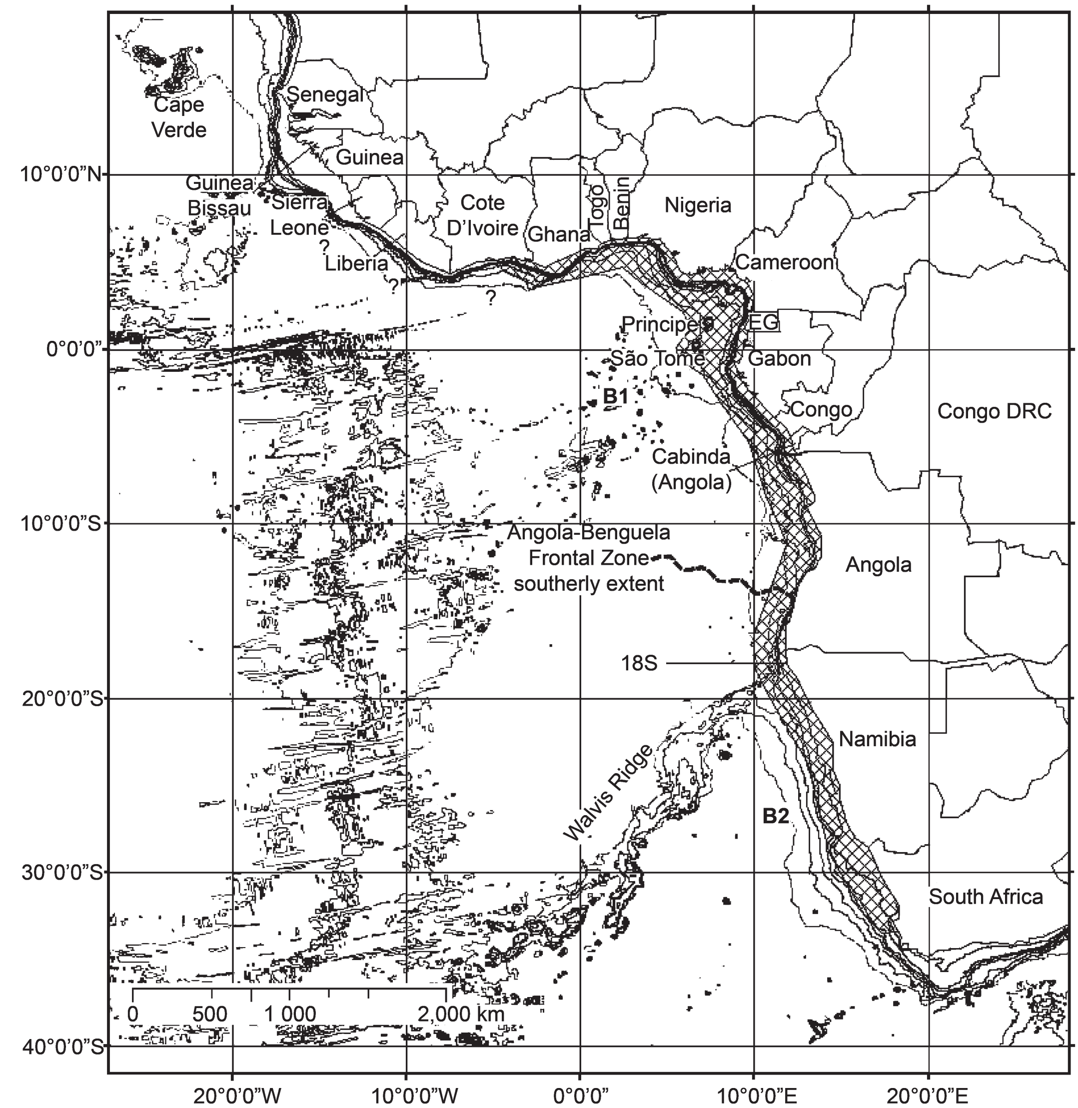


Fig. 1. Distribution of humpback whales in western Africa. The boundary between BSB1 and BSB2 has been proposed to be near 18°S (IWC, 2007b).

in the opposite direction (e.g. Rosenbaum *et al.*, 2009). Differences between these two areas are greater than have been observed between oceanic populations, and are notable in light of the documented photographic and genotypic matches between areas. However, it was noted that the mtDNA migration rates reflects only the female migrants.

The results of SC/62/SH8 suggested directionality of movement and it was noted in discussion that such behaviour could have significant implications for the assessment models. Genetic matches of 11 individuals between areas suggested that animals move from Gabon to WSA as part of their southbound migration. However, sampling effort was also lower off WSA during the period of the northbound migration, and this limits understanding of the potential for migratory movement in that direction.

In further discussion, the question was asked whether the observed genetic differences could reflect maternally directed fidelity to feeding grounds and a shared breeding ground. It was noted in response that the available information was not inconsistent with that scenario, but it also would not explain all of the available evidence. Alternatively, a suggestion was made that genetic differentiation could occur along with observed exchange if animals from BSB2 pass through BSB1 as part of movement between WSA and an unknown breeding site. There is presently no direct data to indicate this behaviour, but it was noted that some individuals satellite tagged off Gabon moved further northwards to Nigeria and into the Gulf of Guinea, as far as Ghana.

SC/62/SH15 examined humpback whale genetic structure in the Antarctic and evidence of connectivity to breeding grounds. This analysis was originally presented in Loo *et al.* (2008), but subsequently updated with samples from the 2006/07 SOWER cruises (increasing the sample sizes for the Nucleus feeding area of BSB). Mitochondrial DNA structure was evaluated for the feeding grounds associated with BSB and BSC, under Allocation Hypotheses 1 and 2 (see appendix 2, fig. 1 of IWC, 2009). Under Allocation Hypothesis 1, Gabon was found to be significantly different from the Nucleus feeding areas of both BSB (10°W to 10°E) and BSC (30°E to 60°E). For Allocation Hypothesis 2, samples from Gabon were found to differ significantly from the BSB nucleus (10°W to 10°E) and BSB/BSC margin (10°E to 40°E), whereas WSA was only found to be significantly different from the B/C margin area. Under both hypotheses, BSC1-3 were significantly different from the B Nucleus feeding area but not the B/C margin or the C Nucleus area. In conclusion, significant differentiation was found between Gabon and the Nucleus feeding region for BSB. The authors interpreted their results to suggest that the majority of Gabon animals may travel beyond the Nucleus area to feed, despite other evidence of exchange. By contrast, the general lack of differentiation between WSA and Antarctic feeding areas suggested connectivity with the Nucleus feeding region for BSB, as well as mixing between WSA and BSC.

Rosenbaum presented the preliminary results of a re-analysis of SC/62/SH15, based on larger sample sizes. This revised analysis detected a significant difference between WSA and both the B and C Nucleus feeding areas, as well as the B/C Margin area. The significant differences between Gabon and the BSB Nucleus feeding areas remained. Nucleus and Margin are new catch allocation areas defined by IWC (2010, p.220).

Additionally, with increased sample sizes from feeding grounds, the Nucleus feeding grounds of B and B/C were found to be significantly different from the feeding grounds associated with C (under Allocation Hypothesis 1, IWC, 2010). Furthermore, no significant differentiation was found among feeding areas under Allocation Hypothesis 2. The authors interpreted these results as broadly indicative of a high degree of mixing and low fidelity to feeding areas.

Carvalho also updated the sub-committee on molecular genetic matches between Gabon, Madagascar and Antarctic feeding grounds. In total, seven matches have been made, including: two between Gabon (BSB1) and Madagascar (BSC3), two between Madagascar and Antarctic feeding grounds and three between Gabon and Antarctic feeding grounds (B Nucleus area).

The sub-committee welcomed these updated analyses and emphasised that this research is and will continue to be relevant to the assessments of Southern Hemisphere humpback whale stocks. The new finding of significant genetic differentiation between WSA and the Antarctic may have resulted from the increased number of samples, or the slightly different distribution of the new Antarctic samples within the Nucleus area. The results had informative implications for the assessment models.

It was further discussed whether the observed genetic differentiation between Gabon, WSA and Antarctic feeding grounds could be consistent with the hypothesis of two different breeding sub-stocks that mix on a shared feeding ground. The sub-committee recommended that a mixed stock analysis should be performed to better inform stock structure assumptions and to increase the available data for assessment modelling. Two initial approaches were suggested. In the first, samples collected at Gabon and WSA would be assumed to represent two discrete breeding sub-stocks mixing in the Antarctic. In the second, the Antarctic and WSA could be assumed to be discrete feeding grounds sharing a breeding ground (Gabon). In both scenarios, samples from the Antarctic would initially be drawn from the Nucleus region for B. However, an additional option would be to combine the Nucleus with the B/C margin, given that analyses currently suggest no genetic differentiation between them. The relative proportions of haplotypes from these sampled populations would then potentially inform the allocation of catches in the assessment model for areas of putative population mixture. It was noted that exchange with adjacent stocks (such as the levels of gene flow between BSB and BSC) could positively bias the estimates of mixing proportions, since allocation will not include the possibility of connections with other regions. However, it was suggested that the effect of introgression of haplotypes from neighbouring regions may be detectable and excludable in the fit of the model to the data.

Rosenbaum also presented a preliminary analysis of mitochondrial differentiation on feeding grounds (10°W-10°E), by latitudinal gradient. Of 110 Antarctic samples studied, 65 were obtained north of 60°S and 45 were collected south of that latitude. Genetic analyses suggested no significant difference between Gabon and samples collected north of 60°S. By contrast, WSA differed from samples obtained both north and south of 60°S on the basis of FST. In the case of the exact test, significance was found only for the samples obtained north of 60°S. The authors interpreted these preliminary results as indicative of some type of latitudinal variation in the distribution of BSB whales in the Antarctic.

The sub-committee also considered new photo-id matching results relevant to the stock structure of BSB, as described below.

SC/62/SH10 presented preliminary results of photographic matching between Gabon (n=1,297), WSA (n=510) and Antarctic Areas II and III (n=130). Fluke type 1 (mostly white) was found to be the most predominant pigment type in the catalogues. Fluke type 3 was the second most commonly observed off WSA and Gabon while types 2, 3 and 4 were relatively equal within the Antarctic Humpback Whale Catalogue (AHWC) holdings for Antarctic Areas II/III. A total of three matches (2 females and 1 male) were found between Gabon and WSA. All resighted whales were seen in late spring and summer months off WSA and in winter months off Gabon. One individual was sighted off Gabon in August and then three months later off WSA in November where it was resighted two months later, apparently remaining in the area during the interim. The same individual had also been sighted on two other separate occasions around a plankton haul and while defecating, further indicating that some feeding activity may occur off WSA. Though two matches were initially found between the WSA catalogue and the AHWC, it was revealed that the 'Antarctic' sightings were actually made during the first day of a SOWER cruise departing from Cape Town and were therefore discounted as matches to the Antarctic Area III.

Discussion of these results focused on the question of whether some of the individuals detected off Gabon have a consistently lower probability of capture than other individuals. Lower capture probabilities can stem from a variety of causes, including less time spent within the sampling area, and could have important ramifications for assessment modelling. To date, there has not been a genetic analysis taking individual sighting histories into consideration (i.e. individuals seen once versus those seen multiple times), but such analysis could potentially be informative. It was noted that goodness of fit tests could be performed on the mark-recapture data from Gabon and WSA to determine first whether there is evidence of significant heterogeneity in the sampled populations (i.e. over time and across seasons).

SC/62/SH31 reported the results of photo-id matching of fluke photographs between WSA (BSB2) and an independent catalogue of whales from the south coast of South Africa and southern Mozambique. The former contained 510 images of 161 individuals. The latter catalogue (311 images of 303 whales) presumably contains east coast humpback whales from BSC1 photographed in the southern migratory corridor off South Africa, and the northern migratory corridor/ breeding ground off southern Mozambique. No matches were detected. It was noted that the independent catalogue was not representative of all whales photographed off the east coast of South Africa, and that the substantial number of images held by Oceans and Coast (the South African governmental agency) have not been compared to WSA.

The sub-committee recommended that every attempt should be made to compare WSA fluke photographs to holdings in the Oceans and Coast catalogue noted above.

Barendse *et al.* (2010) described the results of shore-based observations on humpback whales off Saldanha Bay, WSA. This area was presumed to be a migration corridor for whales from the postulated BSB2 breeding sub-stock. The primary objective of this study, carried out between July 2001 and February 2003, was to examine seasonality of relative abundances (expressed as sightings per unit search effort) of humpback whales. Historical evidence and more recent observations have pointed to a summer presence of whales beyond the time when the southward migration was expected to have ended. The results of this study showed the highest relative abundances from mid-spring (October) through to summer for both field seasons. There were slight relative abundance peaks during mid to late winter, at the time that should correspond to a northward migration; however, these were low compared to the summer relative abundances. Observations of swimming speed, direction and linearity (a migration index) showed mid-spring to be a turning point in the behaviour of whales, after which most appeared to be non-migratory, displaying significantly slower swimming speeds, and non-directionality of movement compared to before this season. Direct observations of feeding and defecation suggest that most humpbacks seen from late spring to late summer probably feed on crustacean prey (including euphausiids). Analysis of seasonal sex composition revealed a significant female bias during mid-spring, possibly explaining male-biases observed on breeding grounds elsewhere. The authors concluded that the area off WSA is not strictly a migration corridor, but also a significant summer feeding ground for humpback whales. Whether it should be regarded as supplementary to a primary Antarctic feeding area, or a primary feeding area in itself for some whales, remains unclear. Furthermore, observations do not exclude the possibility of a strictly migratory component during winter and early spring off WSA, although it is difficult to distinguish from non-migratory whales from available data. Satellite telemetry may be the only method that could help to address this question.

It was noted in discussion that the prevailing evidence suggests that WSA is more consistent with a feeding site than a breeding site, but the individuals sampled there may still represent a separate breeding sub-stock from BSB1. Two predominant activity types were reported off WSA (feeding and travelling), and sub-committee discussion focused on whether differential availability of these whales might have resulted in a bias in the sampling. It was clarified that if such a bias did exist, it would likely favour resident animals.

SC/62/SH5 reviewed the catch history, seasonal and temporal trends in availability and the migrations of humpback whales along the west coast of southern Africa. The major period of catching prior to WWI was relatively poorly documented in terms of the species composition and even the numbers taken, with estimates frequently having to be made from oil production and/or contemporary catches in other regions or by other operations. Humpback whale seasonal availability was distinctly bimodal off South Africa, Namibia and Angola (with the peaks converging with decreasing latitude), but unimodal in Gabon, a pattern that contemporary observers equated with migration. Differences in the timing of the peaks suggested a 'migration speed' of 441-553km/week, consistent with earlier estimates from other areas. After the initial decline in availability in all areas pre-WWI, the catch history in Gabon (where there were apparent recoveries between successive episodes of whaling) differed markedly from those in the three southern grounds, especially off South Africa (where there were no such signs of recovery between almost contemporary episodes of whaling). This suggests some degree of stock sub-structure within BSB. Differences in current genetic composition between whales sampled in Gabon and off the west coast of South Africa have been proposed as evidence of separate breeding stocks, but 11 genetic or photographic matches between the two areas indicate that physical exchange between the regions is not uncommon. An alternative hypothesis of a single breeding ground (in the Gulf of Guinea) but separate, maternally-directed migratory routes to and from different feeding grounds, was proposed.

In discussion of this paper, some commented that the hypothesis of a shared breeding ground was unlikely, noting the strong molecular genetic differentiation between Gabon and WSA, and the absence of strong evidence for maternal fidelity to feeding sites in the Antarctic. Others responded that understanding of movements on and return to Southern Hemisphere feeding grounds is still too limited to exclude the possibility of site fidelity.

The sub-committee concluded the following based on its review of all available information on stock structure.

(1) There is more than one genetically distinct humpback whale population in the eastern South Atlantic.
(2) Gabon is a breeding ground and WSA exhibits characteristics of both a feeding ground and a migratory corridor.
(3) At least some of the animals sampled at Gabon migrate to the Antarctic to feed. That migration may follow an inshore route (via WSA), an offshore route or both. In the latter scenario, individual migrants may maintain fidelity to a particular route or may alternate routes.
(4) Some of the whales that breed at Gabon may maintain maternal feeding site fidelity to west South Africa, such that they do not migrate to the Antarctic.
(5) Individuals observed at WSA may migrate to an unidentified breeding site that is distinct from Gabon. If so, some fraction of those individuals may pass through Gabon, *en route* to that breeding site. Alternatively, the breeding ground of these individuals may lie between Gabon and WSA.

Best commented that the concept of adjacent contemporary breeding stocks in lower latitudes would be a novel one for large baleen whales, and difficult to accept logically without some identification of a mechanism to prevent inter-breeding. He felt that a single breeding stock but with maternally directed migration corridors to feeding grounds was a more plausible scenario.

2.1.3 Abundance estimates

SC/62/SH2 reported on results of within-region photo-id and genotypic matching for WSA. The photo-id catalogue considered tail flukes (TF), right dorsal (RDF) and left dorsal fins (LDF) (including the caudal peduncle knuckles) as identification features. These images were collected from various sources between 1983 and February 2008, with the greatest collection effort corresponding to a period of dedicated humpback whale study based at Saldanha Bay (2001-07). Between-year matching was completed for each ID feature separately; this resulted in the identification of 145 individuals by TF, 237 by RDF and 230 by LDF. Combined ID features, taking into account full sighting histories and using all available identification features including microsatellites, were used to examine attendance patterns within and between years, and a total of 289 individuals were identified in this manner. Looking at the combined-feature database, the authors noted that only 53% of individuals were represented by tail flukes, while about 75% were represented by dorsal fins. It therefore appears that a significant component of the whales at WSA do not display their tail flukes. Between-year matching revealed a relatively high re-sighting rate (using combined features) with 44 individuals seen between years. The longest period between first and last sighting was 14 years, and the average period was 3.4 years. Different types of resightings (one-off, within years and between years) distributed by season showed that most resighted animals were seen from January to April, with this component growing from October onwards. In the winter months, all whales sighted were one-off sightings, alluding to a possible strictly migratory component, as opposed to a more non-migratory (resighted) one seen in other months. Preliminary population estimates using the Chapman's modified Petersen estimator between pairs of six sampling periods (the spring and summer seasons of 2001-07) highlighted two major trends. First, there was considerable variation for the estimates for different pairs of sampling periods: this was attributed to differences in collection effort and method between these periods. The second trend was that there was considerable variation between estimates obtained using different ID features, with RDF giving the highest, TF giving the lowest, and genotypic matches providing intermediate estimates. The very low estimates based on TF suggest that the low incidence of fluking may bias the estimate based on this ID feature negatively. It was further suggested that the higher estimate on RDF could be positively biased due to possible higher numbers of false negatives that may occur using this feature; this needs to be further examined.

Discussion of SC/62/SH2 focused on the reliability of the various datasets for mark-recapture analysis, especially in the context of the assessment modelling. Dorsal fins were the most frequently marked feature in the WSA dataset and yielded the highest abundance estimates. However, multiple marks confirmed that dorsal fin matches were also the most likely to be missed. The authors were surprised to find lower dorsal fin abundance estimates for the left side. They did not photograph distinctive whales preferentially and so laterality of distinctiveness was not thought to be a factor. It was suggested that mark-recapture estimates be undertaken using only the highest quality subset of the dorsal fin data in order to better understand the potential for over-estimation of abundance. However, it was also noted that removing low quality images may inadvertently exclude individuals with lower probabilities of detection (given fewer opportunities to obtain adequate documentation).

With respect to the other available data, the sub-committee observed that the microsatellite data were likely to be the least biased and produce the more precise estimates. However, use of microsatellite data will lead to positively biased abundance estimates if no correction is made for genotype matching errors (e.g. McKelvey and Schwartz, 2004). Some believed that microsatellite based estimates would likely be more comparable to fluke data after such a correction, and that flukes might therefore be the more appropriate feature to use in the event that no such correction could be made. It was further noted that flukes were the basis for assessment modelling of BSC and so most consistent with past work. However, the probability of obtaining a fluke photograph depends on the behaviour of the individuals and so use of flukes will lead to a negative bias if fluking rates are individually different (i.e. if there is heterogeneity). The effects of animal behaviour can potentially be evaluated with fluking rate data. As long as the reason for missing flukes is not due to individual differences then low fluking rates should not bias a population estimate. Microsatellite and photo-id provides the only common datasets for evaluating interchange between Gabon and WSA. Furthermore, only microsatellites permit estimates to be stratified to account for sex-based differences in encounter rates on breeding grounds.

The authors had combined some features for the purpose of exploration, recognising that such combinations might have undesirable effects on population estimates. In discussion, it was noted that while multiple marks can identify missed matches, there may still be a 'tag loss' effect on such abundance estimates if the same suite of features were not captured for all individuals on all occasions.

SC/62/SH11 presented estimates of abundance for humpback whales in Gabon for the period 2001 through 2006, using photographic and genotypic data. The sub-committee discussed the mark-recapture data described in the paper, but the abundance estimates will be evaluated at next year's meeting.

For the purpose of exploration, the initial modelling at the meeting focused on microsatellite data for Gabon and flukes for WSA. However, in light of the issues discussed above, further work is necessary to identify the best data to use in assessment modelling of WSA. Additionally, concerns had been expressed that genotype-based abundance estimates (both direct and population model based) were likely to be appreciably positively biased unless corrections for genotype error can be incorporated. It was concluded that methods and data for addressing genotype error and inter-area exchange in the assessment model be evaluated intersessionally.

2.1.4 Assessment

In its assessment of BSC, the sub-committee used a struck and lost rate of 30% for humpback whale catches in modern whaling prior to WWI (IWC, 2010). SC/62/O2 reviewed first-hand accounts of whaling operations for the period 1880-1915 and the results suggested that the rate used previously was too high. The firing of 31 harpoons resulted in the death of 19 whales, but with no instances of a lost whale. In addition, published logbook data for a catcher in 1917 indicated a struck and lost rate of 7.1%. SC/62/O2 therefore concluded that in 95%-ile terms, an upper limit to the struck and lost rate at this stage in modern whaling would be approximately 15%.

The sub-committee also reviewed the geographic distribution of historical catches in the context of potential allocation to BSB and its sub-stocks (Table 1). In a review of these data, it was noted that the largest component of the

Table 1

Cumulative historical humpback whale catches on BSB feeding and breeding grounds.

Feeding grounds	Total	Breeding grounds	Total
Margin Area AB (50% of A/B)	677.5	Congo	13,145
Nucleus Area B	3,702	Congo/Angola	2,208
Margin Area BC (50% of B/C)	3,164.5	Angola	10,948
		Namibia	1,774
		SW Cape	1,713
Total	7,544.2	Total	29,788

catches came from breeding grounds. Given the assumption of a boundary between BSB1 and BSB2 at 18°S (IWC, 2007b) catches off WSA and Namibia would have been drawn from BSB2. Congo catches were assumed to be drawn from BSB1. There was less certainty regarding the proper allocation of catches off Angola. The sensitivity of the models to assumptions of catch allocation were subsequently explored.

The sub-committee discussed the use of minimum past population sizes (N_{min}) (Jackson *et al.*, 2007) in the population assessment models. N_{min} values of 68 and 24 were calculated for Gabon and WSA respectively (see Appendix 2).

SC/62/SH30 presented three stock structure hypotheses that were used in the assessment models. These hypotheses included: (1) a single, fully-mixed stock; (2) two breeding stocks that mix only on the feeding grounds; and (3) two breeding stocks with partial migratory overlap along the west coast of Africa. Model inputs included historic catch data, absolute abundance data and capture-recapture data.

It was noted in discussion that models 1 and 2 in SC/62/SH30 were no longer considered plausible in light of current evidence. The sub-committee therefore focused its attention on the development of additional plausible stock structure hypotheses. These were developed primarily on the basis of the new information presented. A series of model runs were undertaken to inform the sub-committee on the implications of model selection, as well as the variety of potential input data. Six models and their variants were run during the meeting. Preliminary results suggested that stock structure hypotheses had little implication for the assessment of the sub-stock breeding off Gabon (BSB1). However, the population trajectories varied widely for the other sub-stock found off the west coast of South Africa (BSB2). Based on these results, the sub-committee concluded that additional modelling was required and **agreed** upon a suite of the models that would likely be most informative for assessment (Tables 2 and 3). They were further ranked by analysis priority, as shown in Tables 2 and 3. For each input data type, a reference case and variants were also specified (Table 4). The sub-committee noted that current hypotheses are driven by the available data, and there is inadequate coverage to infer or fully understand structure along some parts of the west African coast.

In conclusion, new information received by the sub-committee (from WSA, in particular) had resulted in a productive discussion of the stock structure of BSB and the work required to complete the assessment. However, there was not adequate time to undertake that work during the meeting. The sub-committee therefore **agreed** to allow intersessional analyses of existing data and modelling, with a plan to complete the assessment during next year's meeting. No new data would be allowed and an intersessional e-mail group would be established to facilitate progress. The details of this work are further specified under Item 6.1.

2.2 New information

2.2.1 Breeding Stock A

SC/62/SH27 reported the movement of an individual humpback whale from Brazil to Madagascar. This whale was genetically identified as female and was first identified on Abrolhos Bank, Brazil (17°49.25'S, 38°43.41'W) in August 1999. The whale was photographed just over two years later in September 2001 from a commercial whalewatching tour vessel in the channel between Ile Sainte Marie/Nosy

Table 2

Priority stock structure hypotheses identified for intersessional BSB assessment modelling. Boxes and place names refer to the actual site where data are available, with the exception of a hypothesised breeding ground of unknown location (identified by dashed circles).

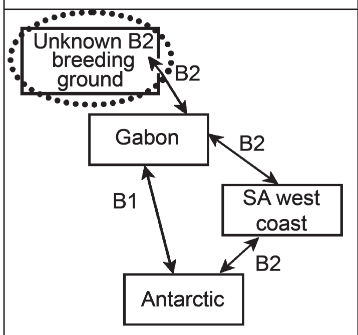
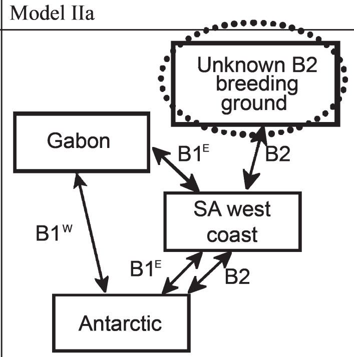
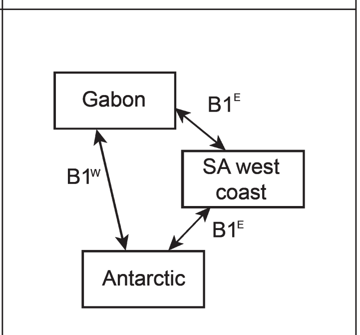
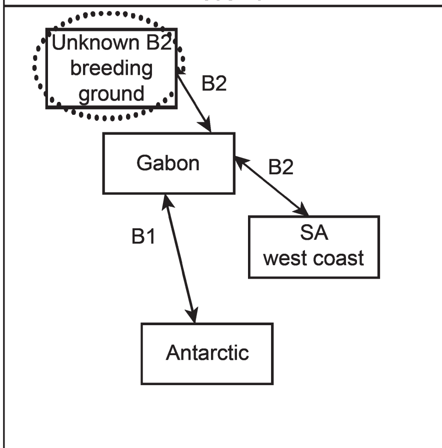
Model Ia	Model IIa	Model III
		
Model description: model assumes two independent breeding sub-stocks which can mix on Antarctic feeding grounds. Whales from breeding sub-stock B1 feed in the Antarctic and migrate to Gabon for breeding. Whales from breeding sub-stock B2 feed off WSA and migrate along the West African coast through Gabon to a separate unidentified breeding ground. Additionally, some portion of B2 animals migrate to Antarctic feeding grounds. Variants on this model were not considered priority for the assessment of BSB.	*Model description:* model assumes two breeding sub-stocks, B1 and B2. B1 has two migratory components, B1E and B1W. Whales from B1W migrate from Antarctic feeding grounds directly to Gabon while whales from B1E migrate through waters off west South Africa before continuing on to the Gabon breeding grounds. Whales from sub-stock B2 feed primarily off WSA, do not migrate past Gabon and migrate to a separate unidentified breeding area. In addition, some portion of animals from sub-stock B2 migrates to Antarctic feeding grounds. Variants on this model were not considered priority for the assessment of BSB.	*Model description:* model assumes a single breeding stock, B1, with two migratory components B1W and B1E. B1W migrates directly to Gabon from Antarctic feeding grounds while B1E migrates through waters off west South Africa before continuing on to the Gabon breeding grounds. The proportion of animals using each migratory route may change over time.

Table 3

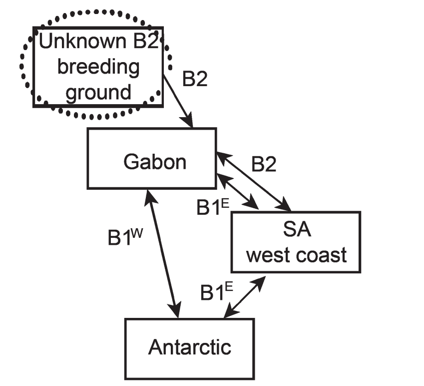
Secondary stock structure hypotheses identified for intersessional BSB assessment modelling. Boxes and place names refer to the actual site where data are available, with the exception of a hypothesised breeding ground of unknown location (identified by dashed circles).

Model Ib



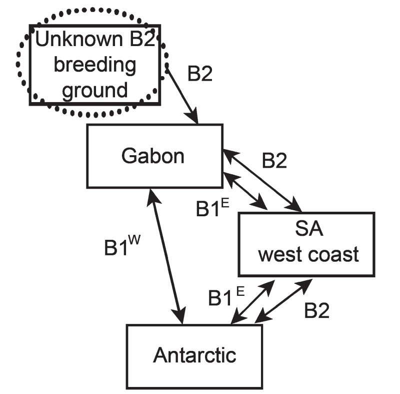
Model description: A variant of Model I in which two independent breeding sub-stocks which do not mix on Antarctic feeding grounds. B1 feeds in the Antarctic and migrates to Gabon for breeding. B2 feeds off WSA and migrates along the West African coast through Gabon to a separate unidentified 7.

Model Ic



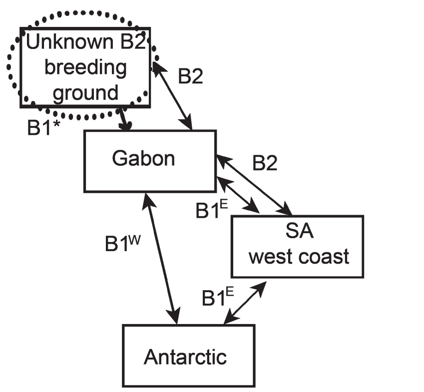
Model description: A variant of Model I in which breeding substock B1 has two migratory components, B1E and B1W. B1W migrates directly to Gabon from the Antarctic feeding grounds. B1E migrates through the waters off west South Africa before reaching the Gabon breeding grounds.

Model Id



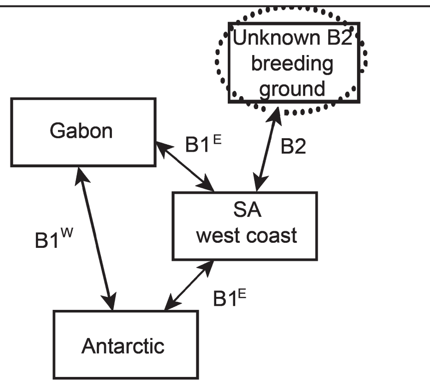
Model description: A variant of Model I in which some proportion of sub-stock B2 also migrates to Antarctic feeding grounds.

Model Ie



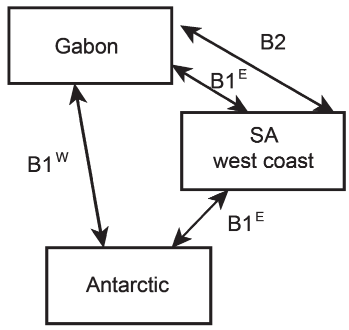
Model description:
A variant of Model I in which some proportion of sub-stock B1 migrates through Gabon to a separate unidentified breeding area.

Model IIb



Model description:
A variant of Model II which assumes two breeding stocks, B1 and B2. B1 is assumed to have two components, B1E and B1W. B1W migrates directly to Gabon from Antarctic feeding grounds while B1E migrates through waters off west South Africa before continuing on to the Gabon breeding grounds. B2 feeds off west South Africa, does not migrate through the Gabon breeding ground and migrates to a separate unidentified breeding area.

Model IV



Model description:
This model assumes two feeding sub-stocks. B1 is assumed to have two migratory components, B1E and B1W. B1E passes through west South African waters before going to Gabon while B1W migrates directly to Gabon breeding grounds from Antarctica. B2 feeds off west South Africa and migrates to Gabon breeding grounds.

Table 4

Input data selected for use in assessment modelling, specified by reference case and variants.

Data category	Population	Reference case	Variants
Capture-recapture	Gabon	Microsatellites* (males-only)	Flukes; microsatellites (both sexes)
Capture-recapture	WSA	Microsatellites*	Right dorsal fin; flukes
N_{min}	Gabon	68 haplotypes (see Appendix 2)	None
N_{min}	WSA	24 haplotypes (see Appendix 2)	None
Catch allocation (North of 40°S)	Gabon	Congo and 50% Angola	Congo and Angola; Congo only
Catch allocation (North of 40°S)	WSA	50% Angola, Namibia and WSA	Namibia and WSA; Angola, Namibia and WSA
Catch allocation (South of 40°S)	Gabon	Retain Allocation Hypothesis 1	None
Catch allocation (South of 40°S)	WSA	Retain Allocation Hypothesis 1	None
Migration to unknown breeding ground	Gabon	25% (i.e. Model Ie)	None
Migration to Antarctic	WSA	50% (i.e. Model Id)	100%; 0% (does not migrate)
Struck and loss rate	Both	0.15 (see SC/62/O2)	-0

*In the case of capture-recapture data, microsatellites will only be used as a reference case if genotyping errors can be incorporated into assessment models. Otherwise flukes will be used.

Boraha and the east coast of Madagascar (approx 16°50'S, 49°50'E). This constitutes a displacement between non-adjacent breeding stocks (A and C3) with a minimum swimming distance of >9,800km and is a new mammalian distance record. The individual was female, contravening the prevailing belief that males more commonly travel longer distances between breeding habitats. The authors noted that their finding highlights the value of opportunistic data collection from whalewatching vessels, and the importance of comparing identified individuals between areas without preconceptions about probable destinations. They also concluded this match provides further evidence that longitudinal movement may be an important feature of humpback whale habitat use in the Southern Hemisphere.

The sub-committee welcomed this very interesting finding and noted that connection between ocean basins, or the existence of long distance movement, has also been observed through the transmission of song between breeding grounds such as Brazil and Gabon, and Gabon and Madagascar (Darling and Sousa-Lima, 2005; Razafindrakoto *et al.*, 2009). It was further noted in the context of inter-basin movements that haplotype analysis of a recent stranding in Indonesia suggested genetic similarities with Brazil, which deserves additional consideration by researchers from Indonesia and Brazil. The sub-committee recognised that while this photographic match provides additional evidence that extraordinary long-range longitudinal movements may occur, these appear to be the exception rather than the rule and should not be over-interpreted. Within-region matches over multiple years have been made on breeding grounds, including Oceania (Garrigue *et al.*, 2004), suggesting considerable site fidelity in the midst of the movements reported from these occasional matches.

SC/62/SH28 presented an update of the density and abundance of the BSA in the Brazilian coast. An aerial survey was performed in 2008 covering the Brazilian coast up to the 500m isobath, from 5° to 24°S. The study area was divided into eight strata, covering a total area of more than 174,000km^2. Data were collected with a double engine aircraft equipped with bubble windows on both sides, which flew at a height of 1,000ft and a speed of 90kn. Abundance and density were estimated through multiple covariate line-transect distance sampling. More than 2,700n.miles were covered and 308 groups of humpback whales were observed. The abundance of whales for the Brazilian coast in 2008, considering $g(0)$=0.68, was estimated to be 9,330 whales (95% CI=7,185-13,214; %CV=16.13). Alternative estimates were provided based on different strategies of bias correction with correcting group size underestimation or alternative $g(0)$. Comparing to previous aerial surveys (2001-05), this stock is undergoing a steady growth. The authors noted that further studies were necessary to reduce uncertainties associated with $g(0)$ estimation and other potential sources of bias. The Humpback Whale Institute is planning a new aerial survey in 2011.

The sub-committee welcomed this survey, which provides a good means to estimate long-term trends for this population. In response to a query, the author noted that weather conditions were good during the surveys, which were only conducted in Beaufort sea state 4 or lower. It was noted that although there had not been any accounting for perception bias in this survey, there are plans to do so in upcoming years.

The sub-committee noted concerns raised during the Hobart Intersessional Workshop for the Comprehensive Assessment of Humpback Whales (IWC, 2007b) regarding the use of the methods of Kinas *et al*. (2006) to estimate $g(0)$. The use of a ratio between the population size estimate from distance sampling (assuming $g(0)$=1) and an independent population size estimate based on capture-recapture methods is inappropriate for estimating $g(0)$ because the different methods have different assumptions and may not be estimating the same population. The author noted that this estimate was used to explore alternative scenarios and was not the main estimate of $g(0)$ used in the study.

2.2.2 Breeding Stock D

SC/62/SH21 described the deployment of satellite tags on southward migrating whales off Kimberley coast, north-western Australia. A total of 23 tags were deployed, and provided 263 days of location data (over 1,250 individual locations after filtering) over a total distance of nearly 20,000km. These datasets will be used to define the spatial and temporal migratory behaviour of humpback whales that winter off western Australia. Despite poor tag survival statistics, the Kimberley deployment has provided the most detailed movement data for humpback whales off northwestern Australia to date. This dataset has also revealed a previously unrecognised migratory behaviour - two of the four whales that provide location data south of Exmouth Gulf, deviated from the expected migratory route close to the coast of Western Australia and were tracked 1,200km into the Indian Ocean.

The sub-committee welcomed this important work and noted that the longevity of the tags used in this study was less than that in studies previously developed along the eastern coast of Australia (Gales *et al.*, 2009). It was observed that deploying satellite tags in deeper areas of the breeding ground off Brazil had doubled tag duration, possibly because tagged whales were less likely to contact the seafloor or because lower whale densities resulted in less physical contact between individuals. In response to a query, it was noted that deployments slightly forward to the dorsal fin and close to the midline of the whale (e.g. fig.3 in Gales *et al.*, 2009) are preferable because they provide the best uplink conditions. It was also observed that these telemetry data are not necessarily informative as to whether whales may be double counted in line-transect aerial surveys conducted off western Australia (Hedley *et al.*, 2009) because counts are carried out during the northbound migration whereas the tagged whales were travelling southbound.

SC/62/SH24 described an unusual peak in recorded mortalities of humpback whales in Western Australia. In 2009, an unprecedented number (*n*=47) of humpback whales were found dead or dying on Australian beaches. Only a few mortalities have been reported per year in previous decades. Most whales were estimated to be calves of the year (44%), with the remaining composed of juveniles/sub-adults (37%) and adults (19%). Many appeared to be grossly underweight, however there was insufficient data available with which to determine cause of death. Three hypotheses were proposed by the authors to explain this peak in recorded mortalities: (1) it does not represent an increase in mortality rate, but is an artefact of searching effort and coastal oceanography; (2) it represents a transient increase in mortality rates, driven by unknown causes which may be associated with processes on the feeding grounds, breeding grounds or both; and (3) it represents the start of an increasing trend in mortality rates, driven by unknown processes on the feeding grounds, breeding grounds or both. The authors considered the latter two hypotheses to be the most plausible, but noted that additional research would be required to discriminate between them.

In discussion, it was noted that continued monitoring of strandings in this region is important, and might inform as to whether this event was related to unusual climatic or oceanographic conditions in the preceding year, or the dynamics of a population approaching carrying capacity. In this regard, it was noted that an unusual die-off of right whales has recently been reported in Argentina (SC/62/ProgRepArgentina), and that one proposed hypothesis is that it reflects a shortage of prey, although no clear cause for this mortality has yet been identified. It was noted that krill cycles are well described in the South Atlantic, and contribute strongly to breeding success in penguins, fur seals and probably also whales (Leaper *et al.*, 2006). However, the eastern Antarctic system is quite different; though currents may be more transient in this region, it is not known if this would potentially dilute the effects of dramatic krill changes in a localised area or increase the time spent foraging with corresponding fitness implications. CCAMLR observations of this system may be able to shed more light on the relationship, although substantial uncertainty currently exists regarding the relationship between krill and whales in this region.

2.2.3 Breeding Stocks E and F

SC/62/SH21 described results from satellite tag deployments on northward migrating humpback whales off Evans Head, eastern Australia. A total of 13 tags were successfully implanted, and provided 371 days of location data (over 1,350 individual locations after filtering), which allowed whales to be tracked for nearly 21,000km. This study will be used to define the spatial and temporal migratory behaviour of humpback whales that winter off eastern Australia. It also provides the first detailed movement data of this species in their proposed calving area around the southern Great Barrier Reef.

In discussion, it was observed that most of the satellite tagged whales were males and that the all of these movements occurred coastally within the Great Barrier Reef (GBR) region. This result was unexpected, considering that this region has only recently been considered a primary breeding ground and that most whales were previously thought to travel to the Coral Sea or the Chesterfields.

SC/62/SH7 reports on a large collaborative comparison of microsatellite genotypes of humpback whales from the migratory corridors of eastern Australia (*n*=734 unique individuals from Byron Bay, Ballina and Hervey Bay, courtesy of Southern Cross University), the South Pacific Islands (Oceania, *n*=1,086 unique individuals, courtesy of the South Pacific Whale Research Consortium) and Antarctic feeding Areas I-VI (*n*=175 unique individuals, courtesy of IDCR/SOWER). Following methods generally described in Steel *et al*. (2008), whales were individually identified from sloughed skin and biopsy samples using 12 microsatellite loci, mtDNA haplotypes and molecular sex identification. Based on matching of unique genotypes, migratory interchange was detected between humpback whales in eastern Australia and New Caledonia (*n*=11) and eastern Australia and Tonga (*n*=1). Migratory interchange was also detected between eastern Australia and summer feeding grounds in Antarctic Area V (*n*=3). There were no whales from eastern Australia detected moving outside the boundaries of Area V (130°E-170°W), despite larger sample sizes in feeding Areas IV and VI. Given that the IUCN has listed the humpback whales from Oceania as endangered, these results have implications for the management of humpback whales in eastern Australia and Oceania (Areas V and VI), because individuals from different breeding sub-stocks may be mixing on both the breeding and feeding grounds. Additionally, this study confirms that the collaborative standardisation of research methods between research groups allows for large-scale matching to investigate migratory interchange (and abundance) of humpback whales.

The sub-committee welcomed this work and noted its relevance for the upcoming assessments of BSE and BSF. In discussion, it was observed that results from this document are consistent with previous data, suggesting that Oceania and east Australia are somewhat isolated from one another (Garrigue *et al.*, In press-b). These data are also consistent with earlier evidence of rare movements between these areas as suggested by Discovery Marks (e.g. Dawbin, 1964). It also was noted that the majority of migrants reported in this study were males (11/15); however notable female movements have also been documented. The prevalence of male matches may have resulted, in part, due to the larger sample sizes obtained for males on breeding grounds and migratory corridors (Brown *et al.*, 1995). It was suggested that collection of genotype data in Hervey Bay, an area known to show changes in the age and sex composition of groups over the course of the season (Franklin *et al.*, In review), may create a bias in sample collection with respect to sex. Female movements such as those between Australia and Oceania reported in SC/62/SH7 have also been documented across Oceania (Garrigue *et al.*, In press-a), and now even between ocean basins (e.g. SC/62/SH27 in Item 2.2.1). In response to a query, it was noted that fluke photographs are available for four individuals among the genotype matches from New Caledonia and therefore movements of these individuals may have previously been reported based on photo-id data. It was also noted that photo-id data is not always associated with the genotyped whales from Australia because sloughed skin samples are collected in Hervey Bay and therefore they cannot be attributed to any individual whale.

SC/62/SH25 presented the results of the first on-water survey and photo-id effort for humpback whales in the Great Barrier Reef Marine Park Cairns/Cooktown Management Area. A total of 138.9 hours were spent on the ocean near Port Douglas/Cairns area, covering 2,540.96km during 21 days in the field, 21 July through 16 August 2009. Twenty-eight groups of whales were observed and comprised 55 animals (33 adults, 12 sub-adults and 10 calves). An average of 2.6 (total) animals were observed each day. The average number of groups observed per day was 1.3, with a mean group size of 1.96 whales. Calves were observed in 10 groups (30%) all of which contained only one calf. Singleton groups were mainly sub-adults (70%). Single adults (*n*=3) were not observed until 13 August, with one recorded singing. During the course of the study, 1,419 digital images were collected and 24 whales were individually identified (16 adults, 6 sub-adults and 2 calves). Five of the 16 adults identified were females accompanied by newborn calves (light grey/white, folded dorsal fins, and <5m). The mean water depth for all whales observed was 26.7m and ranged from 18.8-37.5m. For pods with calves, mean depth was 27.7m and for non-calf pods mean depth was 30.8m. The mean sea surface temperature was 24°C with a range between 23.3-25.1°C. Singing behaviour was observed on five different daily sampling sessions, with songs recorded on three occasions. An additional seven whales were opportunistically identified by Cairns whalewatch operator 'Reef Magic'. These animals were compared to Pacific Whale Foundation's 'Breeding Stock E/Area V Humpback Whale Catalogue'. Seven whales photographed off Port Douglas/Cairns were confirmed to be re-sights of whales in the Catalogue (22.6%). The presence of small, light grey coloured newborn calves in this study is remarkable. Thirty percent of the groups observed contained a calf, compared with previous findings of 11.1% in the Whitsunday Islands - a previously described calving/breeding area. The early presence of mothers with young calves, along with a high percentage of sub-adult whales suggests that migration patterns of east Australian humpbacks may not be as straightforward as previously reported. The high proportion of mother-calf pods observed near Port Douglas/Cairns in July also contradicts previous findings that males typically lead the migration to the breeding areas and outnumber females by a ratio of 2.4:1. The re-sighting histories of seven individuals identified offshore of Port Douglas/Cairns supports interchange between the Whitsundays, Hervey Bay and Eden. All re-sighted animals showed site fidelity for Hervey Bay. Aerial surveys are planned for 2010 to augment vessel surveys to refine distribution and abundance of humpback whales in the Port Douglas/Cairns region of the CCMA. Pacific Whale Foundation continues to make their 'Breeding Stock E/Area V Humpback Whale Catalogue' available to other research groups for comparison.

The sub-committee welcomed this report. In discussion, it was noted that there is a project underway to analyse opportunistic aerial survey data from previous coastal monitoring programmes (e.g. Coastwatch and 'Eye on the Reef') and to include new information from research conducted in the Great Barrier Reef to update a previous analysis presented by Chaloupka and Osmond (1998). These analyses shall assist in clarifying humpback whale habitat use in this area and will be presented to the sub-committee in the upcoming year(s).

SC/62/SH14 presented realised growth and survival rates of Breeding Stock E1 humpback whales identified off Hervey Bay, Queensland and Eden, New South Wales, Australia (1994-2009) estimated from a photographic capture-mark-recapture study of post-yearling whales. Annual realised growth rate and seniority estimates were derived using Pradel's temporal symmetry models in the program MARK. To minimise bias, study sites and demographics were preliminarily investigated using Cormack-Jolly-Seber (CJS) models. Sites HB and ED, and combined (HBED) all failed goodness-of-fit Test 3.SR and had best fitting TSM (time since marking) models suggesting similar biological processes in both sites. The datasets were therefore combined for demographic analyses. Failure of test3.sr may be a result of transients or of considerable differences in vital rates of demographic groups. To evaluate the cause of test3.sr failure, the vital rates and best model fit of three demographics were compared using CJS models. Adult (n=1,860) and sub-adult (n=1,233) groups were modelled together for comparison. Competing models from the candidate set indicated transients in the adult population and potentially also in the sub-adults (inconclusive). Models detected no differences in recapture between groups. Best fit model estimates of annual adult survival were 0.925 (0.946-0.961) and 0.70 (0.587-0.793) for sub-adults. The fully parameterised global model for reproductively active females fit the data well with no goodness-of-fit test component failures (from program RELEASE). For temporal symmetry modelling, females were modelled as one demographic. Transients are a violation of Pradel model assumptions and had to be removed from the other demographics by suppressing first encounters. The removal of transients resulted in sparse data which made it necessary to combine age-groups thereby including unknown whales into a 'post yearling' dataset for temporal symmetry modelling. Best model estimates of realised growth rates for post yearlings were: 12.4% (9.3-15.6%) and 10.7% (8.4-13.0%) for reproductive females. The study also used Pradel's temporal symmetry models to estimate the relative contributions to population rate of change by using the seniority parameter (γ). Where γ is the relative contribution of survival to population growth, and its complement (1-γ) is a measure of the contribution of recruitment. For both groups, contributions of recruitment were quite low. Depending on the demographic (reproductive females or post-yearling whales), survival was either 9.9 or 6.3 (respectively) times more important to population growth than recruitment for BSE1 humpbacks. Several caveats were noted, particularly with regard to the potential bias resulting from the removal of transients from the post yearling group. However the results were considered to be within the range of recent estimates from land-based counts, vessel surveys and photo-id studies. The effect of transients over extended time periods on estimates of population abundance and rate of increase will require a comprehensive comparison of all available photo-id images for this stock of whales. Because rate of change was found to be particularly sensitive to post-yearling survival, the authors concluded that any increased anthropogenic or environmental pressures adversely affecting survivorship is likely to impede the recovery of these populations.

The sub-committee expressed appreciation for this information, which will be particularly informative in light of upcoming assessment of BSE1. It was suggested that presentation of further details about the mathematical models used in SC/62/SH14 would be desirable to assist the sub-committee members in interpreting results of these types of analysis. The sub-committee discussed the presence of 'transients' in the data (indicated by a greater than expected number of whales captured only once during the course of the study). It was suggested that 'transience' is largely caused by the presence of sub-adults (with lower associated survival rates) in the dataset. However, it was noted that the best fitting models that excluded 'transients' resulted in low survival and high growth rate estimates, which is unlikely. While lower survival estimates may be caused by the presence of additional, undetected, transient individuals, the 'transient-excluded' models should have accounted for their removal. Yet, these models still had very low survival rates. It was suggested that low survival probabilities may have instead reflected a degree of temporary emigration (e.g. into Oceania), and that Pollock's robust design model (Kendall *et al.*, 1997) may be of use for exploring this possibility. The sub-committee encouraged pursuing additional models that may help to clarify these issues.

SC/62/SH18 reported estimates of abundance from humpback whales breeding in Oceania (New Caledonia to French Polynesia). This was estimated using quality-controlled datasets of individual identification photographs (1999-2004; 660 individuals) and microsatellite genotypes (1999-2005; 437 males, 277 females). Regional estimates of closed population abundance were greatest for Tonga (n=1,840 using genotypes and n=1,168 CV=0.16 using photo-id), with about half this number in French Polynesia (n=934 using genotypes and 440 CV=0.23 using photo-id) and New Caledonia (n=804 using genotypes and 383 CV=0.35 using photo-id). A Pradel model showed no significant trend in abundance for this population, supporting the conclusion from previous population dynamic models that recovery in the region is much lower than in the adjacent eastern

Australia. The genotype database revealed a sex bias in capture towards males (1.6:1, males: females), so genotypic estimates of abundance were derived by doubling the male-specific estimates, assuming that the true sex ratio is at parity. There is a significant transience signal in the dataset, which may indicate that a proportion of the whales captured in the survey region are travelling to areas not yet surveyed in Oceania. The most optimistic estimate of total abundance for Oceania is estimated at 3,520 whales (CV=0.1) in 2005, using the POPAN model estimate of total 'super-population' abundance. However it is likely to be positively biased by the assumption of zero mortality over the survey period. Among all other male-derived genotype abundance estimates presented in this study (range of n=1,000-4,800), the male-specific Pradel and POPAN estimates from 2003 were closely similar (doubled estimates of males; POPAN n=2,361 CV=0.11; Pradel n=2,304). The POPAN 2003 estimate is therefore proposed as a reasonable estimate of abundance in the Oceania primary survey regions, while the true abundance in the wider Oceania area is likely to fall between this estimate and the higher super-population estimate of 3,520 whales.

The sub-committee welcomed this new abundance estimate, for which funds were received by the IWC. In discussion, the sub-committee noted that the photo-id and genotype data used in the analysis were collected simultaneously. Therefore, some degree of overlap between the two datasets is expected and they should not be presently combined. It was noted that the implications of transience for the estimates of abundance reported in SC/62/SH18 merits further exploration, which will help to better understand the population structure in the region for the purposes of the assessment.

2.2.4 Breeding Stock X

SC/62/SH6 described the genetic distinctiveness and decline of humpback whales in the Arabian Sea. The Arabian Sea has been grouped by the IWC with the Southern Hemisphere distribution as Breeding Stock X (IWC, 2004). Mitochondrial (mt) DNA and nuclear microsatellite data were combined for an expanded number of samples (n=47 individuals) from the Arabian Sea and compared with the genetic regions described in Rosenbaum *et al*. (2009), in order to test hypotheses on the origin and connections of BSX, and to assess the status of the population. Reduced genetic diversity for BSX was confirmed by both mtDNA and microsatellite analyses. Genetic analyses based on 11 microsatellite markers and mitochondrial DNA sequences (485bp) revealed significant differentiation between whales sampled off the coast of Oman (n=67), in the Arabian Sea, whales sampled in the North Pacific and in four Southern Hemisphere regions (microsatellites, smallest F_{ST}=0.0387, p<0.001; mtDNA, smallest F_{ST}=0.112, p<0.000). F-statistics indicate these levels of differentiation are among the highest recorded for population differentiation among any humpback whale populations worldwide. MDIV coalescent analyses showed that BSX diverged earliest from the North Pacific (T>2), and at a later time from the Southern Hemisphere stocks, with the closest divergence time between BSX and BSC (T=0.1684) estimated at ~35,000 years ago. Posterior distributions of migration rates (M) showed that since divergence, limited gene flow has been exchanged between BSX and the Southern Hemisphere. Multiple tests showed a consistent signature of a recent bottleneck between 20ya and ~6,450ya, and pre-bottleneck population sizes between ~550 and ~2,100 animals. Results therefore show that the Arabian Sea population originated most likely as a consequence of an expansion followed by a contraction of the range of southern Indian Ocean whales, or as the result of an immigration event. Although historical gene flow seems to have occurred after divergence, it is very unlikely that migrants are currently being exchanged between the Arabian Sea and the southern Indian Ocean stocks. Shared haplotypes may in fact be simply the result of shared ancestry. The whales in this area represent a unique and isolated population. The estimated time of bottleneck (20-5,400ya) is compatible with whaling (40ya) but cannot exclude an earlier date, or multiple bottlenecks. In favour of a recent bottleneck hypothesis, tests of population expansion suggest that the population has not yet started recovering and may still be in decline.

SC/62/SH20 presents a summary of the population status for humpback whales in the northern Indian Ocean. Both historical whaling data and field research during the period 2000 to 2006 confirm the presence of an isolated resident sub-population of humpback whales in the western Arabian Sea, with an estimated population of 82 (95% CI 60-111) individuals. No dedicated surveys were undertaken on this endangered population during 2007, 2008 or 2009. However, a boat survey was conducted during January/February 2010 in the Gulf of Masirah. Two weeks of survey effort revealed no sightings of humpback whales. Subsequent shore-based observations further south (in the Dhofar region of Hasik) resulted in several sightings over the course of a few days including a resighting of a known individual. In May 2010 further sightings were made during an offshore seismic survey for hydrocarbon reserves. Beach surveys during February and May 2010 revealed 10 stranded baleen whales in the Gulf of Masirah region, including three Bryde's whales entangled in gillnets. At least one live gillnet entanglement is known to have occurred during the period 2007 and 2009. Fishing activity was noted to have increased in the Gulf of Masirah, with up to 60 large fishing vessels recorded per day during 2010 boat surveys, compared to an encounter rate of 5-6 vessels per day during 2003/04 surveys. Government of Oman fisheries statistics reveal a doubling of licensed fishing vessels between 2006 and 2008. Coastal development has also increased with construction of new ports and harbours (including high speed ferry terminals), coastal highways, housing and other development. A large new port at Duqm will divert shipping from one of the world's busiest shipping lanes across known humpback whale habitat. Health concerns were also identified for humpback whales, with over 25% of individuals investigated showing persistent tattoo skin disease. Threats to Breeding Stock X are known to be escalating as fisheries activities, coastal development, shipping, noise and other pressures expand, and intensify. This trend is set to continue in light of human population growth (3.14% per year in Oman) and economic development.

The sub-committee thanked the authors for both papers, noting that this information, in combination with the evidence for genetic distinctiveness, heightens concerns over this population. In spite of these rising concerns, the Arabian Sea population receives disproportionately meagre support for its research and conservation, despite its current status and inferred decline. This population was recently listed by the IUCN as endangered, and in this context it was noted that other populations of similar status (e.g. western gray whales, eastern North Pacific right whales) are appropriately given high levels of recognition and directed research under the IWC and that this high-risk population should merit similar consideration. It was further noted that while the current research was directed at humpback whales, a number of other baleen whale species are also under threat in this region. The sub-committee **strongly recommended** the continuation of research on humpback whales in the Arabian Sea in light of the small population size and escalating threats facing this population (see also Annex J, item 9.3). It particularly noted the difficulty of undertaking such studies for small populations in remote areas.

The sub-committee proposed a series of recommendations for this breeding stock, which they **agreed** to re-name as the 'Arabian Sea population', discontinuing use of the term 'BSX'. These recommendations are ordered by priority.

(1) Studies that enable identification and quantification of threats to the Arabian Sea population should be initiated, including an in-depth investigation into the impact of bycatch.
(2) Studies and surveys in Oman should be continued and expanded in scope to include more detailed genetic, acoustic and behavioural studies, as well as satellite telemetry studies.
(3) Surveys should be encouraged in additional locations in confirmed range countries (Kuwait, India, Iran, Iraq, Oman, Pakistan, Sri Lanka, United Arab Emirates, Yemen), with particular focus on those countries with large coastal regions, such as Pakistan and India. In this regard, abundance surveys should be repeated on a regular basis in order to enable determination of population abundance and trend.
(4) Further investigation into humpback whale occurrence in suspected/potential range countries (Bahrain, Maldives, Qatar, Saudi Arabia) should also be conducted.
(5) Studies and surveys to determine the population identity of whales in the Seychelles Exclusive Economic Zone should be performed.

The Scientific Committee **endorsed** the use of satellite tagging in order to better understand the distribution and movements of this population, though noting that the same precautions used to consider satellite tagging programmes for the western gray whales be applied to this population.

2.2.5 Feeding grounds

SC/62/SH3 described the first pilot study on cetacean distribution off Adélie Land (IWC Area V), the CETA programme (CEtacean distribution in Terre Adélie) which was launched by the French Polar Institute (IPEV). An opportunistic sighting survey was conducted in January 2010 using the R/V *Astrolabe* as a platform of opportunity during an oceanographic survey conducted in coastal waters between 140° and 145°E. Two dedicated observers collected 38 sightings on the continental shelf off the Adélie Land coastline, totalling a minimum of 84 individuals. The sighting effort was 80h. Six Antarctic blue whales, two humpback whales and a number of Antarctic minke whales were identified, as well as type A and C killer whales. Three blue whales and the two humpback whales were photo-identified. One of the two humpbacks was previously photo-identified in Hervey Bay, east Australia in 2002, confirming the migratory link between breeding stock E and area V. A biopsy was collected from one humpback whale. Interestingly, humpback and blue whales were sighted very close to the coastline in the Mertz Glacier Polynya. The second year of this study will be conducted in January 2011, after which data will be combined in an attempt to evaluate relative abundance of cetaceans in the region. This work is a part of the Southern Ocean Research Partnerships on non-lethal whale research (SORP).

The sub-committee recommended the continuation of this programme and thanked the authors for this interesting study, noting its relevance and utility for the upcoming assessments of BSE and BSF. It was added that the humpback whale originally observed in Hervey Bay and matched with this catalogue has also been re-sighted in 2008 off Eden, NSW, further strengthening the migratory connection between the east coast of Australia and Antarctic Area V.

SC/62/SH19 reports on species identification of whale bones collected between 2006 and 2007 from abandoned whaling stations at South Georgia, extending the previous pilot study of Lindqvist *et al*. (2009). This is preliminary work originating from the MSc research of Angie Sremba, Marine Mammal Institute, Oregon State University. The maternally inherited mitochondrial DNA (mtDNA) control region was sequenced (300-500bp) to identify the bone samples to species using the web-based program *DNA Surveillance*. Of the 281 available bone samples, 232 provided DNA of sufficient quality for species identification; 162 humpback whale, 48 fin whale, 19 blue whale, 1 sei whale, 1 southern right whale and 1 elephant seal. The prominence of humpback, fin and blue whale bones in the sample correspond to the early catch record of the whaling industry from South Georgia Island. The historical diversity, as revealed by the mtDNA haplotypes, will be compared to large contemporary samples from humpback whales (e.g. Olavarría, 2007; Rosenbaum *et al*., 2009) and blue whales (LeDuc *et al.*, 2007) in an effort to measure the extent of the 'exploitation bottleneck' of stocks around South Georgia.

The sub-committee welcomed this work and strongly encouraged the continuation of bone collection for 'historical' DNA analysis. The sub-committee noted that this research will be important for the comparison of historic and current population abundance and diversity. The potential risk of sampling the same individual multiple times was discussed. It was clarified that the great abundance of whalebone specimens present in the region allowed for the collection of bones likely belonging to distinct individuals, and that care was taken to choose bones which are not found in large numbers per individual (e.g. ear-bones). It was noted that the great haplotypic diversity found among the whales identified so far (nearly one haplotype lineage per individual) suggests that replication is not a major concern for this dataset.

SC/62/O12 presented a preliminary science field report from the joint Australian-New Zealand Antarctic Whale Expedition, which carried out a six week, non-lethal whale research voyage to Antarctic waters, departing from New Zealand on 15 March 2010. A number of major objectives were accomplished, including the completion of the first successful non-lethal whale research voyage which directly contributes towards the core research projects of the Southern Ocean Research Partnership, and demonstration of a successful model of using small boats, working around a capable ship, for non-lethal whale research in high latitude high seas. Thirty humpback whales were satellite-tagged on these Southern Ocean feeding grounds, and over 60 biopsy skin samples and approximately 60 fluke photo-ids were also collected from this species. In addition, humpback whale 'songs' were recorded on the feeding grounds. This is the first documented record of singing on these Southern Ocean feeding grounds.

Passive acoustics were also used to track and locate vocalising Antarctic blue whales, beginning at a distance of over 100n.miles. There was also some detection of sounds most likely associated with Antarctic minke whales; a species that has been historically difficult to define acoustically. This cruise also included the collection of hydro-acoustics data of whale prey in regions of high and low whale densities which can be used to better define the correlations between krill and whales in the Southern Ocean.

The sub-committee welcomed this research as a tremendous effort and significant contribution to upcoming assessments of humpback stocks BSE and BSF. The sub-committee also noted that this research greatly enhanced the understanding of a highly under-surveyed region and **recommended** that this type of investigation continue and be expanded to other areas in the Southern Ocean.

It was recognised that the progress made thus far on matching individuals between the feeding areas surveyed in SC/62/O12 and neighbouring breeding grounds, through the collaboration of multiple genetic databases, would be especially useful in upcoming assessments. The sub-committee **recommended** that such collaboration be enhanced in the future. The sub-committee also recognised that the transparent data sharing that has occurred post-expedition has been immensely productive with respect to matches identified with the east Australian breeding region.

In response to a query about movement patterns of tagged humpback whales, it was noted that some latitudinal movement was observed, but the majority of the movements were longitudinal and close to the ice edge. It was noted that success of tagging attempts varied by species, but that this expedition had allowed for the development of species-specific strategies which could help improve tag deployment. In future years there is additional intent to focus on satellite tagging of minke whales in addition to humpback whales.

Acoustic detections on the cruise included low numbers of encounters with fin whales (three significant encounters with large groups). In response to a query as to whether pygmy blue whale calls were detected on the transit legs, the authors noted that no transit detections have been made to date, and that analysis of these recordings is still ongoing. With respect to observations of entanglements and fishing gear, it was observed that no entangled whales were encountered, although thorough photo-id data (including the caudal peduncle region, where evidence of entanglement is usually seen) are available for interested researchers to assess for evidence of fishing gear.

2.2.6 Preliminary multi-stock assessment

SC/62/SH33 reported preliminary results from the development of an assessment process that aimed to include all seven Southern Hemisphere humpback whale breeding stocks in a single joint assessment, with the purpose of allowing high-latitude historic catches (i.e. catches taken south of 40°S, where mixing amongst the populations occurs), to be allocated to breeding stocks in proportion to abundance, rather than on set ratios.

The approach could in due course be broadened to allow for uncertainties in the placement of the boundaries assumed to link high latitude catches to breeding stocks. It also incorporated the assumption that the intrinsic growth rate (r) parameters for the various stocks are realisations from a common distribution, thus allowing for data on each to be mutually informative without requiring all to have identical values. Because of the interaction between populations arising from the procedure to allocate high latitude catches amongst breeding stocks, the conventional SIR-based Bayesian approach proved impractical to implement. Instead uniform priors on the various pre-exploitation level (K) parameters were assumed with the intent to later iteratively adjust these to account for their being informative about the values of the r parameters. Initial results were presented purely for the purposes of illustrating the application of the approach.

In discussion, the authors noted that the choice of the upper bound of the prior on K were chosen on the basis of previous population assessments, and were set high enough to allow the inclusion of any viable possibilities, while low enough to allow reasonable computation times. These analyses are still subject to Borel's Paradox, where the uniform prior on K influences r; for this reason the model presented is still under development and suggestions for additional testing and development of this model are welcomed.

The sub-committee looks forward to seeing developments in this model presented at next year's meeting.

2.3 Antarctic Humpback Whale Catalogue

SC62/SH17 reported on interim progress of the Antarctic Humpback Whale Catalogue (AHWC), an international collaborative project maintained by the College of the Atlantic (COA). The collection has grown substantially in size and geographic scope and now contains records of individual whales collected throughout the Southern Ocean Sanctuary, in all of the Antarctic Management Areas, the feeding grounds in southern Chile and also in most of the known or suspected low-latitude breeding areas, allowing comparisons to be made between all of the major regions used by Southern Hemisphere humpback whales without preconceptions about expected movement patterns. During the contract period, the AHWC catalogued 899 photo-id images representing 721 individual humpback whales from Antarctic and Southern Hemisphere waters. These images were submitted by 21 individuals and research organisations. Photographic comparison of submitted photographs to the AHWC during the contract period yielded 34 previously known individuals. These submissions bring the total number of catalogued whales identified by fluke, right dorsal fin/flank and left dorsal fin/flank photographs to 3,665, 413 and 407 respectively.

Matches made during the contract period to previously sighted individuals include re-sightings between breeding stock G and the Antarctic Peninsula (19), between breeding stock G and Chile (3), between breeding stock A and breeding stock C3 (1; see SC/62/SH27) between breeding stock E and the Antarctic Peninsula (2, see Robbins *et al.*, 2008). Within-region re-sightings were identified in the Antarctic Peninsula (3) and breeding stock G (11). Progress continues in efforts to stimulate submission of opportunistic data from eco-tourism cruise ships in the Southern Ocean and from research organisations and expeditions working throughout this region and the Southern Hemisphere.

The availability of these data has broadened our understanding of the exchange between areas and in some cases provided information that was previously not available. A photograph collected from a whalewatching vessel contributed to the first re-sighting between breeding group A and breeding group C identified during the contract period (SC/62/SH27). A new on-line catalogue using Flickr is being developed and tested. This can be viewed at *http://www.flickr.com/ahwc*.

The sub-committee noted the importance of this work, the valuable support provided by the IWC and the extensive effort that has been invested in the catalogue. The sub-committee **recommended** this work to continue especially in light of the progress thus far and the valuable role this information has played in informing population assessments.

3. IN-DEPTH ASSESSMENT OF SOUTHERN HEMISPHERE BLUE WHALES

3.1 New information

An updated line transect estimate of blue whale abundance (further to Williams *et al.*, 2009) was presented from SOWER surveys of blue whales in southeast Pacific waters off Chile (18°30S to 38°S). This re-analysis used methods developed by Hedley and Bravington, which have improved both the abundance and variance estimates. The new spatial model used soap film smoothers, which addressed problems with 'edge' effects. Additionally, improved methods were used to propagate the variance from the model through to the resulting abundance estimate. Abundance was estimated at 303 animals (95% CI 217-455). This new estimate was considered in a simple population dynamics model described previously (Branch *et al.*, 2007). The population was hunted between 1908 and 1972, when 5,782 individuals were caught off Chile, Peru and Ecuador. Minimum conservation status of Chilean blue whales was assessed in a population dynamics model that incorporated the abundance estimate and two historic catch series: one with catches definitely taken in Chilean waters; and the other including all catches in the southeast Pacific. Likely population growth rates were taken from a meta-analysis of rates of increase in large baleen whales. The surveys do not cover the population's entire known range, but if it is conservatively assumed that the estimate applied to the entire population, then the population was at a minimum of 8.9% (95% CI 6.1-13.2%) of pre-exploitation levels under the Chilean catch assumption, and 6.8% (95% CI 4.6-10.1%) of pre-exploitation levels under the southeast Pacific catch assumption.

In discussion, it was noted that this level of population recovery (>8%) is similar to that reported previously by Branch *et al*. (2007).

The sub-committee also received preliminary estimates of blue whale abundance off Isla de Chiloé, southern Chile, based on aerial line-transect surveys carried out in 2007, 2009 and 2010. Estimates for *g*(0) were made based on the proportion of time blue whales were at the surface. Abundance estimates with correction factors for *g*(0) were 97 (CV=0.51), 154 (CV=0.32) and 163 (CV=0.39), respectively. The increase in abundance over years does not necessarily reflect an increase in abundance but rather differences in survey coverage and whale distribution. Blue whale abundance in this region is still considered to be low and therefore vulnerable to lethal anthropogenic impacts.

In discussion, it was noted that the aircraft used had precluded observation of the track line so that the perpendicular distance data had been left-truncated at 900m. Estimates are susceptible to the level of left truncation, and further investigation on these issues appear to be warranted. This may suggest some adjustment of field protocols for future surveys where observers searching patterns are more focused closer to the track line. In discussion, it was suggested that the survey would benefit from including a *g*(0) correction for perception bias, i.e. by surveying from double platforms. However a correction for availability bias had been applied and it was observed that the perception bias for conspicuous whales such as blue whales is generally low. In response to a query, it was noted no new information was available on line-transect surveys covering the Corcovado Gulf, south of Isla de Chiloé.

At last year's meeting, the sub-committee noted that available line transect estimates of blue whale abundance are likely not to represent the total size of the stocks. It had therefore recommended the design and implementation of alternative approaches of abundance estimation. In this meeting, Bannister reported on the progress of an intersessional e-mail group tasked with coordinating researchers to develop mark-recapture estimates of blue whale abundance for western Australia, Chile and other areas, as possible. This information is summarised below.

Surveys carried out by a collaborative research programme (the Alfaguara Project) off Isla de Chiloé between 2004 and 2009 have resulted in the photo-identification of 301 individual blue whales. Approximately 19% of catalogued individuals have been re-sighted within the same season, and 33% between years. Recaptures of photo-identified individuals from other areas in northern and southern Chilean waters suggest that the feeding ground offshore of southern Chile is extensive and dynamic. Overall, the annual return and sighting rates suggest that the waters off northwestern Isla de Chiloé and northern Los Lagos are one of the most important aggregation areas known for this species in southern Chile and the Southern Hemisphere.

The sub-committee welcomed this information and noted that these data have the potential to provide useful additional information on blue whale abundance. Hammond confirmed that he is already collaborating with the authors to produce mark-recapture estimates of abundance with these data.

The sub-committee was informed that a preliminary reanalysis of mark-recapture photo-id data collected from pygmy blue whales in the Perth Canyon, western Australia (2000-10). This was originally presented by Jenner *et al*. (2008). Abundances were derived from boat-based surveys conducted between 2000 and 2010. Proportions of re-sightings ranged from 0-23% (average 8.24%). Analysis was carried out using the POPAN super-population model with time-dependent captures, constant survival and zero entry probabilities, since this is the best fitting model suggested by Akaike Information Criterion values. This model was applied to the 2000-10 dataset and provided a population size estimate of 921 individuals (95% CI=637-1,389), which is similar to the estimate previously reported from the 2000-05 dataset (95% CI=712-1,754 individuals).

It was noted in discussion that the POPAN model may not be the most appropriate choice for fitting these data, given the low number of inter-annual resightings. Clarification was also sought regarding the POPAN entry probabilities, which are required to sum to one in this model, but have been reported as totalling zero. Overall, it was suggested that mark-recapture analyses might more productively focus on closed mark-recapture models, applied to the years with the largest sample sizes (2003-05).

There has been considerable progress on the development of a cooperative Southern Hemisphere blue whale photo-id catalogue (SHBWC) with support from the IWC. In June 2009, regional coordinators discussed the terms of agreement relating to image searching, matching protocols, and photo quality inclusion criteria. To ensure the property rights of images and data, it is currently agreed that SHBWC terms of reference and data sharing agreements should be signed before receiving a basic username and password. Groups that contribute photographs are granted full access to the catalogue.

It was agreed that only perfect to good quality photographs will be uploaded, with two photographs of each side of the whale included when available. To date, nine groups have signed the SHBWC terms of reference and data sharing agreement, including researchers in Chile, the Eastern Tropical Pacific, Australia, Sri Lanka and Antarctica.

The sub-committee welcomed this important work and **recommended** its continuation. In discussion, it was noted that this cooperative group includes the majority of research groups currently studying blue whales in the Southern Hemisphere. The sub-committee also **recommended** that a progress report from the groups contributing to the Southern Hemisphere blue whale catalogue to be presented at next year's meeting.

As recommended last year, the Institute of Cetacean Research (ICR) photo-id catalogue of Antarctic blue whales was classified by Matsuoka and Pastene and submitted to the IWC Secretariat prior to this meeting. A total of 154 photographs taken during the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA 1987/88-2004/05 seasons) will be added to the SHBWC through the appropriate data availability channels. The sub-committee **recommended** that photo-ids from the ICR catalogue should be compared to those already held at the Southwest Fisheries Science Center in order to identify any matches.

SC/62/SH29 reported progress on the archiving and analysis of blue whale photographs collected during annual IWC IDCR/SOWER cruises between 1987/88 and 2008/09. Over 23,000 photographs have been obtained from all six IWC Management Areas, with 219 individual whales identified. Cross matching within and between years yielded five re-sightings in multiple years, including one whale with a 12 year re-sighting interval. Between 2005/06 and 2008/09, annual within-season re-sighting rates were 11%, 18% and 22% respectively. These rates suggest that blue whales exhibit some degree of residency within a summer feeding season.

In discussion, the sub-committee was informed that additional photographs from three IDCR/SOWER cruises during 2001/02 to 2003/04 have now been fully digitised and added to the catalogue. A match has already been made with these additional data. In response to a query as to how many photo-identified blue whales had also been biopsy sampled, it was noted that such information could be retrieved from the electronic database at Southwest Fisheries Science Center.

SC/62/SH21 reported the deployment of satellite tags on pygmy blue whales off southwestern Australia. Three tags were deployed (two males, one female) and the whales were tracked for over 8,000km. The tag with greatest longevity (137 days) provided definitive evidence of a link between whales that feed offshore of the Perth Canyon and those that occur around Indonesia.

In response to a query, it was noted that there were numerous opportunistic records of pygmy blue whales in the Andaman Sea (Rudolph *et al.*, 1997), but that feeding has not been reported. The purpose of the migratory movements described in SC/62/SH21 is still unknown.

SC/62/SH26 described the migratory patterns and estimated population sizes of pygmy blue whales traversing the western Australian coast based on passive acoustics. Thirty-seven sea noise loggers were placed on the sea floor, near the shelf edge along the known migratory route of pygmy blue whales. One noise logger, off Exmouth, was used for a census analysis by converting the acoustic detections of pygmy whales into an estimate of the number of animals passing by the instrument on their south bound migration. Based on recorded call intervals, it was considered that pygmy blue whales, will repeat a call at a minimum of 200s from the start of the first call, allowing the number of pygmy blue whale detections to be interpreted as the number of pygmy blue whales calling within a 200s sampling period. Summing the number of pygmy blue whales heard for each sampling bout across the entire season, the average number of whales heard per day was calculated and then divided by the interpreted transit time of the whale across the logger listening range (based on the detection range of pygmy blue whale source levels), giving an estimate of the total number of whales that migrated past the logger. This estimate was then adjusted, assuming that 8.5-20% of pygmy blue whales in the area are calling at any time, which resulted in an estimate of 662-1,559 pygmy blue whales passing the noise logger listening area during the 2004 southbound migratory pulse.

In discussion, it was noted that the acoustic approach to estimating population size reported here is an exciting theoretical exercise, and that further work into this approach would be greatly encouraged. However it was cautioned that a number of the assumptions in the current method need to be explored in more detail. For example transit times of whales through the detection sphere are assumed to be constant (e.g. half a day per whale, moving at 5 knots through a 120km range), but actually vary depending on the distance of the whale from the data logger. The source level of the whale call used is also from a different portion of the call than is used in the automatic detection routine. Varying this source level may therefore change the listening range substantially. In response to a query as to whether individuals could be identified by their calls, it was noted that the study was not designed to identify individuals in this way.

The sub-committee discussed methods for converting whale calls into abundance indices. The relationship between call intensity and whale number is quadratic, rather than linear, for South African right whales. While this effect is likely to be species specific, it merits a note of caution in the context of estimating abundance. It was observed that while song behaviour can be density dependent, there are many acoustic differences between blue and right whales, with blue whales singing very regularly over time. The sub-committee encouraged further explorations of acoustic methods of estimating blue whale abundance, focusing particularly on underlying assumptions.

Gedamke and Robinson (2010) reported the results of an acoustic survey for whales and seals in eastern Antarctic waters (30-80°E) between January and February 2006. This complemented a traditional visual survey for marine mammal occurrence and distribution. During this survey 145 DIFAR sonobuoys were deployed every 30° of latitude on north-south transects. Underwater sound was analysed for 70 minute samples from each sonobuoy. Blue whales were the most commonly recorded species, identified at 55 of the sonobuoy development sits. Other species recorded include: sperm (46 sites), fin (14), humpback (2) and sei (3) whales, and leopard (11) and Ross (17) seals. Large numbers of blue and sperm whales were detected on the westernmost two transects. They were detected in large concentrations where relatively extensive sea ice remained off the continental shelf and the more eastern waters of the survey off the Prydz Bay region. Two detections of pygmy blue whales represent the most southerly recordings of these species. The combination of acoustic and visual survey methods allow for a more comprehensive view of marine mammal distribution throughout the region during the BROKE-West survey.

SC/62/SH13 described results from passive acoustic monitoring for the presence of baleen whales off the coast of northern Angola, off the Congo River outflow. Two marine autonomous recording units were deployed between March and December 2008 at 15km and 24km offshore, recording continuously at a sample rate of 2,000Hz. Every other week (50%) was reviewed on spectrograms to detect vocalisations of baleen whales in the low frequency bandwidth (0-180Hz). A series of blue whale calls were detected on one day in the examined data, on 13 October. This represents the first confirmed modern documentation of pygmy blue whale presence in southeast Atlantic waters north of 60°S and off the west coast of Africa since the cessation of commercial whaling for blue whales in South Africa, Namibia, Angola and Congo. Comparison with published literature indicated that the calls were of the type attributed to the Sri Lanka population of pygmy blue whales. This is the first time that this call type has been recorded outside the Indian Ocean. The occurrence of a blue whale from this population in the low latitudes (6°S) of the Atlantic Ocean may be the result of an accidental migrant (since it was a single observation) or may indicate an incomplete understanding of the movements of pygmy blue whales. In addition to this series of calls, several other signals were recorded that may represent previously unknown vocalisations of blue whales; if further work supports the attribution of these signals to blue whales, they may represent documentation of a previously unknown dialect of pygmy blue whale calls, and consequently an un-described population. Antarctic blue whale calls were not detected.

In discussion, the recording of a single series of Sri Lanka pygmy blue whale calls was noted as an exciting find. Caution was advised in attributing other sounds with unknown sources to blue whales. The authors agreed that attribution of signals should be interpreted with caution, but indicated that the potentially new calls presented were based on a carefully selected subset of data.

Progress was reported on a genetic survey of Antarctic blue whales, which has been carried out with access to IDCR/SOWER biopsy samples provided by the IWC. These samples (n=218) were received in May 2010. Mitochondrial DNA has been amplified for all samples (n=218), with 134 samples sequenced up to 700bp and 47 haplotypes resolved from these samples. Among these, 25 haplotypes have not previously been described by LeDuc *et al*. (2007), or by a recent analysis of whalebones sampled in South Georgia (SC/62/SH19). Analyses of these data will continue for 58 remaining samples, and the total number of haplotypes found in the population will be used to estimate the minimum historical population abundance of the Antarctic blue whale.

The sub-committee welcomed this work and **recommended** that this study continue. It was observed that this study expands on the haplotype data originally reported by LeDuc *et al*. (2007); the additional haplotypes reported here likely originated from IWC Management Areas II and III, which were under-sampled in the previous study. With regards to the similarities between these haplotypes and those reported from the South Georgia whalebone studies (SC/62/SH19), it was noted that there are a number of haplotypes identified which are still unique to South Georgia, indicating that some blue whale haplotypic diversity was lost during the whaling campaigns. With regards to the comparability of these historical haplotypes with current samples, the amplification of DNA from bone has mostly yielded short haplotypes of lengths 300-500bp, and efforts to acquire and lengthen these haplotypes are ongoing.

The sub-committee received information on an upcoming study of the global taxonomy of blue whales using mitogenomic and nuclear sequence data. This work will be undertaken by the Southwest Fisheries Science Center and aims to conduct a comprehensive genetic assessment of blue whale taxonomy using next-generation sequencing methods to sequence whole mitogenomes and a large number of nuclear regions, for phylogenetic analysis of blue whale samples collected from different geographic areas. The project will particularly focus on determining the sub-specific status of blue whales in the North Pacific.

In response to a query regarding possible geographic gaps in sample availability, it was noted that many collaborations were already in place, and that efforts to collaborate with regional data holders in the North Atlantic are still ongoing. The sub-committee was informed that one sample may be available for analysis from the western South Atlantic. It was noted that eastern South Atlantic museums with collections arising from the whaling period may also yield useful material for genetic analysis. For example the Iziko South African museum holds some jawbones of Antarctic blue whales, and a suspended skeleton may also be available for on-site sampling. Finally, it was noted that previous efforts to search for available samples of Antarctic blue whales had not been focused on pygmy blue whales, so very little material is currently known to be available.

The sub-committee **strongly encouraged** continued collaborative efforts to acquire blue whale samples globally, and welcomed further updates on the results of the study.

Progress on the possible approaches for mitigating depletion of blue whale biopsy samples from SOWER cruises has been discussed by an intersessional email group. A report has been drafted and is currently awaiting review.

4. CONSIDERATION OF REQUESTS FOR ADVICE FROM THE COMMISSION

As part of the Commission's discussions on the Future of the IWC, the Commission's Chair and Vice-Chair developed the document 'Proposed Consensus Decision to Improve the Conservation of Whales' (IWC/62/7rev). This document contains a table (table 4) with proposed whale catches for the period 2010/11-2019/20. A small Scientific Assessment Group (SAG) was established to provide a report (IWC/M10/SWG6) with a concise scientific review on whether it believed that any catches in table 4 are such that the long-term status of the populations concerned would not be negatively affected.

This sub-committee reviewed section 2.6 of IWC/M10/SWG6, which referred to catches of Southern Hemisphere fin whales. Catches will be taken alternately in the Indian Ocean (between 35°E-130°E) and Pacific Ocean (between 130°E and 145°W) sectors of the Antarctic. A total of 10 annual catches will be taken in the period 2010/11-2019/20, starting in the Pacific Ocean sector. Catches will be reduced to 5 individuals until 2019/2020. The sub-committee **agrees** with the general conclusions of the SAG on the likely effect of the catches on the long-term status of Southern Hemisphere fin whales. It noted that in the past there was extensive exploitation (nearly 750,000 whales were killed in the 20th century), that recent information on fin whales in the Southern Hemisphere is poor and that it is not in a position to provide more substantive advice. It also appears unlikely that sufficient information will become available in the interim period (up to 2020) for an RMP *Implementation* to occur and thus unlikely that long-term management advice can be provided by the sub-committee under the RMP.

The sub-committee also observed that there were additional abundance estimates for this population, derived from IDCR/SOWER surveys, which had not been considered by the SAG (Branch and Butterworth, 2001; Butterworth and Geromont, 1995). Branch and Butterworth (2001) estimated that the circumpolar abundance of fin whales south of 60°S was 2,100 (CV=0.36), 2,100 (CV=0.45) and 5,500 (CV=0.53) for CPI, CPII and CPIII respectively. These estimates are negatively biased since the areas north of 60°S were not covered. Butterworth and Geromont (1995) report IDCR estimates extended to south of 30°S by using Japanese Scouting Vessel survey results to provide an index of relative abundance.

5. OTHER

A proposal to collect genetic material from the southeast Atlantic stock of Bryde's whales was described. The precise taxonomic relationships and species delineations within the Bryde's/Eden's whale complex are currently uncertain. In South Africa, 'inshore' and 'offshore' forms of Bryde's whale have been described (Best, 1977), and there has been some uncertainty as to whether they should be referred to as *B. edeni* and *B. brydei* respectively. Recent genetic analysis of one stranded 'offshore' whale, and multiple 'inshore' whales, suggested that both inshore and offshore whales should be classified as *B. brydei* (Penry, 2010). In this analysis only one 'offshore' whale was available for analysis however. A forthcoming research cruise, travelling from the Strait of Gibraltar to Cape Town, South Africa, intends to collect biopsy samples from this offshore population in order to facilitate more in-depth genetic analysis of the relationship between the 'offshore' form and other, more well sampled, Bryde's whale species.

The sub-committee noted that this is a good opportunity to collect samples from a poorly known population with confusing taxonomy. In response to a question, the sub-committee was author informed that that permit applications are in place in Namibia and South Africa. The sub-committee **recommended** the proposal, assuming that relevant permits will be acquired for the Exclusive Economic Zones of these two countries. It was noted that humpbacks are unlikely to be encountered since the cruise is scheduled to occur during the austral summer and will be travelling far offshore between western Central Africa and Namibia. The sub-committee **recommended** that the cruise opportunistically biopsy samples other baleen whales, where legally permitted to do so.

It was observed that there is currently a collaborative project attempting to resolve this taxonomic confusion using publicly available samples (n=64) from the northern Indian Ocean and involving Leslie, Brownell, Perrin (Southwest Fisheries Science Center) and Rosenbaum. Rosenbaum proposed that a collaborative agreement be made between Penry, Best, Leslie and himself, which should enhance the proposed analyses.

6. WORK PLAN AND BUDGET CONSIDERATIONS

6.1 Humpback whales

The sub-committee **agreed** that considerable progress was made during the meeting in reviewing new information presented for BSB (Item 2.1). The sub-committee **agreed** that no new data would be added to the assessment of BSB though updated analyses of existing data could be presented and incorporated into the assessment models. The sub-committee **agreed** that the completion of the assessment of BSB should be a matter of highest priority and **recommended** that the following tasks be conducted intersessionally (with those undertaking the work indicated in parenthesis).

(1) Development of assessment models consistent with stock structure hypotheses selected by the sub-committee (Tables 2 and 3, Item 2.1.3). Stock structure models Ia, IIa and III in Table 2 are high priority, but variations of these models (Table 3) will be considered as sensitivities. The assessment models should use the input data identified as reference case and sensitivities in Table 4, Item 2.1.3. Data output should include the posterior median and the 90% probability interval for the year for which the abundance prior corresponds (Butterworth, Muller and Johnston).
(2) Inspection of mark-recapture data within and between Gabon and WSA for stock structure hypothesis refinement (Barendse and Collins).
(3) Investigate and update estimates of potential and realised error in genetic and photo-id data (Carvalho, Collins, Rosenbaum and Cerchio).
(4) Re-analyse mark-recapture data from WSA using multi-year Program MARK (or equivalent) models to examine the effects of heterogeneity (for fluke data), tag loss (for dorsal fin data) and genotype error on abundance estimates, and assess the most appropriate data on interchange (Barendse, Cerchio, Best).
(5) Conduct feeding-breeding ground mixed-stock analysis in order to estimate stock mixing proportions between Gabon and WSA and the Antarctic in order to further refine stock structure hypotheses for assessments (Rosenbaum, Carvalho, Loo).
(6) Examine catch data for incorporation in population models, which should be sex-disaggregated, if possible (Best and Butterworth).

Additionally, it was recommended that efforts continue to match the WSA catalogue to the substantial number of photo-id images held by the South African government Oceans and Coast (Barendse, Findley and Meyeo). However, it was **agreed** that those new data would not be critical to completing the assessment of BSB.

The sub-committee **recommended** that progress in the assessments be communicated via an intersessional email group under Zerbini. The sub-committee **agreed** that results of model assessments described in (1) as well as any updates listed in (2) to (5) will be distributed for comments among members of the email group until 15 December 2010. The sub-committee also **agreed** that any decision on changes on the assessment models or the input data must be communicated to the members of the email group by 31 January 2011. Final assessment models will be presented and discussed at next year's meeting.

The sub-committee **agreed** that it will be in a position to conclude the assessment of BSB at next year's meeting. Therefore, the sub-committee **recommended** that assessments of BSE and BSF should be initiated and a progress report presented at next year's meeting. An intersessional email group was established under Jackson to assemble all the relevant data needed for these assessments. The assessment of BSD (western Australia) had been completed at the Scientific Committee meeting in St Kitts (IWC, 2006), but because of extensive mixing in the feeding grounds with other stocks (e.g. BSE) this stock might needed to be re-assessed along with BSE and BSF. The intersessional group will also consider the inclusion of BSD in the assessments of the two other stocks.

An item of financial implication for the sub-committee is the Antarctic Humpback Whale Catalogue. A proposal for the continuation of this work with a request for £15,000 is presented in Appendix 3.

Table 5
Intersessional e-mail groups.

Group	Terms of Reference	Membership
Assessment of Southern Hemisphere humpback whale breeding stock B	Prepare to complete assessment of humpback whale breeding stock B during IWC/63	Zerbini (Convenor), Best, Barendse, Butterworth, Carvalho, Cerchio, Collins, Donovan, Findlay, Jackson, Johnston, Muller, Palka, Punt, Robbins, Rosenbaum, Weinrich
Assessment of Southern Hemisphere humpback whale breeding stocks E and F	Collate information needed for the assessment of breeding stocks E and F	Jackson (Convener), Kaufman, Bannister, Baker, Butterworth, Clapham, Holloway, Muller, Pastene, Robbins, Weinrich, Zerbini
Blue whale abundance mark-recapture group	To obtain mark-recapture abundance estimates in W Australia and Chile and elsewhere as possible	Bannister (Convener), Galetti, Hucke-Gaete, Williams, Hammond, Brownell, Double, Olson, Matsuoka
Blue whale sample depletion group	Discuss approaches towards mitigating depletion of blue whale biopsy samples from SOWER cruises	Donovan (Convenor), Baker, Brownell, Double, Rosenbaum

6.2 Blue whales

Four blue whale genetic projects are currently in progress: (1) genetics of blue whales in Geographe Bay, western Australia, as part of a southern Australia wide study (11 samples collected, 11 analysed and archived; Möller, SC/62/ProgRepAustralia); (2) a genetic population structure study of blue whales in the southeast and Eastern Tropical Pacific regions (Flóres-Torres); (3) a global taxonomy of blue whales (Lang); and (4) a genetic analysis of the diversity of IDCR/SOWER Antarctic blue whale biopsy samples and South Georgia whalebones (Sremba). The sub-committee encouraged continuation of this research and **recommended** that results from these studies be reported when they become available.

The sub-committee **recommended** that new or revised estimates of abundance for pygmy blue whales be provided to the Scientific Committee next year; specifically from Chile (Galletti and Hucke-Gaete). It was noted that for Western Australia (Perth Canyon) the scaling of research required to improve the mark recapture data (which is currently very sparse in recaptures) for updated abundance estimates is unlikely to be affordable in the coming year, so an update to this is not expected for next year's meeting.

The sub-committee also **recommended** that work on the Southern Hemisphere Blue Whale Catalogue (SHBWC) be continued as discussed. This will require completion of the matching over the next two years from three Southern Hemisphere regions. This is an item with financial implications with a budget of £18,900 (Appendix 4). This work will be conducted by Galletti, Olson and Jenner.

The sub-committee **recommended** that the intersessional email group under Bannister continues to work toward providing new estimates of mark-recapture abundance of blue whales and to report new information at next year's meeting.

6.3 Other species

The sub-committee recommended a proposal to collect biopsy samples from Bryde's whales in the eastern Atlantic Ocean (see Item 5) during a research cruise carried out at the end of 2010. This is an item with financial implications for the sub-committee with a total cost of £5,000 (Appendix 5).

6.4 E-mail groups

Table 5 shows the membership of the intersessional e-mail groups.

7. ADOPTION OF THE REPORT

The report was adopted on 8 June 2010 at 09:45. Zerbini and Robbins expressed their appreciation to all participants for their hard work, in particular to Jackson and Fleming. The sub-committee thanked the Chair, the co-Chair and the rapporteurs for the successful completion of the report.

REFERENCES

Bamy, I.L., van Waerebeek, K., Bah, S.S., Dia, M., Kaba, B., Keita, N. and Konate, S. 2010. Species occurence of cetaceans in Guinea, including humpback whales with southern hemisphere seasonality. *Mar. Bio. Rec.* 3(e48): 10pp. Published online.

Barendse, J., Best, P.B., Thornton, M., Pomilla, C., Carvalho, I. and Rosenbaum, H.C. 2010. Migration redefined? Seasonality, movements and group composition of humpback whales *Megaptera novaeangliae* off the west coast of South Africa. *Afr. J. Mar. Sci.* 32(1): 1-22.

Best, P.B. 1977. Two allopatric forms of Bryde's whale off South Africa. *Rep. int. Whal. Commn (special issue)* 1: 10-38.

Branch, T.A. and Butterworth, D.S. 2001. Estimates of abundance south of 60°S for cetacean species sighted frequently on the 1978/79 to 1997/98 IWC/IDCR-SOWER sighting surveys. *J. Cetacean Res. Manage.* 3(3): 251-70.

Branch, T.A., Zerbini, A.N. and Findlay, K. 2007. Blue whale abundance in offshore Chilean waters from the 1997/98 SOWER survey. Paper SC/59/SH8 presented to the IWC Scientific Committee, May 2007, Anchorage, USA (unpublished). 9pp. [Paper available from the Office of this Journal].

Brown, M.R., Corkeron, P.J., Hale, P.T., Schultz, K.W. and Bryden, M.M. 1995. Evidence for a sex-segregated migration in the humpback whale (*Megaptera novaeangliae*). *Proc. R. Soc. Lond. Ser. B.* 259: 229-34.

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].

Carvalho, I., Brito, C., Dos Santos, M.E. and Rosenbaum, H.C. In review. The waters of São Tomé: a calving ground for West African humpback whales? 22pp.

Chaloupka, M. and Osmond, M. 1998. Spatial and seasonal distribution of humpback whales in the Great Barrier Reef. pp.89-106. In: Musick, J.A. (eds). *Life in the Slow Lane: Ecology and Conservation of Long-Lived Marine Mammals.* Am. Fish. Soc. Symp.

Darling, J.D. and Sousa-Lima, R.S. 2005. Songs indicate interaction between humpback whale (*Megaptera novaeangliae*) populations in the western and eastern South Atlantic Ocean. *Mar. Mammal Sci.* 21: 557-66.

Dawbin, W.H. 1964. Movements of humpback whales marked in the southwest Pacific Ocean 1952 to 1962. *Norsk Hvalfangsttid.* 53(3): 68-78.

Franklin, T., Franklin, W., Brooks, L., Harrison, P. and Baverstock, P. In review. Seasonal changes in group characteristics of eastern Australian humpback whales (*Megaptera novaeangliae*), Hervey Bay, 1992-2005. *Mar. Mammal Sci.*

Gales, N., Double, M.C., Robinson, S., Jenner, C., Jenner, M., King, E., Gedamke, J., Paton, D. and Raymond, B. 2009. Satellite tracking of southbound East Australian humpback whales (*Megaptera novaeangliae*): challenging the feast or famine model for migrating whales. Paper SC/61/SH17 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 11pp. [Paper available from the Office of this Journal].

Garrigue, C., Constantine, R., Poole, M.M., Hauser, N., Clapham, P., Donoghue, M., Russell, K., Paton, D., Mattila, D.K., Robbins, J. and Baker, C.S. In press-a. Movement of individual humpback whales between wintering grounds of Oceania (South Pacific), 1999 to 2004. *J. Cetacean Res. Manage. (special issue)*.

Garrigue, C., Dodemont, R., Steel, D. and Baker, C.S. 2004. Organismal and 'gametic' capture-recapture using microsatellite genotyping confirm low abundance and reproductive autonomy of humpback whales on the wintering grounds of New Caledonia (South Pacific). *Mar. Ecol. Prog. Ser.* 274: 251-62. [Available from C. Garrigue, Operation Cetaces, BP 12827, 98802 Noumea, New Caledonia].

Garrigue, C., Franklin, T., Constantine, R., Russell, K., Burns, D., Poole, M.M., Paton, D., Hauser, N., Oremus, M., Childerhouse, S., Mattila, D.K., Gibbs, N., Franklin, W., Robbins, J., Clapham, P. and Baker, C.S. In press-b. First assessment of interchange of humpback whales between Oceania and the east coast of Australia. *J. Cetacean Res. Manage. (special issue)*.

Gedamke, J. and Robinson, S.M. 2010. Acoustic survey for marine mammal occurrence and distribution off East Antarctica (30-80°E) in January-February 2006. *Deep-Sea Res. II* 57: 968-81.

Hedley, S.L., Bannister, J.L. and Dunlop, R.A. 2009. Group IV humpback whales: abundance estimates from aerial and land-based surveys off Shark Bay, western Australia, 2008. Paper SC/61/SH23 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 17pp. [Paper available from the Office of this Journal].

International Whaling Commission. 1998. Report of the Scientific Committee. Annex G. Report of the sub-committee on Comprehensive Assessment of Southern Hemisphere humpback whales. *Rep. int. Whal. Commn* 48:170-82.

International Whaling Commission. 2004. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 6:1-60.

International Whaling Commission. 2006. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on the Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 8:151-70.

International Whaling Commission. 2007a. Report of the Scientific Committee. Annex H. Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks. *J. Cetacean Res. Manage. (Suppl.)* 9:188-209.

International Whaling Commission. 2007b. Report of the Workshop on the Comprehensive Assessment of Southern Hemisphere humpback whales, 4-7 April 2006, Hobart, Tasmania. *J. Cetacean Res. Manage. (special issue)*.

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.

Jackson, J.A., Patenaude, N.J., Carroll, E.L. and Baker, C.S. 2007. How few whales were there after whaling? Inference from contemporary mtDNA diversity. *Mol. Ecol. Notes* 17: 236-51.

Jenner, C., Jenner, M., Burton, C., Sturrock, V., Salgado Kent, C., Morrice, M., Attard, C., Möller, L. and Double, M.C. 2008. Mark recapture analysis of pygmy blue whales from the Perth Canyon, Western Australia 2000-2005. Paper SC/60/SH16 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 9pp. [Paper available from the Office of this Journal].

Kendall, W.L., Nichols, J.D. and Hines, J.E. 1997. Estimating temporary emigration using capture-recapture data with Pollock's robust design. *Ecology* 78: 563-78.

Kinas, P.G., Andriolo, A. and Engel, M.H. 2006. Integrating photo-identification and aerial surveys to estimate *g*(0) for humpback whales (*Megaptera novaeangliae*) in the Brazilian breeding ground. Paper SC/A06/HW24 presented to the IWC Workshop on Comprehensive Assessment of Southern Hemisphere Humpback Whales, Hobart, Tasmania, 3-7 April 2006 (unpublished). 8pp. [Paper available from the Office of this Journal].

Leaper, R., Cooke, J., Trathan, P., Reid, K. and Rowntree, V. 2006. Global climate change drives southern right whales (*Eubalaena australis*) population dynamics. *Biology Letters* 2: 289-92.

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.

Lindqvist, C., Probst, A., Martin, A.R., Wiig, Ø. and Bachmann, L. 2009. Molecular species identification of historical whale remains from South Georgia. *Mar. Mammal Sci.* 25(1): 229-38.

Loo, J., Méndez, M., Pomilla, C., Leslie, M.S., Best, P.B., Collins, T., Engel, M.H., Ersts, P.J., Findlay, K.P., Bonatto, S., Kotze, P.G.H., Meyer, M., Barendse, J., Thornton, M., Razafindrakoto, Y., Ngouessono, S., Vely, M., Kiska, J., Olavarría, C., Baker, S., Aguayo, A., Thiele, D., Ensor, P. and Rosenbaum, H. 2008. Update on the evaluation of genetic structure on the feeding grounds and their connectivity in Breeding Regions. Paper SC/60/SH11 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 11pp. [Paper available from the Office of this Journal].

McKelvey, K.S. and Schwartz, M.K. 2004. Genetic errors associated with population estimation using non-invasive molecular tagging: problems and new solutions. *J. Wildl. Manage.* 68: 439-48.

Murphy, P.F., Van Waerebeek, K. and Jallow, A.O. 1997. Cetaceans in Gambian coastal waters. Paper SC/49/SM11 presented to the IWC Scientific Committee, September 1997, Bournemouth (unpublished). 8pp. [Available from the Office of this Journal].

Olavarría, C. 2007. Population structure of Southern Hemisphere humpback whales. D.Phil thesis, University of Auckland, Auckland.

Penry, G. 2010. Chapter 4. Taxonomic position and identity of the South African Bryde's whales, inferred from analysis of the mitochondrial control region. PhD thesis, University of St. Andrews, Scotland.

Picanço, C., Carvalho, I. and Brito, C. 2009. Occurrence and distribution of cetaceans in São Tomé and Príncipe tropical archipelago and their relation to environmental variables. *J. Mar. Biol. Assoc. UK* 89(5): 1071-76.

Razafindrakoto, Y., Cerchio, S., Collins, T., Rosenbaum, H. and Ngouessono, S. 2009. Similarity of song patterns among humpback whales from Madagascar and Gabon indicates significant contact between South Atlantic and southwest Indian Ocean populations. Paper SC/61/SH8 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 15pp. [Paper available from the Office of this Journal].

Ritter, F. 2010. Short description of a near-miss event involving a large vessel and humpack whales (*Megaptera novaengliae*) off Antarctica. Poster presented to the ECS Annual Conference, Stralsund, Germany, 22-24 March 2010.

Robbins, J., Dalla Rosa, L., Allen, J.M., Mattila, D.K. and Secchi, E.R. 2008. Humpback whale photo-identification reveals exchange between American Samoa and the Antarctic Peninsula, and a new mammalian distance record. Paper SC/60/SH5 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 4pp. [Paper available from the Office of this Journal].

Rosenbaum, H.C., Pomilla, C., Mendez, M.C., Leslie, M.C., Best, P.B., Findlay, K.P., Minton, G., Ersts, P.J., Collins, T., Engel, M.H., Bonatto, S., Kotze, D.P.G.H., Meyer, M., Barendse, J., Thornton, M., Razafindrakoto, Y., Ngouessono, S., Vely, M. and Kiszka, J. 2009. Population structure of humpback whales from their breeding grounds in the South Atlantic and Indian Oceans. *PLoS ONE* 4(10): 11pp. [e7318. doi: 10.1371/journal.pone.0007318].

Rudolph, P., Smeenk, C. and Leatherwood, S. 1997. Preliminary checklist of Cetacea in the Indonesian Archipelago and adjacent waters. *Zoologische Verhandelingen* 312: 1-48.

Steel, D., Garrigue, C., Poole, M., Hauser, N., Olavarría, C., Flórez-González, L., Constantine, R., Caballero, S., Thiele, D., Paton, D., Clapham, P., Donoghue, M. and Baker, C.S. 2008. Migratory connections between humpback whales from South Pacific breeding grounds and Antarctic feeding areas based on genotye matching. Paper SC/60/SH13 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 9pp. [Paper available from the Office of this Journal].

Weir, C.R. 2007. Occurrence and distribution of cetaceans off northern Angola, 2004/05. *J. Cetacean Res. Manage* 9(3): 225-39.

Weir, C.R. 2010. A review of cetacean occurrence in West African waters from the Gulf of Guinea to Angola. *Mammal Rev.* 40(1): 2-39.

Williams, R., Branch, T.A., Zerbini, A.N. and Findlay, K. 2009. Model-based abundance estimates and an assessment of minimum population status of blue whales off Chile from the 1997/98 SOWER survey. Paper SC/61/SH32 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 9pp. [Paper available from the Office of this Journal].

Zerbini, A.N., Clapham, P.J. and Wade, P.R. 2010. Assessing plausible rates of population growth in humpback whales from life-history data. *Mar. Biol.* 157(6): 1225-36.

Appendix 1

AGENDA

1. Introductory items
    - 1.1 Opening remarks
    - 1.2 Election of Chair
    - 1.3 Appointment of rapporteurs
    - 1.4 Adoption of the Agenda
    - 1.5 Review of documents
2. Assessment of Southern Hemisphere humpback whales
    - 2.1 Assessment of Breeding Stock B
        - 2.1.1 Distribution
        - 2.1.2 Population structure
        - 2.1.3 Abundance estimates
        - 2.1.4 Assessment
    - 2.2 New information
        - 2.2.1 Breeding Stock A
        - 2.2.2 Breeding Stock D
        - 2.2.3 Breeding Stocks E and F
        - 2.2.4 Breeding Stock X
        - 2.2.5 Feeding grounds
        - 2.2.6 Preliminary Multi-Stock Assessment
    - 2.3 Antarctic Humpback Whale Catalogue
3. Assessment of Southern Hemisphere blue whales
    - 3.1 New information
4. Consideration of requests for advice from the Commission
5. Other
6. Work plan and budget considerations
    - 6.1 Humpback whales
    - 6.2 Blue whales
    - 6.3 Other species
7. Adoption of the Report

Appendix 2

CALCULATION OF MINIMUM PAST POPULATION SIZES (N_{MIN}) FOR USE IN ASSESSMENT MODELS OF BREEDING STOCK B

Jennifer Jackson

The minimum past population sizes (N_{min}) for these two sub-stocks were calculated using haplotype frequencies known from Gabon and West South Africa (WSA). For Gabon (*n*=1,336 individuals), 63 private haplotypes were identified; for WSA (*n*=251 individuals), 3 private haplotypes were identified.

The basic N_{min} correction (four times the number of haplotypes [*h*] associated with the sub-stock, 4**h*) has been agreed by the IWC (2007). Since the sub-stocks under consideration are known to be subject to a degree of migratory exchange, the value of *h* was downwardly corrected in order to be conservative and to account for the possibility that low frequency Gabon haplotypes were undetected in WSA due to the smaller sample size available from the latter population. In Gabon, private haplotypes found at a frequency of less than 1/251 (i.e. at a lower frequency than any of the 251 individuals biopsy sampled in the WSA dataset) were considered to potentially be present and detectable in the WSA region if sampling were increased. Therefore these haplotypes were excluded, yielding a conservative N_{min} value of *h*=17 haplotypes. A basic correction for N_{min} to account for females and juveniles yields a lower boundary estimate of 68 individuals.

For WSA, the total number of private haplotypes was upwardly adjusted in order to obtain *h*, after an examination of the comparative frequencies of haplotypes in the two sub-stocks. We chose to exclude all haplotypes that were not found in a much higher (>2%) frequency in WSA compared to Gabon. This cut-off was based on examination of the relative frequency distribution of haplotypes, since there was a large frequency difference between haplotypes falling below this boundary and those falling above (Fig. 1). This approach yielded 6 haplotypes, providing a WSA N_{min} boundary of 24 whales.

REFERENCE

International Whaling Commission. 2007. Report of the Scientific Committee. Annex H. Report of the sub-committee on other Southern Hemisphere whale stocks. *J. Cetacean Res. Manage. (Suppl.)* 9: 188-209.

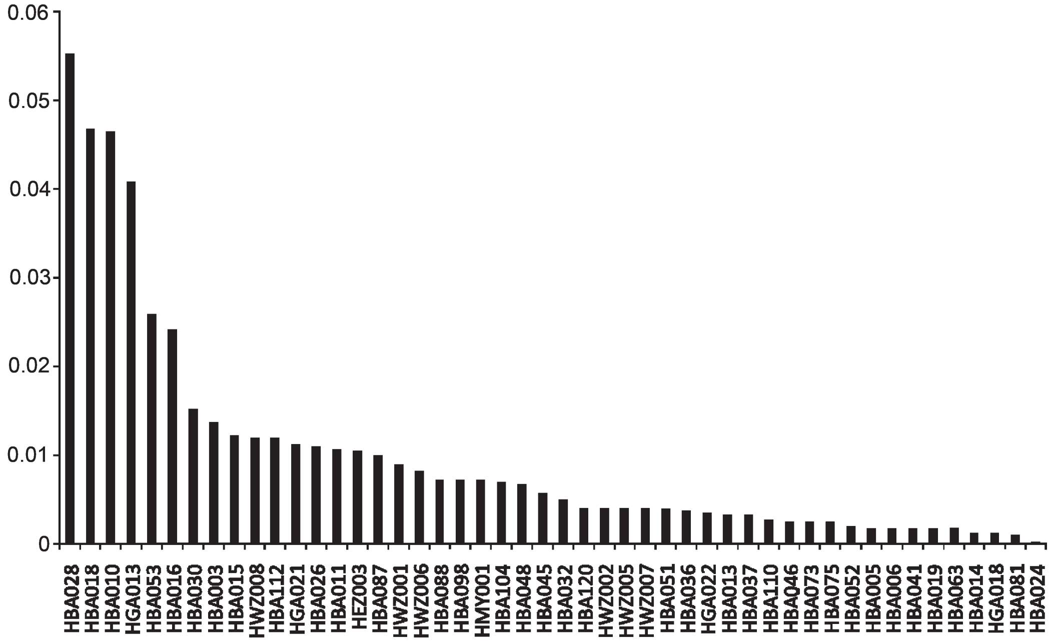


Fig. 1. Bar plot of the magnitude of haplotype frequency differences between WSA and Gabon haplotypes, including only haplotype frequencies which were higher in WSA than in Gabon.

Appendix 3

PROPOSAL: IWC RESEARCH CONTRACT 16, ANTARCTIC HUMPBACK WHALE CATALOGUE

Brief description of project

We have made tremendous progress in the catalogue with funding support from the IWC. With increased funding during this contract period we more than tripled the number of individuals catalogued over the previous year. The AHWC has grown by 25%, adding 974 new individuals in the last two years. Increasing awareness of the project among research organisations, tour operators and other potential contributors has widened the scope of the collection. Contributions from areas that had not previously been sampled or were previously under-represented have extended the geographic coverage and resulted in an unprecedented re-sighting between two widely-separated breeding stocks, and two additional re-sightings documenting the movement from Samoa and the Antarctic Peninsula.

The project has a hemispheric scope and the database spans more than two decades. As a result the AHWC is in an excellent position to make a substantial contribution to the Southern Ocean Research Partnership and other research and management initiatives.

Recognising the scope of work to be accomplished in the coming year and the importance of timely analysis to the contributing researchers and the scientific community, and reflecting recent changes in the international currency markets, we are requesting that funding be continued at £15,000. We will seek funding from other sources to provide the remaining funds required. Additional resources are provided by College of the Atlantic, including equipment and student assistants provided by College of the Atlantic, and time donated by Project Investigators Judith Allen and Carole Carlson.

Researchers' names

- Judith M. Allen, Carole Carlson and Peter Stevick, College of the Atlantic, 105 Eden Street, Bar Harbor, ME 04609 USA.

Estimated total cost with breakdown as needed

This proposal seeks £15,000 to continue the cataloguing of submitted photographs and further develop and enhance the system for online access. Budgetary amounts are in GBP.

Salary:
Project and database management £3,200
Photo comparison £10,000
Fringe @ 16.5% £1,650
Supplies £150
Total budget £15,000
Requested from IWC: £15,000

Appendix 4

PROPOSAL: SOUTHERN HEMISPHERE BLUE WHALE CATALOGUE PROJECT

Brief description of project

Very little is known about the migration of blue whales, population sizes, whether the currently defined populations (McDonald *et al*., 2006) are defined correctly, and the level of interchange of these populations. In discussions at the 17th International Marine Mammal Science Meeting in Cape Town, a unanimous agreement was made among a large number of current leading Southern Hemisphere blue whale scientists that a concerted international effort among researchers must be made to bridge this gap in information. The answers to these kinds of questions can be facilitated to a great extent through obtaining photos of whales, and comparing them to different locations and times to quantify the resight rate of individuals. In 2008, the IWC supported the creation of a Southern Hemisphere Blue Whale Catalogue (SHBWC) and Centro de Conservacion Cetacea in Chile was identified as the ideal organisation to develop a central web-based system by which southern hemisphere blue whale photo-id matching can take place. The software has been developed and tested during 2009 and currently researchers are discussing data availability and sharing agreements as well as quality control.

Matching will be conducted during next two years through this platform by researchers from three Southern Hemisphere regions. Given the large number of researchers involved, this will be facilitated through one coordinator within each region. However, comparisons of blue whale photo-id and the significant number of individuals catalogued will be time consuming and researchers will probably not have enough free time to dedicate to the matching process, an essential part of the project. Therefore the project needs to secure funding to ensure the matching process is completed.

This project intends to allow a comparison of blue whale photos among a noteworthy list of researchers working in the Southern Hemisphere. The facilitation of cross regional matching will result in a considerably better understanding of the basic questions relating to blue whale populations in the Southern Hemisphere.

Links to specific IWC recommendations

(1) The Committee recommends the continuation of this important work [*Southern Hemisphere Blue Whale Catalogue*] as it will provide useful and relevant information for future assessment of blue whales.

(2) The Committee reiterates its recommendation from last year that attempts to derive absolute abundance estimates of blue whales in this region [*Chile*] be made in order to provide information required for the assessment of this population.

(3) The Workshop [*Cetaceans and climate change,* IWC, 2010b] made a number of recommendations and the Committee endorses these below. With regard to the Southern Ocean, the Committee endorses a number of specific Workshop recommendations for future work, including: continued investigation and analysis of individual identification data for blue whales (genetic and photographic) for potential mark-recapture studies.

(4) The following issues are high priority topics [for Other Southern Hemisphere Whale Stocks in 2009; IWC, 2010a]: blue whales (with emphasis on non-Antarctic blue whales).

Methodology

The SHBWC software has been already developed and tested, however researchers have made some useful comments and therefore additional improvements on the software such as picture management (colour, brightness, size defined for each user) to facilitate comparison, or user capabilities to modify its own catalogue properties, will be required.

Currently researchers are in the process of uploading their catalogues and the matching process will start to take place after the uploading process is complete. Matching will be made by comparisons of pigmentation pattern of blue whales from left and/or right side.

To ensure the matching process is completed by the end of 2011, dedicated persons will have to be assigned for each region to conduct the matching among regions and then the matching process between regions will have to take place. In case researchers do not have time to upload their catalogues, regional coordinators will be in charge in appointing dedicated persons for both uploading and matching processes.

Timetable

- Software improvements - August-November 2010.
- Uploading of catalogues - February-November 2010.
- Regional Matching Process - December 2010-June 2011.
- Inter-regional Matching Process - July-December 2011.
- Final report to IWC - January 2012.

Estimated total cost with breakdown as needed

Time taken to carry out matching varies from region to region according to the number of individuals to be compared.

- Personnel costs all regions (2011): £18,900
- Total: £18,900

REFERENCES

IWC. 2010a. 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):* 218-251.

IWC. 2010b. Report of the Workshop on Cetaceans and Climate Change, 21-25 February 2009, Certosa di Pontignano dal Rettore dell Universita degli Studi de Siena, Italy. *J. Cetacean Res. Manage. (Suppl.) 11(2):* 451-480.

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.

Appendix 5

PROPOSAL: A PROPOSAL TO COLLECT GENETIC MATERIAL FROM THE SOUTHEAST ATLANTIC STOCK OF BRYDE'S WHALES

Brief description of project

The taxonomic situation of the Bryde's/Eden's/Omura's whale complex is a little confused. One of the problems is that Olsen's (1913) description of *Balaenoptera brydei* clearly included specimens from the inshore and offshore forms (*sensu* Best, 1977) of Bryde's whales off South Africa, and until recently it has been unclear whether these two forms can be referred to the smaller *B. edeni* and the larger *B. brydei* respectively.

In a recent genetic analysis of 26 specimens of Bryde's whales from South Africa, one stranded individual that resembled the offshore form morphologically formed a clade with *B. brydei* from the South Pacific, North Pacific and Eastern Indian Ocean, and only differed from its conspecific in the South Pacific by 0.2%. The remaining 25 specimens (some of which were collected as biopsies from the inshore population) proved in a maximum likelihood analysis to group more closely with *B. brydei* than with the two other *B. edeni* populations (coastal Japan and Malaysia (Pulau Sugi)). In addition, pairwise differences in the mtDNA sequences were higher between the inshore animals and *B. edeni* from Malaysia (2.3%), than between inshore animals and the Antarctic sei whale (1.7%) and *B. brydei* (~0.8%). The South African inshore and offshore forms differed from each other by 0.7%. This is much less than would be expected if the inshore form was clearly identified as *edeni* (~2%). These findings support the suggestion that the two forms could both be *brydei* (Penry, 2010).

Although these results seem conclusive, it is important to remember that only one specimen from the offshore population (and that a stranded animal) was available, and there is therefore a definite need for further sampling, preferably biopsies, from the southeast Atlantic stock of Bryde's whales.

In principle the forthcoming relocation of the research ship *Whale Song* from the Mediterranean to Cape Town, South Africa, via the Straits of Gibraltar provides an ideal opportunity to collect such samples, provided permission to undertake research in the EEZs of relevant coastal states can be obtained. Tentative agreement to undertake such sampling has been given by the owner and master of the vessel, Curt Jenner of the Centre for Whale Research, Western Australia, who has also agreed that Gwen Penry (whose PhD thesis at the University of St. Andrews is cited above) can accompany the cruise and take responsibility for the collection and analysis of the samples.

Although the *Whale Song* is due to receive a Paxarms gun on arrival in Cape Town, she currently lacks any biopsy capability. Although this gun can possibly be re-routed to Malta, the pelagic sampling of Bryde's whales would be greatly enhanced if the vessel had a Larsen gun available, especially in the expected wind-strengths that may preclude the deployment of a small boat on many occasions but might still allow sampling from the mothership using a weapon with the muzzle velocity of the Larsen gun. Unfortunately the existing IWC Larsen guns are presently in Bali and are due to be shipped to Japan for the forthcoming North Pacific sightings survey. It is suggested that an additional Larsen gun be purchased prior to the cruise of the *Whale Song* and shipped to Malta before its departure in late October 2010. This gun could then remain on board for the STC cruise planned after the vessel's departure from Cape Town.

Funds are being sought here to enable this gun to be purchased and shipped to Malta. Any samples collected on the voyage to Cape Town will be the property of the IWC, on the understanding that the MRI Whale Unit will have the first rights to have the samples processed and the results published. The Larsen gun will remain the property of the IWC and its disposition after the cruise will be at the discretion of the IWC on the advice of the Scientific Committee.

Researchers' names

Peter Best

Estimated total cost with breakdown as needed

- Purchase of Larsen gun and accessories: £4,500.
- Shipping of the gun to Malta: £500.
- Total: £5,000.

REFERENCES

Best, P.B. 1977. Two allopatric forms of Bryde's whale off South Africa. *Rep. Int. Whal. Comm. (Special Issue)* 1: 10-38.

Best, P.B. 1996. Evidence of migration by Bryde's whales from the offshore population in the southeast Atlantic. *Rep. Int. Whal. Comm.* 46: 315-322.

Olsen, Ø. 1913. On the external characters and biology of Bryde's whale (*Balaenoptera brydei*), a new roqual from the coast of South Africa. *Proceedings of the Zoological Society of London* 1913: 1073-1090 + 5 pl.

Penry, G. 2010. Chapter 4. Taxonomic position and identity of the South African Bryde's whales, inferred from analysis of the mtDNA control region. *PhD thesis, University of St Andrews, Scotland.*

Appendix 6

SHORT TITLE: MODELLING OF SOUTHERN HEMISPHERE HUMPBACK WHALE POPULATIONS

(This proposal was discussed by the Scientific Committee after the sub-committee meeting)

Brief description of project

The project will focus on two issues:

(a) Assessment of breeding stock B. Deliberations at the 2010 Annual Meeting have led to a number of variants of stock-structure models for this population being proposed. Computer software needs to be developed to implement these models to take account of tag-recapture data to estimate not only the abundance of trends in the Gabon and west South Africa regions where these data are collected, but also of animals identified in both of these areas to estimate mixing proportions, and of adjustments for factors such as genotype matching error rates. Possibilities to extend the current assessment method from a sex-aggregated to a sex-disaggregated form also need to be investigated.

(b) Simultaneous analysis of all seven breeding stocks using the current age-aggregated model. This is desirable so that: the catch allocation uncertainty is taken into account in a consistent and even-handed manner, i.e. if more catches are allocated to one stock, less must simultaneously be allocated to another; uncertainties in the boundaries for such allocations can be properly included in the analysis; and likely similarities in intrinsic growth rate parameters for the different stocks can be properly factored into the analyses. Development of this model has commenced, but it needs to be taken beyond the stage reported to the 2010 Annual Meeting.

Timetable

Initial report on (a) to an intersessional steering group by November 2010, with further report to the 2011 Scientific Committee meeting.

Researchers' names

Butterworth, Johnston, Muller.

Estimated total cost with breakdown as needed

Salary contribution: £3,500.

Annex I

Report of the Working Group on Stock Definition

Members: Bravington (Convenor), Amaral, Baba, Bachmann, Bamy, Brockington, Butterworth, Campbell, Carvalho, Castellote, Cipriano, de Moor, Donovan, Fleming, Gaggiotti, Hoelzel, Jackson, Jérémie, Kanda, Lang, López-Mirones, Luna, Lusseau, Lyrholm, Øien, Okada, Pampoulie, Pastene, Punt, Scordino, Skaug, Suydam, Uoya, Vázquez, Víkingsson, Waples, Weir, Werner, Wiig, Yamakage, Yasokawa, Yoshida, Young.

1. INTRODUCTORY ITEMS

1.1 Election of Chair and appointment of rapporteurs
Bravington was elected as Chair, and also acted as rapporteur.

1.2 Adoption of Agenda
The adopted Agenda is given as Appendix 1.

1.3 Review of documents
The documents considered were SC/62/SD1-2.

2. STATISTICAL AND GENETIC ISSUES RELATING TO STOCK DEFINITION
SC/62/SD2 presented information regarding the acoustic behaviour of fin whales in the western Mediterranean Sea and adjacent North Atlantic waters. Seafloor recorders were deployed during 2006-09 to further contribute to knowledge of movement patterns and population structure within and outside of the Mediterranean basin. Analysis of 24,280 recording hours revealed typical long, patterned sequences of 20Hz pulses, back beats, 135-140Hz notes and downsweeps. Acoustic parameters (inter pulse interval, pulse duration, pulse bandwidth, centre and peak frequency) were compared between signals from the Mediterranean Sea and northeast North Atlantic Ocean (NENA) using a hierarchical regression analysis to compare and characterise fin whale sounds. Pulse interval and pulse bandwidth showed the highest variability between study areas revealing two clearly differentiated acoustic patterns, one attributed to all North Atlantic study areas, Strait of Gibraltar and southwestern Mediterranean basin (Alborán Sea) and another to the northwestern Mediterranean basin (Balearic, Provenzal and Ligurian Seas). These acoustic patterns were related to two different fin whale populations. The first one, with a pulse interval of 15 seconds and a pulse bandwidth of 5Hz, corresponds to the resident Mediterranean population; the second one, with a pulse interval of 13 seconds and a pulse bandwidth of 6.5Hz, corresponds to a NENA population. In particular, 135-140Hz notes and the presence of songs composed exclusively of back-beats strongly suggests that the NENA population might be Icelandic (EI or F stocks) or Norwegian (N stock). Mediterranean fin whales were never detected in the Alborán basin or the Gibraltar Strait suggesting that their distribution range excludes this region of the southwestern Mediterranean basin. The presence of NENA fin whales in the Strait of Gibraltar area and Alborán Sea was seasonal, from early winter till early summer, and short detections also occurred during summer and further east, within the Balearic Sea. This reveals that male NENA fin whales enter the Mediterranean Sea primarily during breeding season and spatial and temporal overlap may exist between populations. The author of SC/62/SD2 discussed how these results match the current knowledge on fin whale use of the Strait of Gibraltar and could fit the genetic scenario of the Mediterranean fin whale subpopulation, where a low recurrent gene flow between NENA and Mediterranean whales has been proposed as the most plausible hypothesis. The author ended his presentation by recommending that current distribution ranges of these fin whale populations should be reviewed based on these acoustic results.

In discussion, the SDWG welcomed the work in SC/62/SD2, and encouraged the plans to follow up with biopsy sampling. SC/62/SD2 shows a case where acoustic data have been able to generate plausible yet previously-unsuspected hypotheses about stock structure. The SDWG also recalled its previous discussions about the benefits of, and difficulties associated with, the use of acoustic data in stock definition (e.g. IWC, 2005). Previous considerations have often focused on humpback whales, which are known to learn and imitate acoustic behaviour; this complicates the interpretation of acoustic signals in population-dynamics terms. By contrast, fin whales appear to have stable acoustic behaviour, at least after maturity. Other studies on fin whales have shown a negative correlation between acoustic and genetic distance, allowing discrimination between the songs of different populations in both the North Atlantic and North Pacific Oceans (see Hatch and Clark, 2004). This is a species for which acoustics is particularly useful in generating hypotheses and indeed subsequent sampling strategies.

2.1 DNA data quality
This item concerns guidelines for marker validation and systematic quality control in genetic studies to be used in stock structure discussions relevant to management (IWC, 2009b). The guidelines now form a 'living document', available on the IWC website. The Committee has identified the desirability of proposing numerical guidelines, where feasible, for some of the quality control measures. Last year, it was agreed to start a literature review on this subject through an intersessional email group, led by Tiedemann. Unfortunately, Tiedemann had to withdraw from this year's meeting at the last moment, and it has not been possible to progress on this item. It remains on the agenda for next year's meeting.

2.2 Guidelines for analysis methods
In parallel with the development of data quality guidelines, the Committee has asked the SDWG to provide guidelines for some of the more common types of statistical analysis of genetic data that are employed in IWC management contexts. The guidelines will cover two aspects: comments on general statistical usage; plus summaries of the appropriate domains of application of, and limitations of, different stock structure tools such as STRUCTURE, BayesAss, etc. The document

contains a motivating example (North Pacific Bryde's whales) that demonstrates the kind of management questions faced by the Committee.

An intersessional email group under Waples has been preparing sections of this document. SC/62/SD1 describes the overall structure of the document (as shown in IWC, 2009c), and shows the draft sections that have been prepared so far. The SDWG thanked Waples and the other authors for their past-and-future-efforts. This is a complex document, and much further work will be required to complete all sections. However, after one further iteration, the document should be ready to go onto the IWC website. In terms of the structure of the document, a number of suggestions were made.

- Descriptions of genetic methods in the main part of the document should be kept short, and focused on strengths and weaknesses in management contexts (including but not limited to *CLA*-like applications). More comprehensive descriptions may be provided in appendices.
- An 'FAQ' would be desirable. For example: 'I have some samples from the feeding grounds but not the breeding grounds. What should I do?'
- The theoretical population-dynamic example from IWC (2009c) should be incorporated as an illustration of the distinction between demographic (i.e. management-related) and genetic differentiation of stocks.
- The sections dealing with particular methods should be cross-referenced against results from TOSSM (see Item 3), which has taught us a great deal about the likely performance or otherwise of various commonly-applied stock identification methods in management contexts.
- Consideration could be given to using simulated datasets from TOSSM to illustrate the steps and pitfalls involved in analysing real data using a particular method.
- When this document is ready, it will have entailed a great deal of effort, but it should be of lasting importance. It deserves to be published, both online via IWC and in peer-reviewed literature.

The intention for this year's SD working group meeting was to devote most of the time available to working on this document. Progress was somewhat restricted since two Scientific Committee members with custody of substantial sections were unable to attend. The review and update of this document will likely be the main task of the SDWG at next year's meeting.

3. TOSSM (TESTING OF SPATIAL STRUCTURE MODELS)

3.1 Update on progress
The aim of TOSSM is to allow simulation-testing of the performance of population structure methods intended for use in conservation planning. Specifically, methods can be tested in terms of how successfully they set spatial boundaries for management. The TOSSM software is available as an R package on CRAN, with extensive documentation and supplementary materials. Simulated datasets are available for three of the five Archetypes identified by the Committee (IWC, 2009a, p.51); the exceptions are Type III (cline) and Type V (persistent feeding stocks). Interested parties can develop their own datasets for specific types of population structure, e.g. clines. Many other aspects of TOSSM can also be adapted to particular needs, e.g. different management regimes.

Table 1

Methods tested under TOSSM, and where to read about them (see reference list).

Always-one-stock	Martien *et al.* (2008)
Wombling	Martien and Gregovich (2008)
Monmonnier	Martien and Gregovich (2008)
Waples/Gaggiotti	Martien and Gregovich (2008)
Close-kin (Oyvind/Skaug)	Økland *et al.* (2008)
STRUCTURE	Martien *et al.* (2007)
BayesAss	Edwards and Butterworth (2007)
Seq hyp test	Poljak Grez *et al.* (2006)
MIXPROP	IWC (2007)
GENELAND	IWC (2007)

To date, the SDWG has reviewed TOSSM results from ten methods (Table 1). All tests relate to performance on Archetypes I (panmixia) and/or Archetypes II (breeding ground samples/harvest, with migration). No other Archetypes have been used in testing so far. Most test results relate to total population size 7,500, with sample sizes of 600 animals at 30 microsatellite loci, and a variety of migration rates. The papers listed below and the associated Scientific Committee reports should be consulted for full details. Briefly, though, the Oyvind/Skaug (close-kin) method was usually able to identify the appropriate number of demographically independent units for management regardless of migration rate, but all other methods eventually failed to detect demographically independent units when the migration rate became too high. Some methods were also prone to detecting stock structure when none was actually present. The Monmonnier and Waples/Gaggiotti methods performed much better than any of the other non-close-kin approaches, being able to cope with migration rates of at least 5*10-4 per capita *per annum* in the scenarios tested.

No papers were received this year on further method-tests using TOSSM. Just as last year, the Committee noted the relevance of Archetype IV to North Pacific minke whales, where STRUCTURE is receiving extensive use, and encouraged the submission of papers to next year's meeting on testing STRUCTURE's performance using Archetype IV. Tests need not be restricted to overall management performance; more detailed aspects, such as the reliability of individual assignments, can easily be investigated too.

Mark-recapture as well as genetic data is becoming widely used in the Scientific Committee's deliberations over stock structure. Bravington offered to investigate the feasibility of adding simulated mark-recapture data to TOSSM datasets. As yet, there are few if any formal methods for incorporating mark-recapture and genetic data into a single analysis of stock structure, but this is likely to change; TOSSM should be prepared.

3.2 Proposals for further work
So far, there have not been any tests of coalescent-based methods in TOSSM. Computational complexity has probably been the limiting factor. Jackson offered to investigate the feasibility of testing one type of coalescent model (MDIV) under TOSSM. The SDWG welcomed this offer.

4. OVERALL WORK PLAN BEFORE AND DURING NEXT YEAR'S MEETING

- Furtherance of guidelines for analysis.
- Receive updates on guidelines for DNA Data Quality.
- Statistical and genetic issues concerning stock definition.
- TOSSM.
- Unit-to-conserve.

5. ADOPTION OF REPORT

The report was adopted at 18:52 on Monday 7 June 2010.

REFERENCES

Edwards, C.T.T. and Butterworth, D.S. 2007. Development of a Boundary Setting Algorithm based on migration rates estimated using BayesAss and its preliminary application to TOSSM datasets. Paper SC/59/SD6 presented to the IWC Scientific Committee, May 2007, Anchorage, USA (unpublished). 16pp. [Paper available from the Office of this Journal].

Hatch, L.T. and Clark, C.W. 2004. Acoustic differentiation between fin whales in both the North Atlantic and North Pacific Oceans, and integration with genetic estimates of divergence. Paper SC/56/SD6 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 37pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2005. Report of the Scientific Committee. Annex I. Report of the Working Group on Stock Definition. *J. Cetacean Res. Manage. (Suppl.)* 7:247-53.

International Whaling Commission. 2007. Report of the 2nd TOSSM (Testing of Spatial Structure Models) Workshop. *J. Cetacean Res. Manage. (Suppl.)* 9:489-98.

International Whaling Commission. 2009a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 11:1-74.

International Whaling Commission. 2009b. Report of the Scientific Committee. Annex I. Report of the working group on stock definition. *J. Cetacean Res. Manage. (Suppl.)* 11:248-57.

International Whaling Commission. 2009c. Report of the Scientific Committee. Annex I. Report of the working group on stock definition. Appendix 2. Guidelines for DNA data quality control for genetic studies relevant to IWC management advice. *J. Cetacean Res. Manage. (Suppl.)* 11:252-56.

Martien, K.K., Archer, E. and Taylor, B.L. 2007. Simulation-based performance testing of the Bayesian clustering program STRUCTURE. Paper SC/59/SD3 presented to the IWC Scientific Committee, May 2007, Anchorage, USA (unpublished). 10pp. [Paper available from the Office of this Journal].

Martien, K.K. and Gregovich, D. 2008. Comparative performance testing of spatially explicit genetic analytical methods. Paper SC/60/SD4 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 10pp. [Paper available from the Office of this Journal].

Martien, K.K., Gregovich, D. and Punt, A.E. 2008. Evaluating the performance of the *CLA* when population structure is not correctly identified. Paper SC/60/SD3 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 10pp. [Paper available from the Office of this Journal].

Økland, J.M., Haaland, Ø.A. and Skaug, H.J. 2008. A boundary setting algorithm based on genetically determined close relatives. Paper SC/60/SD5 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 12pp. [Paper available from the Office of this Journal].

Poljak Grez, D., Punt, A.E., Cope, J.M. and Brandon, J.R. 2006. Application of a sequential hypotheses testing method to example TOSSM data sets. Paper SC/58/SD1 presented to the IWC Scientific Committee, May 2006, St. Kitts and Nevis, West Indies (unpublished). 8pp. [Paper available from the Office of this Journal].

Appendix 1

AGENDA

1. Introductory items
   - 1.1 Election of Chair and appointment of rapporteurs
   - 1.2 Adoption of Agenda
   - 1.3 Review of documents
2. Statistical and genetic issues relating to stock definition
   - 2.1 DNA data quality
   - 2.2 Guidelines for analysis methods
3. TOSSM (Testing of Spatial Structure Models)
   - 3.1 Update on progress
   - 3.2 Proposals for further work
4. Overall work plan
5. Adoption of Report

Annex J

Report of the Working Group on Estimation of Bycatch and Other Human-Induced Mortality

Members: Perrin (Convenor), Acquarone, Allison, Amaral, An, Baker, Baldwin, Bamy, Breiwick, Brito, Brownell, Cañadas, Cipriano, de Stephanis, Ferguson, Fortuna, Funahashi, Gallego, Hoelzel, Kaufman, Kock, Larsen, Lauriano, Leaper, Liebschner, Luna, Marcondes, Mattila, Nelson, Panigada, Park, Parsons, Podestá, Ridoux, Ritter, Rose, Rowles, Simmonds, Sironi, Štrbenac, Stachowitsch, Tchibozo, Urbán, Vasquez, Vély, Weinrich, Williams, Wright.

1. CONVENOR'S OPENING REMARKS AND TERMS OF REFERENCE

Perrin welcomed the participants. The Terms of Reference for the Working Group continue to relate to issues of estimating human-induced mortality of great whales other than directed take so that such mortality can be subtracted from any catch limits that might be calculated using the RMP.

2. ELECTION OF CHAIR

Perrin was elected Chair.

3. ADOPTION OF AGENDA

The adopted Agenda is given as Appendix 1.

4. APPOINTMENT OF RAPPORTEURS

Leaper, Mattila and Weinrich agreed to act as rapporteurs.

5. AVAILABLE DOCUMENTS

The following distributed documents were relevant to the Working Group: SC/62/BC2, BC4-8; SC/62/NPM4, NPM26; SC/62/SH6, SH20; Report of the Workshop on Welfare Issues Associated with the Entanglement of Large Whales; Bernaldo de Quirós *et al.* (2010); and the national Progress Reports.

6. COLLABORATION WITH FAO ON COLLATION OF RELEVANT FISHERIES DATA

There has been an ongoing effort by the Secretariat and the Sea Mammal Research Unit (University of St Andrews, UK) to consolidate data on entanglements submitted in annual Progress Reports into a single database. The Secretariat has been working on the most recent years' data, while SMRU has been working on data from 1980. No report was available from SMRU but data for the period 2004-09 have now been entered by the Secretariat.

7. PROGRESS ON JOINING THE FISHERIES RESOURCE MANAGEMENT SYSTEM (FIRMS)

The IWC is currently an observer to the FIRMS partnership (Fisheries Resources Management System), a collaborative partnership organised by the FAO which enables fishery management bodies to share information. Part of the FIRMS partnership work involves the elaboration of an inventory of fisheries, including gear characteristics and some indicators of fishing effort. Full partnership awaits the compilations of the entanglement data held by the IWC and the development of a coherent database. Details of data structure and data access are required as part of the FIRMS partnership agreement. It had not been possible to develop the IWC database fully during the intersessional period and hence full partnership with FIRMS had not been pursued.

8. PROGRESS ON INCLUDING INFORMATION IN NATIONAL PROGRESS REPORTS

Entanglements and ship strikes reported in the national Progress Reports are summarised in Appendix 2.

Last year the Committee had considered a proposal to develop a mechanism for online submission of the information on bycatch and entanglements currently submitted in national Progress Reports. No new information was available on progress in this direction.

9. ESTIMATES OF BYCATCH MORTALITY OF LARGE WHALES

9.1 Report of intersessional Workshop

The Report of the intersessional Workshop on Welfare Issues Associated with the Entanglement of Large Whales contained information that was of potential use to the Working Group. The Workshop brought together veterinarians and scientists working on the scope and impact of large whale entanglements, as well as the directors of disentanglement response programmes from most countries which currently have established programmes (e.g. Australia, Canada, South Africa and the USA). The Workshop reviewed current knowledge about and responses to these events, in order to advise member countries about potential actions, decisions and outcomes and their biological and welfare implications.

The Workshop began with an overview of recent information about the scope (e.g. species, gear type, hot spots, and impacts) of large whale entanglement. Much of the overview was a review of information previously brought to the Working Group; however, it was supplemented with new information from parts of Canada (Newfoundland, Labrador), South Africa, Mexico and the USA. Based on review and synthesis of this accumulated information, the Workshop made several conclusions of interest to the Working Group, as follows.

- All species of large whales are at risk of entanglement to varying degree, but minke, humpback, right (both North Atlantic and southern) and gray whales are the most frequently reported.
- All types of stationary or drifting gear (i.e. not actively towed) pose potential risk to entangle, but pound, set and fyke-type nets, along with gillnets and various pot-type gear, are most frequently implicated.
- Entanglements can occur wherever this type of gear and large whales overlap in distribution, and this is not

limited to feeding grounds but also includes breeding grounds as well as migratory pathways.
- Given the cryptic nature of large whale entanglements in combination with the paucity of experienced observers and lack of formal reporting networks, entangled whales are severely underreported globally.
- Regional shifts in fisheries and gear types can produce major differences in the character of entanglements and reporting frequency (e.g. coastal versus offshore gear placement).

Based on these conclusions, the Workshop made the following relevant recommendations:
- that coastal nations establish adequate programmes for monitoring entanglement of whales; and
- that member countries improve reporting to the IWC through national Progress Reports.

The Workshop discussed several ways that countries might improve their monitoring and the accuracy of their reports. These included interviews of fishers and other mariners likely to observe entangled whales (e.g. whale watch operators), scar-based studies of local whale populations, more thorough examination of stranded animals and the establishment of entanglement response programmes. With regard to the latter, the Workshop discussed the need to safely improve the data collected during disentanglement operations, including the gathering of key health data, and stressed the importance of identifying the individual entangled whales for improved assessment of survivorship.

In discussion, the Working Group **agreed** with these conclusions and recommendations, and, understanding that improvements in data collection and reporting would be very helpful to its work, **recommended** that all member countries which have coastal fishing operations that overlap with whale distribution be encouraged to more accurately report the occurrence and nature of the incidence of large whale entanglement and establish entanglement response programmes where applicable. In addition, it was **recommended** that existing and new programmes communicate with each other to standardise and maximise the usefulness of the data collected during their response to these events, and that they ensure that the appropriate data are made available to their respective national Progress Report. In addition, given that much of our current information on all anthropogenic causes of mortality comes from examinations of stranded animals, the Working Group also **recommended** that the Commission encourage members to facilitate thorough necropsies whenever possible on all large whales irrespective of population status, since this will be required to better estimate entanglement mortality rates including for species that may be subject to whaling.

There was discussion of the definitions of terms in the Workshop report, in particular the definition of 'entanglement'. Concern was expressed that a definition that is too specific might discourage useful information from being reported to authorities. In response it was noted that this definition was agreed upon by the many experts at the Workshop, and that it was the experience of those who have established national entanglement response programs that the most important step in improving reporting was the establishment of the actual network itself, as once the presence of a network is broadly known, most responders appear to err on the side of reporting all possible entanglements.

Finally, in response to a question about the number of countries that have organised entanglement response networks, it was noted that currently Australia, Canada, South Africa, New Zealand, the United Kingdom and the United States have relatively well-established networks. In addition, all of the directors of the networks that were in attendance at the intersessional Workshop had indicated their impression of the value of meeting to share information and standardise data collection. They expressed an interest in continuing to meet periodically in the future and noted that these meetings might also invite representatives from governments wishing to establish formal, safe entanglement response capabilities.

9.2 Mortality in longline fisheries

A preliminary global review of operational interactions between odontocetes and the long-line fishing industry described bycatch events of humpback and Bryde's whales in addition to depredation by sperm whales (SC/62/BC6). Some long-line fisheries are at risk of becoming economically unviable due to the incidence of catch depredation. Identifying and developing mitigation strategies to reduce depredation may also reduce entanglement risk for odontocetes. Acoustic mitigation tools have proven difficult to develop and to assess. In contrast, recent innovations in physical depredation mitigation devices have yielded promising results, although they have received less attention to date. The enthusiasm of fishers to be involved in developing mitigation tools should not be underestimated, and studies to test such devices can potentially provide additional data on bycatch rates.

9.3 Entanglement mortality in Oman

SC/62/SH20 described entanglement mortality for a resident sub-population of humpback whales in the western Arabian Sea (Breeding Stock X), which is geographically, demographically and genetically isolated and remains severely depleted. Analysis of scarring on the caudal peduncle region of photographically identified humpback whales in Oman in 2003 indicated that between 30-40% of all whales examined were likely to have been involved in entanglements with fishing gear (Minton *et al.*, in press). Fishing effort off the coast of Oman and in other parts of the Arabian Sea is increasing rapidly, and drifting and set gillnets as well as fish traps are already widely used. During surveys in 2010, densities of fishing vessels were recorded and these were up to an order of magnitude higher than during previous surveys between 2000 and 2006. While sighting rates during 2010 were very low, beach surveys revealed 10 stranded baleen whales, of which 3 showed evidence of entanglement.

Although there were no monitoring of bycatch or reporting schemes at the time of the study, the Government of Oman subsequently established a national stranding committee. The Working Group welcomed this as a contribution to better reporting and **recommended** that the Commission encourage all member states which do not have stranding reporting networks to establish these. It was noted that the previous scar study had not been repeated because no humpback whales were observed during recent surveys. Studies of raw wounds were encouraged should whales be encountered. These could lead to a locally derived survivorship estimate similar to studies in the Gulf of Maine. The importance of measures of fishing effort was also noted; density of fishing vessels is a useful statistic based on data collected during whale surveys. Indications of fishing effort can also be gained from the number of licences for fishing vessels in Oman, which doubled between 2006 and 2008.

9.4 Bycatches in Korea and Japan

SC/62/NPM26 presented information from surveys of products from minke whales on the market in the Republic of Korea. Individual identification of products by DNA profiling provided direct information on the minimum number of whales entering into commercial trade. A total of 177 samples of common minke whales were purchased in markets of Busan, Ulsan and Pohang during 7 market surveys from February 2004 to February 2005. In an attempt to improve on methods of previous estimates (Baker *et al.*, 2007), these market surveys were conducted at regular intervals and from a standardised number of outlets. Following quality control review of information from mtDNA control region sequences, sex identification and genotyping of up to 6 microsatellite loci, 169 of the products provided sufficient information for individual identification. Matching of DNA profiles resolved 90 individuals, 69 of which were sampled in only one of the 7 surveys. This 'minimum census' exceeds the reported bycatch of 61 minke whales from official records in 2004 and the average of 85 per year reported for the three-year period, 2003-05. As the sampling was far from exhaustive, the true take of common minke whales by Korea is likely to be substantially larger than documented by the current reporting. Capture-recapture estimates based on these replicate samples could provide an improved estimate of the true takes over time and inform population dynamic models of the 'J' stock.

The small number of replicate samples from the same individuals suggested that whales pass through the market quite rapidly. This is consistent with the estimated 'half-life' for products from individual whales on the Korea market of 1.8 months from previous surveys (Baker *et al.*, 2007). The rapid throughput is likely to be a result of most meat on the Korean market being sold fresh rather than being frozen and stored for longer periods. The reported bycatch for Korea in 2009 was 54 minke whales and it was noted that the previous market survey results suggest that this is likely to be an underestimate.

The Working Group also welcomed publication of a recent paper describing incidental entrapments of minke whales in waters of the Republic of Korea (Song *et al.*, 2010). This paper provided a considerable body of information on the nature of the fishing gear and bycatch which had been previously requested by the Scientific Committee.

SC/62/NMP4 presented a method to estimate the number of past incidental catch of minke whales off the coast of Japan. The method applies a GLM with Poisson error distribution to the BPUE data to estimate the number of incidental catches off the coast of Japan for the period from 1955 to 2000 (believed to be under-reported). BPUE was defined by the number of the incidental catches per number of 'large-size' and 'salmon' set nets. BPUE data from 1994 to 2006 were used. A new regulation allowing the selling of meat of bycaught whales came into force in 2001, so reported bycatches after 2001 are considered reliable. Under this assumption a BPUE trend and correction factor for the incidental catches until 2000 were estimated (standardised for the period 2001-06 using the GLM). The correction factor was used to estimate bycatch levels in the period 1955-2000.

Concerns were raised about the assumptions regarding trends and the multiplicative factor used to adjust reported bycatch figures for the period 1979-2000. It was noted that there was considerably more variability in the early reported figures with CVs for the 1980s and 1990s being three to six times higher than since 2001. Based on this it was suggested that a multiplicative adjustment was not appropriate and that the reports of zero bycatch for some years, which also resulted in zero estimates, were implausible. Concerns over the consistency of reported bycatch for the period 1979-2000 might also invalidate the trend analysis.

The Committee will require an agreed dataset for a time series of bycatch data around Japan for the *Implementation Simulation Trials* for North Pacific common minke whales. It was **suggested** that additional estimates should be presented to the first intersessional Workshop, once a timetable for *Implementation* had been decided. It was also **recommended** that the time series of minke whale bycatches from the Republic of Korea should also be considered at the same meeting. Attention also needs to be given to other types of fisheries around Japan, particularly since around Korea, gillnets and fish pots account for a substantial proportion of the bycatch. It was also noted that some of the large family-owned trap nets off the coast of Japan have been in place for a long time. It is possible that records of whale bycatch have been kept, even if these were not reported to the authorities at the time. Such records could provide a useful set of data.

10. REVIEW METHODS TO ESTIMATE MORTALITY FROM SHIP STRIKES

10.1 New data on ship strikes

A compilation of records of collisions between large vessels and southern right whales in Uruguayan waters using different sources of information including personal observations was presented in SC/62/BC2. In the coastal area of Uruguay, the southern right whale is one of the most common cetacean species during austral winter and spring (June to November). Between 2003 and 2007, seven southern right whales were recorded with large wounds due to collisions. Cuts were located in the supra-occipital, cranial, caudal and dorsal areas of the whales' bodies. Five of the seven records were *post mortem* and two whales were seen alive with large propeller scars. One of the live whales was an adult female (with a calf) that showed five parallel slashes that were estimated to be 2.5 to 3m long. Given the dimensions, location and other characteristics of the wounds on the seven animals, the authors concluded that they corresponded to propeller cuts produced by large vessels. The moderate decomposition of the five carcasses indicated recent death and a high probability that this had occurred in Uruguayan jurisdictional waters. The dates of the records were consistent with the seasonal presence of right whales in shallow Uruguayan waters during the calving season.

The Working Group welcomed this information which constituted the type of review of ship strike incidents requested for inclusion in the database. The value of these data in allowing relative comparisons of southern right whale collision rates along the southwest Atlantic coasts was also noted. Some data are available on shipping densities, and collision rates appear lower farther south along the Argentinean coast in areas of lower shipping traffic compared to Uruguay.

Ritter presented a detailed observation of a near-miss event from a 123m cruise ship involving a humpback whale off Antarctica. He noted a lack of data on near-miss events in the scientific literature. Observations were made from the bridge of a cruise ship during a regular cruise along the Antarctic Peninsula. In February 2009, the vessel sighted two humpback whales logging on the surface approximately 500m in front of the ship. The ship travelled at a speed of less than 10kn in a straight direction, thereby closing in on the whales without purposefully approaching them. The animals only appeared to react at a distance of about 10m from the vessel, when they showed a startle reaction and turned away vigorously from the vessel. This case together with the occurrence of similar observations leads to the suspicion that near misses may be a frequent phenomenon. Also, the avoidance manoeuvres of the whales were remarkable, because the response was only at the last second. This underlines the fact that large whales might not respond 'automatically' to the approach of a large vessel. Hence, slow vessel speed only, as well as placing dedicated observes aboard, might not be enough to generally avoid collisions.

In discussion, it was noted that this single observation should not be over-interpreted, although Ritter noted another two close encounters with travelling minke whales during the same cruise. Without knowing the noise field of the ship and propagation conditions, the noise level received by the whales cannot be determined. It was also noted that even when whales can hear an approaching vessel, they may not respond because they have become used to the passage of ships. They may simply ignore ships, since in their prior experience the noise has not presented an immediate threat. Whale response to approaching vessels is a key unknown in models of collision risk, and some understanding can be gained from studies of near-miss events. Some data have been collected from high speed ferries on encounter rates and near-miss events. In Hawaii, a high speed ferry operator was legally required to report near-miss events, which may provide an additional dataset. It was also noted that for consistency in future reports, a more precise definition of a 'near miss' would be helpful.

10.2 Progress in modelling risk

While there is evidence of ship strikes of fin whales in the Mediterranean Sea, the degree to which this may pose a population-level threat is unknown. Baseline information on abundance and trends of fin whales in the Mediterranean Sea is poor and as a result a proposal for a basin-wide survey has been developed in the context of ACCOBAMS and endorsed by the IWC Scientific Committee.

Panigada described surveys of fin whales off the Italian coastline to provide data on temporal and spatial distribution and abundance. These data are intended to improve evaluation of the conservation implications of anthropogenic mortality including ship strikes.

Preliminary conclusions drawn from the first year's survey were that a simple comparison with data from past shipboard surveys suggests an appreciable decrease in presence and density of fin whales in the Pelagos Sanctuary area in the summer. Comparison of the winter and the summer aerial surveys showed considerable variation, with higher numbers using the Sanctuary area during the summer months, when human activities (and potential impact on cetaceans) reach maximum levels. Fin whales were not sighted during the winter survey, although previous acoustic data indicated some presence. He noted that the information provided by these surveys may be particularly useful in assessing whether ship strikes are affecting the Mediterranean fin whale population; at present there are no indications of negative trends for this species, but systematic monitoring programmes, such as the one presented here, represent a framework to provide robust data to assess this. The project plans to increase the survey scope beyond the Pelagos Sanctuary to explore the possibility of fin whales using other adjacent waters. Additional knowledge of population structure and movements will help inform the risk of collision in current fin whale habitats.

The abundance estimates discussed were not corrected for $g(0)$ but Panigada believed that perception bias was close to 1 and noted that corrections for availability bias will be investigated using available telemetry and behavioural data collected in the past. Associated vessel data are being collected through Automatic Identification System (AIS) data in the survey area (AIS is required on all vessels of greater than 300 gross registered tonnage (g.r.t.) and will be required on fishing vessels over 15m by 2014) as well as visual sightings of all vessels observed during the survey.

The Working Group **encouraged** the continuation of this effort as an important part of both modelling the risk of ship strikes to fin whales in the Mediterranean and understanding the potential impacts of ship strikes on fin whale populations in one of the locations where risk of ship strikes appears unusually high and are known to be numerous.

11. PROGRESS IN DEVELOPING A GLOBAL DATABASE OF SHIP STRIKES

The IWC has been developing a global database of incidents involving collisions between vessels and whales since 2007. The specification and developments have been reported annually to the Scientific Committee. The need for and value of such a database has also been recognised by the International Maritime Organization (IMO) and ACCOBAMS, amongst others. The IMO has issued a circular recommending that any information gathered on ship strikes should be provided to the IWC. In addition, a leaflet has been developed by the Belgian Ministry of Environment, including details on reporting collisions, and will be distributed as widely as possible throughout the shipping industry. The leaflet is available in Arabic, Chinese, English, French, Russian and Spanish on the IWC website.

A list of tasks related to the database had been identified at last year's meeting, and most of these were near completion or had been completed. The database does not have a dedicated co-ordinator, and progress has relied on informal arrangements among the Secretariat, members of the data review group and an external contractor. Nevertheless, the tasks relating to improving the data entry system and tools for the data review group had made good progress. Although the current approach may continue to be acceptable at present, it should be reviewed annually in the light of the work required. The Working Group noted that many other successful databases relied on having a dedicated co-ordinator and **recommended** that this be considered for the IWC ship strike database.

With increased awareness of the existence of the database it is anticipated that the rate of data entry and requests for data will increase. This may require increased attention to the validation process, particularly for reports entered by the public. In Hawaii reports of possible collisions increased by an order of magnitude following publicity of the issue and issues related to data included law enforcement as well as scientific considerations. Reports from people on shore were often unreliable and careful validation was needed to determine whether the information provided was accurate.

There may also be a need to distinguish situations in which a whale swims into a vessel from those in which the vessel runs into a whale. Although vessel speed is recorded in the database it was suggested that zero vessel speed may not be adequate to identify all cases of contact due to whale movement.

The Working Group **recommended** an additional category in the database for situations in which stationary vessels were impacted by a whale.

The Working Group discussed the proposed programme of work on the ship strike database and **endorsed** the actions suggested in Appendix 3. It was noted that providing information in the publicly available data on cases that were not classified as 'definite' ship strikes could be informative. These data could be important for estimates of total mortality, for example in the case of a number of strandings where some proportion were known to be from ship strikes but the cause of mortality was unknown for others. Currently, reports of strandings or floating carcasses would only be entered in the database if there was at least some evidence that these were a ship strike. However if the evidence was weak, these would be classified as a 'possible' ship strike. It was suggested that it would be useful to investigate the proportion of carcasses which showed no external signs of ship strike injuries that subsequently were identified as ship strikes following a full necropsy.

The Working Group **agreed** at this stage to limit publicly available data to confirmed definite incidents but to review this again at future meetings. The need exists for very clear descriptions and caveats regarding the level of certainty of all data that are made available from the database.

The IWC and ACCOBAMS will hold a joint Workshop on reducing risk of collisions between vessels and cetaceans in Monaco from 21-24 September 2010. The geographical focus of the Workshop will be on the Mediterranean Sea and the Canary Islands, but many of the agenda items are relevant to global considerations including data gathering and estimation of numbers of collisions. Risk modelling will be on the agenda of the Workshop and this will be reported on at next year's meeting.

12. MORTALITY FROM ACOUSTIC SOURCES

There was no new information submitted on this topic. However, it was noted that Bernaldo de Quirós *et al.* (2010) reported development of an improved method for processing and analysis of gas embolisms found in stranded cetaceans. Such embolisms have been hypothesised to be related to acoustic sources.

13. MORTALITY FROM DEBRIS

SC/62/BC5 described a model-based approach to identify areas where whales are most likely to encounter floating marine debris including 'ghost' fishing gear in the coastal waters of British Columbia, Canada. The methods were applied previously to model spatial variability in ship strike risk to fin, humpback and killer whales. Areas with the highest density of marine debris were often quite distant from the largest urban areas, which suggests that these regions may serve as a sink for marine debris. Overlap between debris and whales was presented on a 2km grid based on a spatial model of whale density from sightings surveys at 1km resolution. Areas with highest overlap between debris and whales were also often distant from human settlements, and therefore spatial biases in reporting rates of debris related mortalities are likely. In order to quantify the magnitude of mortality of whales due to entanglement in marine debris, additional resources would have to be allocated to monitor remote areas.

The database used to assess debris had coarse categories of debris. The importance of debris, especially 'ghost' fishing gear, was discussed. It was noted that in some cases, ghost gear may take up to 30% of the total catch of target species; in these cases up to 30% of entanglements may be attributable to ghost gear. While some cases of entanglements in ghost gear have been reported, the relative mortality related to active versus abandoned gear remains unknown. Identification of deaths due to ingestion of marine debris usually requires a full necropsy. As also noted with reference to entanglements, the Working Group **recommended** that necropsies be undertaken on all large whales irrespective of population status, since this will contribute to estimates of mortality rates including for species that may be subject to whaling.

14. OTHER ISSUES

14.1 Actions arising from intersessional requests from the Commission

The Committee was requested to review Annex {DNA} of IWC/62/7rev. This contains a section on market sampling schemes. Although the objective of these schemes is to act as a deterrent to illegal activity and to detect such activity, they may also potentially provide information of value for estimating bycatch. The Working Group has discussed a number of studies in previous years that have used market surveys to make inference about levels of bycatch. A Workshop in 2005 included the objectives of reviewing available methods that have been used to provide estimates of large cetacean bycatches via market samples and to identify information about the markets that would be required for a market sampling approach (IWC, 2006). Following the Workshop, a study to describe the structure of the Japanese market for whale meat in order to assist in the development of a sampling design was commissioned (Williams, 2006). Simulation studies were also conducted to investigate the implications of different assumptions about various aspects of market structure on estimates of the numbers of whales entering the market (e.g. Leaper and Cooke, 2007). The Group has also previously agreed that availability of data from DNA registers would improve estimates of total take from market surveys, including the potential for tracking known individuals through the market to understand more about market pathways. The estimates of bycatch from market surveys to date have been derived from surveys conducted by independent groups. Under the proposals in Annex {DNA} these surveys would have to be done by the national authorities.

There was some discussion as to whether the proposals in Annex {DNA} would allow unreported local bycatch entering the market to be distinguished from international trade that might include whales that had originated from takes from a different stock. It was noted that the implications of the requirement for an officially-attested documentation of chain of custody from time of collection to results of matching (Annex {DNA} 2.1(6)) would preclude matching of samples from market surveys that were not conducted by the national authorities.

14.2 Other potential sources of human-induced mortality

While there have been no reported cases of cetacean mortality caused by collision with marine renewable energy developments, SC/62/E7 and SC/62/E8 noted the potential for such mortality. Carter *et al*. (2008) examined this issue in proceedings of the ASCOBANS/ECS Workshop: Offshore Wind Farms and Marine Mammals, April 2007.

15. WORK PLAN AND BUDGET REQUESTS

The Working Group agreed to carry over a number of items from this year's Agenda and to give attention to the topics intersessionally:

(1) collaboration with FAO on collation of relevant fisheries data and joining FIRMS;
(2) progress in including information in national Progress Reports;
(3) continued development of the international database of ship strike incidents;
(4) estimating risk and rates of bycatch and entanglement;
(5) review of methods to estimate mortality from ship strikes;
(6) review of methods for assessing mortality from acoustic sources and marine debris; and
(7) consideration of methods and data sources for establishing time series of bycatch.

No new items were proposed for the Agenda, but other topics may emerge intersessionally. Work on the ship strike database will involve a budget request of £5,000 for further refinement and maintenance of the database.

16. ADOPTION OF THE REPORT

The report of the Working Group was adopted at 10:42 on 5 June 2010.

REFERENCES

Baker, C.S., Cooke, J.G., Lavery, S., Dalebout, M.L., Ma, Y.U., Funahashi, N., Carraher, C. and Brownell, J., R.L. 2007. Estimating the number of whales entering trade using DNA profiling and capture-recapture analysis of market produce. *Mol. Ecol.* 16(13): 2617-26.

Bernaldo de Quiros, Y., Gonzalez-Diaz, O., Saavedra, P., Arbelo, M., Sierra, E., Mendez, M. and Fernandez, A. 2010. Methodology for field-gas sampling, transport and analysis in the laboratory of gas embolism found in stranded cetaceans. Abstract presented to the European Cetacean Society, 2010.

Carter, C.J., Wilson, B. and Black, K.D. 2008. Marine renewable energy devices: a collision risk for marine mammals? *ECS Special Publication Series* 49: 60-62. Proceedings of the ASCOBANS workshop 'Offshore wind farms and marine mammals: impacts and methodologies for assessing impacts' held at the European Cetacean Society's Annual Conference, The Aquarium, San Sebastian, Spain, 21st April 2007.

International Whaling Commission. 2006. Report of the initial workshop in the use of market sampling to estimate bycatch of large whales. *J. Cetacean Res. Manage. (Suppl.)* 8:357-65.

Leaper, R. and Cooke, J. 2007. Further simulations of whale meat markets to investigate sensitivity of sampling designs to assumptions about market structure. Paper SC/59/BC4 presented to the IWC Scientific Committee, May 2007, Anchorage, USA (unpublished). 6pp. [Paper available from the Office of this Journal].

Minton, G., Collins, T., Findlay, K., Baldwin, R., Ersts, P.J., Rosenbaum, H., Berggren, P. and Baldwin, R.M. in press. Seasonal distribution, abundance, habitat use and population identity of humpback whales in Oman. *J. Cetacean Res. Manage. (special issue)*: 35pp.

Song, K., Kim, Z., Zhang, C.I. and Kim, Y.H. 2010. Fishing gears involved in entanglements of minke whales (*Balaenoptera acutorostrata*) in the East Sea of Korea). *Mar. Mammal Sci.* 26: 282-95.

Williams, S.C. 2006. Consultancy report on the consumption and distribution of whale meat in Japan. Paper SC/58/BC3 presented to the IWC Scientific Committee, St Kitts and Nevis, June 2006 (unpublished). 22pp. [Paper available from the Office of this Journal].

Appendix 1

AGENDA

1. Convenor's opening remarks and Terms of Reference
2. Election of Chair
3. Adoption of Agenda
4. Appointment of rapporteurs
5. Available documents
6. Collaboration with FAO on collation of relevant fisheries data
7. Progress on joining the Fisheries Resource Monitoring System (FIRMS)
8. Progress on including information in national Progress Reports
9. Estimation of bycatch mortality of large whales
    9.1 Report of intersessional Workshop
    9.2 Mortality in longline fisheries
    9.3 Entanglement mortality in Oman
    9.4 Bycatches in Korea and Japan
10. Review methods to estimate mortality from ship strikes
    10.1 New data on ship strikes
    10.2 Progress in modelling risk
11. Progress in developing global database of ship strikes
12. Mortality from acoustic sources
13. Mortality from debris
14. Other issues
    14.1 Actions arising from intersessional reports of the Commission
    14.2 Other potential sources of human-induced mortality
15. Work plan and budget requests
16. Adoption of the Report

Appendix 2

ANTHROPOGENIC MORTALITY (OTHER THAN DIRECTED TAKE) OF LARGE WHALES FOR THE CALENDAR YEAR 2009 AS REPORTED IN THE NATIONAL PROGRESS REPORTS

Table 1

Anthropogenic mortality of large whales reported in Progress Reports.

	Australia	Belgium	Brazil	Chile	Denmark	France	Italy	Japan	Korea	Mexico	New Zealand	Norway	Spain	UK	USA	Total*
Minke whale																
Ship strike	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Entanglement	-	-	-	1	1	-	-	119	54	1(1)	-	1	-	-	2	179(1)
Blue whale																
Ship strike	1	-	-	-	-	-	-	-	-	-	-	-	-	-	4	5
Entanglement	1[1]	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Humpback whale																
Ship strike	3	-	1	-	-	-	-	-	-	-	-	-	-	-	10	14
Entanglement	29(27)	-	-	-	-	1	-	4	-	7(5)	-	-	-	-	9(6)	50(24)
Sperm whale																
Ship strike	-	-	-	-	-	-	3	-	-	-	-	-	2	-	-	5
Entanglement	-	-	-	-	-	1	-	-	-	-	-	-	1	-	1(1)	3(1)
Fin whale																
Ship strike	1	1	-	-	-	1	2	-	-	-	-	-	1	-	2	8
Entanglement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3
Sei whale																
Ship strike	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	2
Entanglement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bryde's whale																
Ship strike	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entanglement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern right whale																
Ship strike	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entanglement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Southern right whale																
Ship strike	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2
Entanglement	1(1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1(1)
Bowhead whale																
Ship strike	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entanglement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gray whale																
Ship strike	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Entanglement	-	-	-	-	-	-	-	-	-	-	1(1)	-	-	-	-	1(1)
Pygmy right whale																
Ship strike	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entanglement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Killer whale																
Ship strike	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entanglement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1(1)	1(1)
Short-finned pilot whale																
Ship strike	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entanglement	3(3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3(3)
Unknown whale																
Ship strike	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Entanglement	2(2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2(2)

*Numbers in brackets indicate the subset of whales reported to have become free or released alive; the square brackets represent fate unknown. These types of incidents are not reported in all Progress Reports. Ship strikes include incidents that may not have been fatal. Progress Reports of Croatia, Germany, Ireland, Italy, Netherlands, Norway and Portugal reported no large whale deaths, while Brazil and Sweden did not report on incidental anthropogenic mortality.

Appendix 3

PROPOSAL FOR FURTHER DEVELOPMENT AND MAINTENANCE OF THE IWC SHIP STRIKE DATABASE INCLUDING POLICY ON DATA ACCESS AND USE

Leaper, Donovan, Panigada, Ritter and Weinrich

Suggested policy on data availability, access and use

The fully validated data in the database are currently from published sources and so up until now data access rules have not been an issue. As new unpublished data are entered, then those providing data may have concerns about allowing full public access to these data. Such concerns may include:

(i) data being publicly available may infringe on the first right to publish;
(ii) data that identifies a vessel or company may create bad publicity; and
(iii) the inevitable uncertainty related to certain records may be misinterpreted.

Publicly available data

It is expected that requests for data will increase as the existence of the database becomes better known. There is a need for a system which allows users to download basic data from the website such that most requests for data do not need to be dealt with on an individual basis. This requires these basic data to be fully publicly accessible, at least in summary form. At a minimum, users will wish to establish whether a record they are aware of is already in the database. One of the most common requests to date has been a list of records for a particular area, and in many cases this has been a result of people working on collision data wanting to check whether the IWC database contained incidents that they were unaware of. We suggest the following fields should be available within the downloadable summary data:

Field in bold type. Additional notes in standard type.

Date
Where exact date is not available this is given as a text field, e.g. 'before August 2001'.

Location
This is made up of two fields, a categorical field giving the large area e.g. 'Mediterranean' (i.e. it will be part of a standard list of 'large' geographical areas). There may also be included a descriptive field which contains more detail on location if available. Actual Latitude and Longitude would not be given.

Species
This contains categorical fields for scientific name (or categories if uncertain e.g. 'unidentified large baleen whale') and local or common name.

Confidence in species ID
This is a categorical field indicating the confidence in the species identification.

Type of incident
This is divided into four categories of reports; observed collision incident, carcass found on bow, carcass observed floating, stranded carcass.

Outcome of collision
A categorical field, from no observed injury to death.

Vessel type
A categorical field with broad types of vessel and size class if report was of an observed collision incident.

Reported to local stranding network?
Categorical 'Yes/No/Not known' for stranded animals. If a stranding network had been known to be involved, then the investigations conducted including whether a full necropsy had been carried out would be listed.

Entered from a published source?
If so, the reference would be given.

The database has categories for the level of confidence that the incident was a direct collision between a vessel and a live whale. We propose that only the 'ConfirmedDefinite' category is included in the publicly available data (this currently applies to about 70% of the records).

Suggested policy for full access to data

It is hoped that the level of data made available publicly would be sufficient for most users, but contributors would not feel that this infringed upon their ability to publish data that they had submitted. The IWC Antarctic humpback whale catalogue has a similar policy of providing basic data (e.g. an image of each whale) publicly but restricting access to the full data set. It is anticipated that this level of data would be adequate to filter a large proportion of data requests. Requests for full data access in order to conduct analyses such as relating risk to vessel type or speed, mortality assessments, and mitigation measures would need to be dealt with on an individual basis.

For work done in the context of the Scientific Committee, the Committee has the Data Availability Agreement which could be used to guide applications for access to data. Procedure A would be appropriate for any collision reports that were from stocks subject to whaling under the RMP or AWMP. Requests for data outside of the activities of the Committee may be more problematic. One option would be that the Data Review Group would consider such requests.

Proposed intersessional tasks

(1) Re-establish the Data Review Group (last year's group was Leaper, Cañadas, Donovan, Double, Ferguson, Mattila, Panigada, Ritter, Rowles, Tandy and Weinrich).
(2) Review all data entries including standardisation of codes from earlier data entries. Enter data from national Progress Reports and papers presented to IWC/62. The intended output would be a fully reviewed database that would be available prior to the IWC/ACCOBAMS Workshop 21-24 September 2010.
(3) Develop a database handbook describing and listing all the fields and field codes. This would form a PDF file that could be downloadable from the website to assist with data entry and also provide information on all the fields in the database for those who could not use the schema directly.
(4) Develop written definitions for determining whether an incident was classified as a definite, probable or possible strike. These definitions can draw on nationally developed criteria. Some historical data may have been categorised according to different criteria, and so where clear criteria have been applied this will be recorded in the database.

Committee members with data to be entered into the database and requiring funding to do this are encouraged to submit proposals to the Secretariat.

Budget

4 weeks work on data validation/creating handbook: £3,000.
Intersessional work on data entry including new incidents reported intersessionally: £2,000.

Annex K

Report of the Standing Working Group on Environmental Concerns

Members: Moore (Convenor), Amaral, Aruna, Baldwin, Bejder, Bjørge, Brito, Brockington, Brownell, Campbell, Cañadas, Castellote, Cerchio, Charrassin, Chilvers, Clark, Collins, Cozzi, De Quiros, De Stephanis, Deimer-Schüette, Donoghue, Edwards, Ferguson, Fernández, Flóres, Fossi, Gales, Gallego, Galletti, Gedamke, Groch, Holm, Iñíguez, Jaramillo-Legorreta, Jérémie, Kock, Koski, Lauriano, Lens, Liebschner, Lovell, Luna, Lusseau, Marcondes, Mate, Mattila, Moore, Nelson, Øien, Palka, Panigada, Parsons, Podestá, Punt, Reeves, Ridoux, Ritter, Rojas-Bracho, Rosa, Rose, Rosenbaum, Rowles, Scordino, Simmonds, Sironi, Stachowitsch, Štrbenac, Suydam, Taylor, Uoya, Urbán, Vazquez, Vély, Víkingsson, Weinrich, Weller, Werner, Williams, Wright, Ylitalo, Young, Zerbini.

1. CONVENOR'S OPENING REMARKS

Moore welcomed the participants to the Standing Working Group on Environmental Concerns (SWG).

2. ELECTION OF CHAIR

Moore was elected Chair.

3. ADOPTION OF AGENDA

The adopted Agenda is given in Appendix 1.

4. APPOINTMENT OF RAPPORTEURS

Taylor and Ylitalo were appointed rapporteurs. Rowles assisted in compilation of the report.

5. REVIEW OF AVAILABLE DOCUMENTS

SC/62/E1-E14; SC/62/BRG3, SC/62/SH12, SC/62/SH20, SC/62/WW2, SC/62/WW5; Alter *et al*. (2010); Clark *et al*. (2009); Dolman and Simmonds (2010); and Hildebrand (2009).

6. RECEIVE THE STATE OF THE CETACEAN ENVIRONMENT REPORT (SOCER)

SOCER provides an annual update, requested by the Commission, on: (a) environmental matters that potentially affect cetaceans; and (b) developments in cetacean populations/species that reflect environmental issues. The topics are organised according to the environmental concerns identified by the IWC. The SOCER is based on papers published in peer-reviewed journals between 2008 and 2010 and is tailored for a non-scientific audience.

The report consists of a regional (in 2010, the Arctic region) and a global section and includes a glossary of species and scientific terms. The bibliometric analysis has been shifted into a separate paper (SC/62/E2). The editors of SOCER request that Scientific Committee members submit entries in the form of pdf files of published papers (in 2011, the region of focus will be the Southern Ocean), whereby the traditional submission form will remain valid for more recent, ongoing or breaking developments not yet available in published form. This is designed to avoid delays in crucial information because, as one SOCER entry points out, conservation-related papers take three times longer to be published than papers of other biology specialists.

The overwhelming issue in the literature published in 2008-10 for the Arctic was climate change (i.e. rate of ice loss and ecosystem shifts) but many of the papers in the review period had already been summarised in previous SOCER global sections because of their global significance (see, e.g. the summary of Huntington and Moore, 2008 in Stachowitsch *et al.*, 2008). There were few pollutant studies specifically on cetaceans in 2008-10, but the Arctic Monitoring and Assessment Programme (AMAP) 2009 Assessment of Arctic Pollution Status (*http://www.amap.no/*) provides a comprehensive review of pollutant levels in the Arctic (SC/62/E1 did not review this report as it was itself a review and was not specifically focused on marine mammals).

Globally, the environmental issue that progressed most over the past year seemed to be underwater noise, especially disturbance from boat traffic, impacts of sonar on beaked whales (for which researchers are getting a clearer idea of why these animals seem to be affected more than other species) and the acoustic impacts of wind farms (discussed in SC/62/E7 and SC/62/E8). During discussion, it was noted that the Arctic was covered in special issues of *Ecological Applications* in 2008 (Volume 18, Supplement) and *Science of the Total Environment* in 2010 (Volume 408, Issue 15). Next year the SOCER will focus on the Southern Ocean. The editors of the SOCER requested that SWG members respond to the annual submission request by the Secretariat's requested deadline. The members of the sub-committee thanked the authors for compiling the SOCER.

SC/62/E2 offered a bibliometric analysis of the cetacean scientific literature, based on a 2004 request from the then-Chair of the Scientific Committee as an addition to the established SOCER format. The analysis evaluated two different databases - one maintained by the Natural History Museum of Los Angeles County and the BIOSIS database. It was determined that for 2005-08, there was a relatively steady percentage of papers being published (nearly half) that were focused on conservation topics and this was probably an underestimate. An earlier era (35 years earlier) was then examined and it was determined that there has been a shift in focus from basic biology topics to conservation topics in cetacean research, even though much is still to be discovered about cetacean biology. This reflects a similar trend in other biological disciplines, such as coral reef ecology. Clearly understanding threats facing cetaceans has gained in importance within the research community, within the policy community, and even within funding agencies and sources, which often include a conservation focus in their funding criteria. Therefore the growing focus on conservation issues in forums such as the IWC Scientific Committee is appropriate.

7. REVIEW PROGRESS IN PLANNING FOR POLLUTION 2000+, PHASE II

7.1 Workshop report

An intersessional Workshop on POLLUTION 2000+ was hosted by Drs Frances Gulland and Jeff Boehm of The Marine Mammal Center in Sausalito, California from 22-24 February 2010. Fifteen participants with expertise in chemical contaminants, toxicology, cetacean biology, veterinary medicine and biomarkers of contaminant exposure and effects, participated in this event. The goals and objectives of the Workshop included the following:

(1) develop integrated modelling approaches and a risk assessment framework for evaluating the cause and effect relationships between pollutant exposure and cetacean populations:
  (a) further refine the conceptual model developed at the Workshop in Barcelona;
  (b) develop the draft models and risk assessment framework;
  (c) review and assess modelling approaches to meet the framework;
  (d) evaluate existing models that could be tested and develop a plan for testing these models with available datasets; and
  (e) assess the model characteristics needed and a plan for developing new models if needed;
(2) develop a prioritisation hazard identification framework to evaluate the broad number of environmental pollutants; and
(3) identify data needs and available datasets or case studies that would be appropriate for the models that are exposure driven, source driven or effects driven.

Several presentations were given that provided information on risk assessment frameworks, chemicals of emerging concern, contaminant exposure and effects in cetaceans as well as modelling approaches and case study examples. Biomarkers of chemical exposure and effects were also discussed, with the workshop purposefully selecting those that have been validated in cetaceans and would most likely provide relevant information for population-level assessments, such as those affecting reproduction or survival.

The Workshop agreed upon an international prioritisation survey of subject matter experts in chemical contaminants, marine mammals and/or toxicology. To develop the survey, the general approach was to establish cetacean (based on diet composition and trophic level), geographical and contaminant categories (based on chemical properties, bioaccumulation and exposure potential); assess existing information on contaminant exposures and biological effects (negative impacts on reproduction and health); determine where information was strong enough to prioritise contaminants; develop an international survey format; and identify and query subject matter experts. It was agreed that once the survey had been finalised, each Workshop participant would send the survey to 2-3 subject matter experts, with a cover letter from the POLLUTION 2000+ Steering Committee. The Workshop proposed that the survey would be finalised in spring 2010, and would then be sent to subject matter experts and a report compiled during 2010. A final report on the prioritisation survey results will be presented to the 2011 Scientific Committee meeting.

Data gaps and research needs were identified by the Workshop, with most of the short, medium and long-term research requiring new efforts or additional support of existing efforts. In addition, the following recommendations were made by the Workshop.

(1) Improve existing concentration-response (CR) function for PCB-related reproductive effects. Re-initiate efforts to derive a CR function based on surrogate species for reproductive effects in relation to PCB exposure.
(2) Derive additional CR functions to address other endpoints (i.e. survival) in relation to PCB exposure. This may be accomplished using a multi-stage modelling approach. Additional CR functions could be derived using data from surrogate species (e.g. experimental studies and/or wildlife and human epidemiological studies) as well as through synthesis of recently acquired information from small cetaceans (European harbour porpoise strandings and US bottlenose dolphin capture-release health assessments).
(3) Integrate improved concentration-response components into a population risk model (e.g. individual-based model) for one or more case study species (e.g. bottlenose dolphin and/or humpback whale).
(4) Develop new biomarkers and improve the linkages between lower and higher levels of organisation (molecular → individual → population). The highest priority for biomarker development should include those with direct relevance to population-level endpoints such as reproduction and survival.

Some of the cetacean populations proposed for case study models by the workshop may not be appropriate. For example, the US Navy dolphins are moved frequently from facility to facilty and thus their contaminant levels could change. Rowles noted that they were proposed as a potential model and have not yet been agreed upon by the Navy. When the Navy animals are moved their food may not significantly change as far as contaminant burdens and nutritional quality are concerned. The Navy veterinarian programme has long-term health information on their animals and has a strong interest in the development of biomarker and health indices. The bottlenose dolphin case study model presented in the workshop report was an example of how PCB exposure could affect calf survival and potentially influence the dolphin population. PCBs may have other effects on fecundity or survival that were not incorporated in to this model.

The SWG also noted that it is difficult to make the critical link between exposure effects on the health of individuals and how that translates to the population health trends and, that an advantage of working with cetaceans is the availability of tissue banks that can serve as great resources for population genetic studies. At a special session on evolutionary toxicology at the European Society of Environmental Toxicology and Chemistry meeting held in Seville in late May 2010, it was proposed that an approach such as this would be quite useful.

The SWG also noted that the ICES Working Group on Marine Mammal Ecology (WGMME) met in the Azores 12-15 April 2010 and that one of the WGMME's Terms of Reference was: 'Review the current contaminant loads reported in marine mammals in the ICES area, the cause–effect relationships between contaminants and health status, and the population-level effects of environmental impacts.' The WGMME also made several recommendations with regard to pollutants in marine mammals that are listed in the report that is available at *http://www.ices.dk/reports/ACOM/2010/WGMME/wgmme_final_2010.pdf*. The SWG endorsed the recommendations of the ICES WGMME.

Moore thanked the Workshop convenors for the report as it gives a solid foundation and framework to move forward with POLLUTION 2000+ Programme.

7.2 Other pollution information

The main objective of SC/62/E9 was to apply, for the first time, a suite of sensitive non-lethal biomarkers in skin biopsy of the mysticete species Bryde's whale (*Balaenoptera edeni*) to evaluate the toxicological status of this cetacean in the Gulf of California. A 'multi-trial-biomarker-tool' was developed, combining protein biomarkers (western blot of CYP1A1, CYP2B) with concentrations of organochlorines (OCs) and polycyclic aromatic hydrocarbons (PAHs) measured in this species. The levels and effects of OCs and PAHs in skin biopsies of fin whale (*Balaenoptera physalus*) populations of the Gulf of California and the heavily polluted areas of the Mediterranean Sea were also examined. Higher levels of DDTs, PCBs and PAHs were detected in the zooplankton-eating fin whales compared to the fish-eating Bryde's whales; in contrast, much higher levels of both CYP1A1 and CYP2B were detected in the fish-eating species. These data suggest a peculiar evolutionary process of the two isoforms of CYP in the fish-eating Bryde's whales, demonstrating similar levels of both cytochromes similar to the odontocete species resident in Sea of Cortez (C. Fossi, pers. comm.). The interspecies investigation shows the presence of a higher 'toxicological stress' in the Pelagos fin whale population (Mediterranean Sea) highlighted by warning signs such as higher levels of DDTs, PCBs and PAHs, elevated levels of CYP1A1 induction and, as previously reported by Fossi and collaborators, the up-regulation of ERα and E2F-1 genes, combined with a lack of CYP2B induction in both field and *in vitro* experiments.

The development of new tools to detect the effects of persistent organic pollutants (POPs), emerging contaminants of concern and PAHs on Mediterranean cetaceans using a suite of sensitive biomarkers was described in SC/62/E10. A multi-response *in vitro* method to detect toxicological effects of contaminant mixtures was examined using slice integument biopsies of stranded and free-ranging animals. In this study, an *in vitro* assay using skin biopsy and liver slices was applied, combining molecular biomarkers (western blot of CYP1A1, CYP2B) and gene expression levels (qRT-PCR of CYP1A1, HSP70, ERα and E2F-1) in response to chemical contaminant exposure (OCs, PBDEs, PAHs) for stranded Mediterranean *Stenella coeruleoalba*. The main goal of this experiment was to identify among the various assays, the biomarker and/or series of biomarkers that best allows us to diagnose the presence of a specific class of pollutants (OCs, PBDEs, PAHs) or a mixture of them for future investigations in field studies.

The SWG noted that making comparisons of PAH biomarkers between two cetacean populations could be difficult as PAHs are transient and exposure levels are not known. However, wild cetaceans are likely to be exposed to a mixture of chemicals so developing a wide range of biomarker techniques for biopsy samples that can cover a variety of chemical contaminant classes, as well as any potential synergistic effects would be useful. In order to compare data among studies, the SWG recognised the importance of standardisation of contaminant concentration reporting (e.g. wet weight, lipid weight, dry weight).

Rowles and Ylitalo provided an overview of the Deepwater Horizon MC252 oil spill that occurred in the Gulf of Mexico. On 20 April 2010, an explosion occurred on the semi-submersible Deepwater Horizon oil-drilling platform situated approximately 50 miles southeast of the coast of Louisiana. The fire resulting from the explosion could not be extinguished, and as a result, the oil platform sank and crude oil began spilling into the waters of the Gulf of Mexico approximately 5,000 feet below the surface on 22 April 2010. At the time of the SWG meeting, attempts to cap the oil riser had been unsuccessful and crude oil continued to enter the marine waters of the Gulf of Mexico.

In response to this spill, the Wildlife Branch of the Unified Command, including State and Federal Trustees and the responsible party, developed response networks for marine mammals, sea turtles and birds. Additional resources (financial, physical, and experts) were used to enhance the capacity of the established stranding networks in the Gulf of Mexico. Four facilities were identified and supplied for de-oiling of manatees, dolphins and sea turtles. In addition, staff members from the national stranding program are rotating through the response teams. Other experts such as husbandry staff from public display facilities and the Navy as well as veterinary experts in wildlife from North America have been contracted to assist. To date, these personnel have responded to 31 stranded dolphins and 277 sea turtles, most of which have been dead. In addition to the stranding response, there are on water efforts to find and rescue dead and live turtles.

Clean up efforts that include skimmers, trawls and the Big Gulp also have the potential to trap or kill sea turtles and some turtles have been collected during these operations. It is highly likely that others have been incidentally killed during response actions. In addition there are efforts underway to protect nesting beaches both from the oil and from the mitigation or clean up. Protocols and assessments are underway to determine the appropriate action once hatchlings emerge.

As part of this event, Natural Resource Damage Assessments have begun and over 20 technical working groups are fully operational. A bottlenose dolphin project along the coastal areas from Louisiana to the west coast of Florida has started and includes pre-spill photo-id and biopsies. That project may continue throughout the response time period and into the post clean up time periods. In addition, since the first week of May aerial surveys over the area have been conducted utilising fixed wing aircraft and helicopters. These will be continuing periodically over the following months. Future plans include boat-based surveys, possibly tagging and biopsy of the offshore cetaceans, surveys for manatees, and boat based assessments of turtles including some nest success assessments. Longer term planning for assessments of these species as well as the prey and habitat upon which they depend is underway.

The SWG discussed fishing enforcement, categorisation of oiled marine mammals and sea turtles, as well as lessons learned thus far with respect to the oil spill. Due to the large extent of this spill and the potential impacts on marine resources in the region, information obtained from this event will increase our ability to respond to similar events in the future. The SWG **commended** all groups that are responding to impacted marine mammals and turtles in the region.

The SWG needs to learn as much information as we can from this tragedy so that we: (1) can accurately assess impacts; and (2) are better prepared for potential future oil spills. The SWG **strongly recommended** that the United States Government and the responsible party:

- search for and examine as many cetacean carcasses as possible that may have been impacted by the spill through detailed necropsies and thorough tissue sampling;

- analyse tissues for contaminants specifically related to spilled oil (i.e. polycyclic aromatic hydrocarbons, dispersants and mixtures of the two);
- provide detailed chemical composition of the dispersants that have been used in the Gulf of Mexico. The chemical composition of dispersants is currently considered proprietary in the United States. Because dispersants can be toxic and may have negative impacts on cetaceans, damage assessment scientists need to understand the chemical composition of dispersants; and
- develop and examine a suite of biomarkers that will be useful for understanding impacts from the spilled oil and use of dispersants in the Gulf of Mexico. Understanding the efficacy of biomarkers for future assessments may allow for assessing exposure or sublethal impacts from exposure to spilled oil, dispersants and clean-up efforts by biopsying live animals.

The situation in the Gulf of Mexico also emphasises the need to have adequate baseline data before oil and gas exploration, development or production occurs in an area. There are relatively few baseline data available in the Gulf of Mexico that are available for predicting, mitigating or measuring impacts. Therefore, for member governments with on-going or planned offshore oil and gas activities within their territories the SWG **strongly recommended** the collection of the following baseline data as soon as possible:

- contaminant levels in cetaceans, their prey and in sediments, especially polycyclic aromatic hydrocarbons (PAHs) but also other contaminants that may interact with PAHs;
- biomarker levels in cetaceans and their prey;
- abundance and distribution of cetaceans and their prey; and
- condition of habitat (i.e. water quality, sediment quality, etc.).

The SWG **strongly recommended** contingency planning for oil spills in areas of oil and gas development. The SWG looks forward to receiving further information on the studies into the effects of this spill at future meetings.

8. REVIEW PROGRESS OF CETACEAN EMERGING AND RESURGING DISEASE (CERD) WORKING GROUP

SC/62/E5 reviewed the recent accomplishments and upcoming plans of the Cetacean Emerging and Resurging Disease (CERD) Working Group (WG), as follows.

Skin disease
The Skin Disease Subgroup made some progress on the development of a website for skin lesions in cetaceans and on the standardisation of skin lesion/disease descriptions.

Diagnostic laboratories and veterinary experts
Utilising the fields developed at last year's meeting for diagnostic laboratories, the WG has identified regional experts who would be willing to provide the information and complete the draft list of diagnostic laboratories by region, ocean basin or country. Regional experts have been identified for the following countries: Argentina, Belgium, Brazil, Canada, Germany, India, Netherlands, Spain/Canary Islands, United Kingdom and the United States.

Prioritisation of pathogens in cetaceans
Based on recommendations for prioritisation of pathogens for the CERD and needs identified by the Working Group on Marine Mammal Unusual Mortality Events in the US, a pathogen assessment and prioritisation scheme was developed and implemented in 2010 as a pilot assessment with a small number of Subject Matter Experts (SMEs) identified by the Working Group on Marine Mammal Unusual Mortality Events. The details of this pilot study are described in SC/62/E4.

Emergency response
In addition to the southern right whale mortality in Peninsula Valdez, Argentina (see SC/62/Rep1), an increase in stranding and mortality of humpback whales occurred in Brazil over the last four years. In Australia's western coast an unexpected die-off of 46 humpback whales occurred in 2009 (SC/62/SH24). These facts highlight the needs of enhancing communication between the different networks and discussion of these mortalities in a larger perspective. In addition, the emergency response team assisted in the response to a sperm whale mass stranding along the Adriatic coast of Italy in December 2009 and to a beaked whale mass stranding in the Azores.

Enhance capacities and communications between stranding networks
Over the past year there were several efforts by different individuals or organisations to enhance the capacities of existing stranding programmes, build or initiate stranding programmes in areas that had no programme, or better coordinate regional networks. As a part of this effort stranding training and capacity building workshops were held in four regions: West Africa, Caribbean, Brazil and India as well as a meeting in the US.

Caribbean
Three workshops were held this year in Panama, Curaçao and Guadeloupe. These workshops were a priority action identified by UNEP's Specially Protected Areas and Wildlife (SPAW) Programme's Marine Mammal Action Plan (MMAP) for the Wider Caribbean Region (WCR) (information available at *http://www.cep.unep.org/publications-and-resources/marine-and-coastal-issues-links/marine-mammals*), modelled after the first Eastern Caribbean stranding response workshop held in Trinidad and Tobago in 2005.

Panama
NOAA in collaboration with, and with the support of, the National Environmental Authority of the government of Panama, the Regional Activities Center for the Protocol for Specially Protected Areas and Wildlife of the Cartagena Convention, the Commonwealth of Puerto Rico Marine Mammal Rescue Program, and the University of Las Palmas, Canary Islands convened a Regional Marine Mammal Stranding Response Training Workshop for Spanish-speaking nations of the Wider Caribbean Region on 22-23 April 2010 in Panama City, Panama. Over 100 participants from 12 countries including Venezuela, Colombia, Panama, Dominican Republic, Belize, Costa Rica, Guatemala and Nicaragua attended the workshop. The Workshop provided marine mammal stranding response training and participants discussed capacity building for stranding response in the wider Caribbean.

French Caribbean Territories Regional Workshop
The Regional Workshop for the French-speaking Caribbean Territories in response to marine mammal strandings was held from 8-10 January 2010 in Bouillante, Basse Terre

in Guadeloupe. The Workshop hosted thirty participants, representing Protected Area management organisations, government departments and non-governmental organisations from five French-speaking islands and territories (Guadeloupe, Haiti, French Guiana, Martinique and St Martin).

Curaçao Workshop
The Dutch Caribbean Regional Workshop for Effective Implementation for Marine Mammal Stranding Response (DCSW) was hosted by at the Curaçao Sea Aquarium from 5-7 November 2009 in the Netherland Antilles. The Southern Caribbean Cetacean Network (SCCN) (*http://www.sccnetwork.org/home*), recently established in Curaçao, organised this stranding workshop in cooperation with the Dutch Caribbean Nature Alliance (DCNA) (*http://www.dcnanature.org/welcome/index.html*), and with the Eastern Caribbean Cetacean Network (ECCN) (*http://www.eccnwhale.org*). The goal of the workshop was to build capacity, to review the techniques and protocols for responding to stranding incidents for marine mammals and to facilitate possibilities for collaboration in the Dutch Caribbean Islands.

Brazil
The first Seminar for Training Veterinarians in Aquatic Mammal Necropsies was organised by the Brazilian Government and held at the Centro Mamíferos Aquáticos (Aquatic Mammals Center). This event occurred in Itamaraca Island, from 12-16 April 2010 and was attended by nearly thirty professionals from all regions of Brazil.

India
A first-of-its-kind Marine Mammal Stranding Workshop was held at the Central Marine Fisheries Research Institute (CMFRI), Kochi, India from 21-23 January 2010. This event was organised by NOAA and CMFRI with funds provided by the Indo-US Science and Technology Forum (IUSSTF), India and NOAA. The workshop was aimed at increasing awareness and interest in marine mammals among the scientific community and the local public, and to provide the necessary impetus and training to collect relevant stranding data and create regional stranding networks in different parts of coastal India. A more specific goal was to communicate the inherent scientific value of data collection from stranded animals, maintaining a stranding database, and engaging in environmental stewardship to conserve and protect marine habitats and their inhabitants. Forty-two participants from 23 organisations attended the workshop. A follow up regional Marine Animal Necropsy Training and Stranding Workshop is proposed for January-February 2011 at the Madras Veterinary College Chennai, India.

West Africa
As part of the effort to address the Illegal, Unreported, Unregulated fishery bycatch of non-target species including cetaceans, NOAA has been working with various partners to enhance the capacity of countries to adequately detect bycatch. For West Africa this effort has been focused on observer and stranding capacity building for marine mammals and sea turtles.

National Stranding Meeting (United States)
NOAA held the second National Marine Mammal and Sea Turtle Health and Stranding Conference (*http://reefshark.nmfs.noaa.gov/pr/stranding/*) at the National Conservation Training Center in West Virginia from 6-9 April 2010. The conference had more than 260 participants from the US, Canada, South Africa, West Africa, India, Caribbean, UK, the Netherlands, Brazil and Argentina. It included didactic teaching, laboratories, stranding scene investigations, necropsies, panels and workshops on topics such as forensic science, euthanasia, mass stranding response, epidemiology, emerging diseases, sound in the ocean, oil spill response and marine mammal and sea turtle medicine. The conference was a fantastic way for building collaboration and communication within US networks and between US networks and those in other countries.

Inventory of Stranding Networks
Utilising information from the ICES Working Group (2009) and the IWC Ship Strike Working Group (2009), a broad inventory of global stranding networks has been developed. The inventory contains the contact information for stranding networks in alphabetical order by country. The CERD Working Group needs to determine recommendations for maintaining and accessing the information.

The University of Las Palmas, Canary Islands and the Marine Mammal Center, Sausalito, California have both indicated a willingness to host interns or persons to gain additional experience in stranding response and necropsies. Other mechanisms for capacity building, training and outreach have been discussed and electronic mechanisms for enhancing communication are being explored.

The SWG acknowledged the accomplishments of the Working Group and **commended** the CERD for their contributions.

SC/62/E4 summarised a cetacean pathogen assessment and prioritisation scheme. Numerous microbes have been isolated and reported in cetaceans. These reports have varied from the isolation of a bacterial species once in one animal to the association of a virus to numerous mass mortality events. During 2009-10, the task of prioritising cetacean pathogens was undertaken on behalf of the Working Group on Marine Mammal Unusual Mortality Events US, as a survey using a small number of SMEs. The results of this survey may serve as a pilot study for the CERD task on a broader scale. The survey evaluated pathogens utilising the following factors:

- likelihood of marine mammal exposure to the pathogen;
- if exposed, likelihood of marine mammal illness;
- if exposed, likelihood of marine mammal death;
- if exposed, likelihood of marine mammal epizootic (often implying high probability of animal to animal transmission); and
- public health implications: zoonotic, reportable in the US or emerging/re-emerging diseases among humans.

The study used a total of 76 pathogens for which there were peer-reviewed publications describing those pathogens in marine mammals. Although there are numerous additional pathogens observed in marine mammals, this study focused on those identified in peer-reviewed published reports. Raw risk scores and weighted risk scores (incorporating survey participants' confidence in their risk ratings), were used to prioritise pathogens for large cetaceans and small cetaceans. Adequate published data were only available to prioritise pathogens for small cetaceans; therefore, the results are reported only on small cetaceans. The ten highest priority pathogens (with the highest total scores) among small cetaceans were morbillivirus, parapoxvirus, *Brucella* spp., anisakis, calicivirus, herpesvirus, nasitrema, *Clostridium* spp., *Escherichia coli* and toxigenic *Escherichia coli*.

Of the 76 pathogens included in the survey, 27 (35.5%) were potentially zoonotic, and 12 (15.8%) and 20 (26.3%)

were associated with reportable and emerging/re-emerging human diseases in the United States, respectively. The next steps for prioritisation would be to broaden the SMEs participating in the study to include more experts from other countries. In addition a process for evaluation of emerging pathogens and those without peer-reviewed publications should be developed that may address the significant time lag in getting information peer-reviewed and published in a timely manner.

The SWG **commended** the pathogen prioritisation work of the CERD and acknowledged the importance of developing a process for evaluating emerging pathogens that are not yet published in peer-reviewed journals. In general discussion of SC/62/E4, it was noted that the southernmost record of lobomycosis in a bottlenose dolphin in South America was reported in May 2010. Although CERD is not currently tasked to compare the pathogens present in cetaceans to those present in terrestrial species, the SWG expressed an interest to examine pathogen ecology and the interactions of pathogens throughout the ecosystems in which they reside. The SWG noted that this approach is supportive and is part of the global and national 'One Health' approach to medicine (*http://onehealthinitiative.com/index.php*) highlighting the importance of the integration of surveillance systems in wildlife, domestic animals, public health and environmental health.

The importance of disease and dolphins captured for dolphinariums was illustrated with the case of live-captured Solomon Island Indo-Pacific bottlenose dolphins that, despite having been exposed to the zoonotic pathogens *Brucella* and *Toxoplasma* (Omata *et al.*, 2005; Tachibana *et al.*, 2006), were exported to a facility in Cancun, Mexico where members of the public would be swimming with animals.

As an example of a One Health approach it was noted that the US Agency for International Development (USAID) has provided funding for a large programme to enhance capacity and establish a comprehensive and interconnected intervention package for Emerging Pandemic Threats due to infectious disease transmission from animals to people. It will be implemented through five projects as follows.

(1) PREDICT: to monitor for and increase the local capacity in 'geographic hot spots' to identify the emergence of new infectious diseases in high-risk wildlife such as bats, rodents and non-human primates that could pose a major threat to human health.
(2) RESPOND: to strengthen the human capacity of countries to identify and respond to outbreaks of newly emergent diseases in a timely and sustainable manner.
(3) IDENTIFY: working with the UN World Health Organization (WHO), UN Food and Agriculture Organization (FAO), and the World Organization for Animal Health (OIE) to support the development of laboratory networks and strengthened diagnostic capacities in the 'geographic hot spots' for new emergent diseases.
(4) PREVENT: to build an effective behaviour change communication response to zoonotic diseases, support efforts to characterise 'high-risk' practices that increase the potential for new disease threats from wildlife or wildlife products to spread and infect people, and formulate behaviour change and/or communication strategies and interventions that meet the challenges posed by the emergence of a new infectious disease.
(5) PREPARE: to provide technical support for simulations and field tests of national, regional and local pandemic preparedness plans to ensure that countries have the capacity to implement response plans effectively during pandemic events.

The programme is focusing on 24 countries in wildlife outbreak hotspots, but does not include capacity building for infectious diseases of marine species.

The SWG **commended** projects that integrate a One Health approach to build capacity in countries that are responding to diseases that are shared by people and wildlife or are transmitted between people, domestic animals and wildlife. However the SWG expressed concern that the current efforts do not include marine species, in particular cetaceans. The SWG **recommended** that marine species be considered by USAID and other organisations including OIE and WHO that are implementing approaches to One Health. These programmes should integrate marine mammal disease surveillance and communication into the capacity building and surveillance programmes in all countries. The CERD WG should work with these organisations to identify areas of cooperation and enhancement.

9. REVIEW NEW INFORMATION ON ANTHROPOGENIC SOUND AND CETACEANS, FOCUSING ON MASKING SOUNDS

The SWG has included an item on underwater sound on its annual agenda each year since 2004, when a mini-symposium on anthropogenic noise was conducted as part of the SWG's sessions (IWC, 2005). The scope of the 2004 symposium was broad, with presentations on: (i) the effects of noise on marine animals, including possible synergistic effects; (ii) physical acoustics and ambient noise; (iii) audition and physiology of hearing; and (iv) whale communication and behaviour. Conversely, in 2006, a two-day pre-meeting of the SWG was convened to specifically address the potential for seismic surveys to impact cetaceans (IWC, 2006). The terms of reference for the pre-meeting were to review: (i) information on seismic sound sources and their effects on cetaceans; (ii) case studies where seismic surveys were conducted near cetaceans or in 'critical' habitats; (iii) current mitigation and monitoring programmes, including an evaluation of their effectiveness; and (iv) potential impacts to cetaceans, including recommending changes to mitigation and monitoring during all phases of seismic surveys. In most other years, information on underwater sound has been considered under a 'generic' agenda item (e.g. Review new information on acoustics) under the standing 'Other habitat related issues' item on the agenda. Frequently, recommendations developed at the 2004 and 2006 meetings regarding steps to address the effects of anthropogenic sound on cetaceans were reiterated at these annual meetings.

In 2009, a presentation was made on low-frequency 'masking sound'. This presentation precipitated the notion of making this a focal-topic for presentation within the SWG sessions at this year's meeting.

9.1 Concerns related to anthropogenic masking of low-frequency sounds

Acoustic masking from anthropogenic noise is increasingly being considered as a threat to marine mammals, particularly low-frequency specialists such as baleen whales. Low-frequency ocean noise has increased in recent decades, often in habitats with seasonally resident populations of marine mammals, raising concerns that noise chronically influences life histories of individuals and populations. In contrast to physical harm from intense anthropogenic sources, which can have acute impacts on individuals, chronic effects such as masking from noise sources has been difficult to quantify at individual or population levels, and resulting effects have been even more difficult to assess. Clark *et al*. (2009) represents an analytical paradigm to quantify changes in an animal's acoustic communication space as a result of spatial, spectral and temporal changes in background noise, providing a functional definition of communication masking for free-ranging animals and a metric to quantify the potential for masking of communication. The sonar equation, a combination of modelling and analytical techniques, and measurements from empirical data can be used to calculate time-varying spatial maps of potential communication space for singing fin (*Balaenoptera physalus*), singing humpback (*Megaptera novaeangliae*) and calling right (*Eubalaena glacialis*) whales. These examples illustrate how the measured loss of communication space as a result of differing levels of noise is converted into a time-varying measure of communication masking. This proposed paradigm and mechanisms for measuring levels of communication masking can be applied to different species, contexts, acoustic habitats and ocean noise scenes to estimate the potential impacts of masking at the individual and population levels.

Moore thanked the intersessional steering group chaired by Suydam, as well as Gedamke for his overview presentation on masking.

Several papers were presented on this topic. SC/62/E3 presented information regarding potential negative effects on the reproduction and survival of fin whales by shipping and airgun noise. Seafloor recorders were deployed in the western Mediterranean Sea and adjacent NE Atlantic waters during 2006-09 to monitor noise levels and fin whale presence. Acoustic parameters of 20Hz pulses (inter-pulse interval, pulse duration, pulse bandwidth, pulse centre and peak frequencies) were compared for areas with different shipping noise levels, different shipping intensities in the Strait of Gibraltar and during seismic airgun events. Statistically significant differences were detected between noise contexts. In general, both temporal and spectral parameters of their vocalisations were negatively correlated with ambient noise levels. In high noise conditions such as intensive shipping activity or airgun activity, 20Hz pulse duration shortened, bandwidth decreased and centre and peak frequencies decreased. The author of SC/62/E3 discussed how these results are interpreted as a compensation mechanism to noise, to reduce masking of their signals. Fin whales position their calls in a frequency band of lower ambient noise level and increase signal redundancy. However, this mechanism increases energy costs by forcing the whales to use suboptimal frequencies in an activity that can last for long periods of time and song functionality might be compromised by shifts in acoustic parameters that might carry important biological information.

The author indicated that paper SC/62/SD2 describes how pulse interval and pulse bandwidth are acoustic parameters that carry information regarding the identity of the population. SC/62/E3 also presented results from the analysis of fin whale movement patterns during a scientific seismic survey. Bearings to singing whales indicated that whales moved away from the airgun source and out of our detection area for a time period that extended well beyond the duration of the airgun activity. The author highlighted that the reaction to airgun shots occurred when the seismic survey vessel was at an approximate distance of 285km, indicating that fin whales might be sensitised to this acoustic stimulus, reacting to the presence of this particular noise rather than to its intensity. However, shipping noise in the Strait of Gibraltar reached noise levels well above the airgun shots but fin whales did not leave the area nor cease their acoustic display, suggesting that they might have been habituated to this continuous noise source. The continuous nature of shipping noise as well as the intensive frequency of seismic surveys in marine areas of interest to geophysicists, could easily induce a negative chronic effect in fin whale fitness. Both habituation and sensitisation processes, particularly in a chronic context, could have negative effects on their reproduction success and survival by the increase in energy expended due to the shift in spectral and temporal parameters of their vocalisations, spatial displacements and song functionality compromise by the compensation mechanism to noise masking.

The author indicated that the seismic survey identified in paper SC/62/E3 had scientific purposes and their airgun array was much smaller than commercial surveys. In Europe, scientific surveys are commonly not regulated and controlled as are commercial surveys and thus become an important environmental concern. The SWG **recommended** that scientific surveys should be regulated and controlled in the same legal frame as are commercial surveys (at least for Spain since the author has confirmed a clear legal lack over these particular type of surveys in the Spanish EEZ), since seismic surveys may utilise source arrays as large or larger than commercial arrays, and would have similar potential impacts on cetaceans. Similarly, the author commented that current mitigation procedures and guidelines are far from effective for low frequency specialists such as balaenopterids. Results from this paper demonstrate how fin whales reacted to airgun shots at an approximate distance of 285km. Based on these results, the only effective mitigation procedures would be spatial and seasonal restrictions. However, knowledge of spatio-temporal distribution of most mysticetes is very limited and spatial and seasonal restrictions are rarely applied. The SWG **recommended** that baseline data be collected regarding seasonal and spatial distribution of mysticetes in areas of interest for the geophysical community (both scientific and commercial) before survey operations.

SC/62/E12 reported on a distant seismic survey that was recorded on three autonomous long-term acoustic recorders deployed between Tasmania and the Antarctic continent. These instruments were located approximately 450, 1,500 and 2,800km from the survey site. Recordings were analysed for the presence of airgun signals with hourly 13-minute sound files from a five-day period separated into 'seismic' *vs* 'non-seismic' files for analysis. Sound levels across a 20-50Hz bandwidth were calculated for 1 sec. samples and compared between the seismic and non-seismic datasets to assess the percentage of time that sound levels increased due to the presence of airgun signals. During seismic operations, a distinct shift of the entire distribution of sound pressure levels in the 1 sec. samples occurred suggesting even during 'quiet' periods between shots, sound levels remained slightly elevated. Compared to mean background noise during 'non-seismic' periods, noise levels were increased on the closest logger by between 6-15dB for 32% of the time when airgun shots were recorded. During non-seismic periods, sound levels were thus elevated less than 1% of the time. Sound levels were elevated by more than 3dB for 52%

of the time during seismic surveys, compared to just 6% of the time during non-seismic periods. On the central logger, levels were increased by 6+dB for 22% of the time during seismic periods, as compared to just 2% during non-seismic periods. Levels were increased by 3+dB for 51% of the time during seismic periods, compared to 7% during non-seismic periods. And finally, on the southern-most logger, levels were elevated by at least 3dB for 50% of the time during seismic, compared to 19% during non-seismic periods. At this stage, we have not attempted to calculate how these increases in background noise levels would impact on the detection ability of whales that vocalise in this 20-50Hz bandwidth. But clearly, the noise increases would decrease the detection range of biological signals or at least make them more difficult to detect at reasonable ranges from a source.

It was noted that the papers presented focused primarily on what might be termed 'absolute masking', in that it represents the end of communication capabilities. There will almost certainly be impacts related to reduction in information transfer and quality, which would arise from what might be termed 'partial masking', as well as the initiation of stress responses, at lower levels of noise exposure. The SWG **recommended** that the masking potential of anthropogenic sources be quantified and acoustic measurements be standardised to ensure that datasets among researchers are comparable.

SC/62/E13 described variation in right whale contact calls with new data from Auckland Islands southern right whales. This research was conducted in late July and early August 2007 and 2008, during two research trips to the Auckland Islands. Recordings of southern right whales were made in Port Ross, generally in the presence of large numbers of right whales. A total of 171 contact calls have been classified and analysed thus far from these recordings; 123 from 2007 and 48 from 2008. Contact call start frequency of Auckland Island southern right whales is not differentiated from contemporary southern right whales from the south Atlantic, although it is greater than that of all historical right whale recordings and lower than that of contemporary recordings of both northern right whale species. The maximum frequency of Auckland Island southern right whale contact calls is not differentiated from contemporary or historic recordings of southern right whales but is lower than that of all northern right whale species. While historic recordings of these Auckland Island southern right whales are not available, the current description of their sounds represents a valuable dataset for comparison with north and south Atlantic right whales whose contact calls have been hypothesised to have increased in frequency as a result of exposure to anthropogenic noise. Unlike other populations of right whales, these Auckland Island animals live in an environment with exceptionally low levels of anthropogenic noise, given the isolation of the breeding ground and their likely Southern Ocean feeding areas.

In discussion it was noted that some factors might exacerbate masking (i.e. hearing loss from chronic low level noise exposure and/or age). It was also noted that there are difficulties when looking at differences between, rather than within, populations. The authors pointed out that previous studies making comparisons between populations have been used to suggest anthropogenic noise alters calling behaviour. With that in mind, the authors suggested SC/62/E13 describes a valuable dataset of right whale calls from whales likely to have an exceptionally low level of exposure to anthropogenic noise.

In SC/62/SH20, breeding Stock X was discussed as an endangered population of geographically, demographically and genetically isolated humpback whales, resident in the western Arabian Sea, with an estimated population of 82 (95% CI 60-111) individuals. Recent information from range countries, in particular Oman, reveals that threats to this population are escalating, expanding and intensifying. Human population growth rates in the region are among the highest in the world (>3%), and economic development includes rapid and large-scale coastal construction projects and growth of fisheries, shipping and other industries. In the Gulf of Masirah, Oman, a large new port is currently under construction and will divert shipping traffic from one of the world's busiest shipping lanes across an area of humpback whale habitat where previous dedicated boat surveys have recorded some of the highest encounter rates. This area is also among other locations in the region where seismic surveys and other hydrocarbon exploration activities (such as exploratory drilling) are ongoing or planned.

The SWG noted the great concern expressed about this population's status in the Southern Hemisphere sub-committee and about fisheries pressure in the Bycatch sub-committee. Further, as an apparently non-migratory, resident population, acoustic masking presents threats to the abilities of these animals to use acoustics for functions relating to life, including foraging, mating and mother-calf contact. The SWG **strongly recommended** that further research is conducted on Breeding Stock X, including studies directed at quantifying the impacts of acoustic disturbance and masking, in order to obtain information of value to conservation planning and protection of this population.

SC/62/BRG3 summarised observations of cetaceans off western Kamchatka from published literature and other sources. The waters off the western coast of Kamchatka in the Okhotsk Sea are highly productive and produce a large fraction of the total Russian commercial fish and shellfish catches. This region is also the site of a sizeable oil and gas lease area, which is in the exploratory phase of development. While fisheries-related research has been conducted off western Kamchatka for several decades, there has been essentially no directed research on cetaceans and other marine mammals. In total, 351 sightings of 14 cetacean species have been recorded from the 1940s until the present. The sightings included six endangered species: bowhead whales, humpback whales, blue whales, sei whales, North Pacific right whales and gray whales. The low number of sightings of large whales in recent times (in contrast to apparently high historical abundance implied from whaling data) likely reflects a lack of appropriate survey effort as well as low numbers, at least for gray, bowhead, blue and right whales. Given the diversity and conservation status of species using this area, further research is required, notably in light of the potential impacts of oil and gas development. In this regard, plans for the West Kamchatka license area have progressed, with seismic operations set to resume in the summer of 2010. Development of the Koryakia-1 block in adjacent Shelikhov Bay is anticipated in the near future.

Information made available to the SWG concerning a programmatic environmental impact statement by DMNG (a seismic company in the Russian Far East), indicated that there are plans for numerous seismic surveys over the next 10 years in many parts of the Sea of Okhotsk as well as in Anadyr Bay and the Chukchi and East Siberian seas. This implies that most populations of large whales in the region will be increasingly exposed to airgun noise during the open-water season.

In light of the need for further information on the status of cetaceans off western Kamchatka, and the potential impacts on endangered species of oil and gas development in the region, the SWG **recommended** that additional surveys for cetaceans be conducted in the area. The SWG also **recommended** conducting seismic surveys and other potentially disturbing industrial activities, during times of lower cetacean density (i.e. during spring and autumn, outside the primary feeding season) whenever possible.

Suydam described seismic surveys planned for the Chukchi and Beaufort seas off Alaska in 2010. Statoil plans to conduct a combined 2D (i.e. broad scale) and 3D (i.e. fine scale) seismic survey in the Chukchi Sea using a 3,000in^3 airgun array. The survey will occur for 60 days beginning in late July or early August. ION Geophysical plans to conduct a 2D seismic survey across the Alaskan Beaufort Sea using a 4,330in^3 array. They intend to begin in early October and continue into December. There will be sea ice present at that time so an icebreaker will precede the source vessel and the airgun array and streamer will be towed below the surface to avoid ice. This survey was planned in order to avoid disturbing bowheads during the indigenous hunt that occurs in the Beaufort Sea in September and October. In addition to the seismic surveys, other industrial activities are planned including: (1) surveys to document ice gouging and strudel scouring; (2) barging; and (3) exploratory drilling in each of the Beaufort and Chukchi seas (those drilling operations were recently postponed until at least 2011). The US and Canadian Coast Guards are also planning a seismic survey to document the extended continental shelf, as part of a multinational effort related to the Law of the Sea. Further, seismic surveys are planned for the Canadian Beaufort Sea and the Russian Chukchi Sea in 2010. There will be a large amount of anthropogenic sounds in the waters of the Beaufort and Chukchi Seas in 2010. Typically, concerns have largely focused on the behavioural impact to bowheads and other marine mammals from industrial sounds. With such widespread activity, there is an increasing need to understand and mitigate cumulative impacts, including the possibility that anthropogenic noises are masking sounds produced by whales and hindering important life functions, as well as temporal displacements from critical areas.

The SWG was informed that industry has initiated a Joint Industry Program (JIP), funding research into an alternative technology called marine vibroseis. The goal of the JIP is to have an alternative source operational within the next few years. The SWG **encouraged** this research and **recommended** continued development of alternative methodologies with lower source levels. Additional information on survey technologies can be found in Weilgart (2010), the Okeanos workshop report 'Alternative technologies to seismic airgun surveys for oil and gas exploration and their potential for reducing impacts on marine mammals' (available from: *http://www.sound-in-the-sea.org/download/AirgunAlt2010_en.pdf*).

9.2 Other factors related to masking

Jensen *et al*. (2009) studied the masking effects of small (2 and 4 stroke) outboard engines on common bottlenose dolphins and short-finned pilot whales. They found that at 50m and a boat speed of 5 knots, communication ranges for pilot whales were reduced by 58% and for bottlenose dolphins by 26%. At 10 knots and a distance of 200m there was approximately a 70% decrease in communication distance for both species, with approximately a 90% reduction for pilot whales and over 80% for bottlenose dolphins at 50m. At 2.5 knots, at 50m, there was little masking noise. Moreover, the boats produced substantive broadband noise (up to 200dB re 1μPa peak to peak) when the boats changed gears, which could occur several times a minute when the small boats were manoeuvring – a common occurrence for both whalewatching vessels and also small-boat based studies of focal small cetacean groups.

Dunlop *et al*. (In press) was briefly summarised, which reported an increase in humpback whale aerial behaviour correlated with increasing natural ambient noise levels as wind speeds increased. It was suggested that this increased aerial behaviour allowed communication in a noisier environment, i.e. to overcome masking. It was noted that this might result in additional energetic costs to breeding humpback whales.

9.3 Case studies

A brief summary of the discussions and conclusions of the Workshop on Cumulative Impacts of Underwater Noise with Other Anthropogenic Stressors on Marine Mammals (SC/62/E6) was reported to the SWG. The original report should be seen as the definitive document (available at *http://www.sound-in-the-sea.org/download/CIA2009_en.pdf*). It was reported that the workshop participants agreed that effective management should include comprehensive cumulative impact assessments (CIAs), which should include noise and its various effects. CIAs are especially needed to appropriately account for non-lethal and sub-lethal effects of human disturbance, including stress-related effects that can reduce reproductive rates and/or increase 'invisible mortality' (i.e. unmeasurable, given existing survey and detection methods). At very low data levels, an estimation of the cumulative exposure to human activities (or even simply a list of activities and locations) should be possible. Marine mammal distribution and abundance information can then be overlaid on this and, if data permits, population models, in particular individual-based models, can then be used to estimate the resulting cumulative impacts. With enough data, it should also be possible to consider physiological processes within an individual to better account for the interactions between the disparate initial effects upon an animal. A new way of considering this conceptually was presented to the SWG. Participants of the workshop agreed that the introduction of anthropogenic noise sometimes introduced incidentally and the presence of other tangible threats should be reduced to the maximum extent possible to allow marine mammal populations to more resiliently face the now-unavoidable consequences of climate change, some of which are already becoming evident. They also noted that CIAs were better suited to marine spatial planning and ecosystem-based management, rather than the project-based management approaches that are currently used.

The SWG **recommended** that member governments work to develop a quantitative approach for assessing cumulative impacts. Assessments should incorporate the various ways that anthropogenic sounds might impact cetaceans and their prey.

The SWG was informed of a 2008 study on shipping noise in coastal waters of British Columbia, Canada. Large between-site differences in ambient noise levels were persistent over the six-month deployment in 2008.

Smaller differences were found between ambient noise levels in critical habitats for northern and southern resident killer whales during shorter pop-up deployments in 2009. Sound propagation models indicated that container ships moving through these waters ensonify large areas, and this could mask substantial fractions of the foraging space of a humpback whale in the vicinity. In geographically complex regions (e.g. archipelagos or convoluted passages), this sound propagation is similarly complex, but it appears generally that whales would receive less 'advance warning' acoustically from a ship that is approaching in such habitats than they would from the same sound source in open ocean. The apparent link in this case between acoustic propagation and ship-strike risk in geographic bottlenecks would benefit from integrating acoustic studies and density surface modelling in a spatially-explicit risk assessment (Williams and O'Hara, 2010).

Lusseau presented SC/62/WW5, a summary of progress from a project tasked to develop a formal mathematical structure from the Population Consequences of Acoustic Disturbance (PCAD) conceptual framework (available at *http://www.nap.edu/catalog*). The working group was convened by the University of California Santa Barbara with support from the Office of Naval Research and is meeting every six months over a three year period. During these meetings modellers and field researchers meet to develop approaches and discuss the feasibility to fit them to a wide range of existing data to try parameterising the agreed models. This PCAD working group has made significant progress over the first two meetings. It decided to develop three statistical models to provide the linkages from disturbance to population dynamics. Work has focused on the first models (disturbance to physiological conditions). It developed a state space modelling approach (SSM) based on Lorenz and McFarland's concepts (the hydraulic model and its subsequent extensions) that behaviour emerges from the interactions between the motivational states of individuals and the environment. Motivational states and physiological conditions (at first here body condition) are hidden processes that are linked to observed behaviour. The parameters of these processes are then inferred (exploring both maximum likelihood and Bayesian estimation methods) by fitting these SSMs to behavioural time series. First implementations with simple systems (southern elephant seals at-sea movement) proved extremely successful and body condition time series could be estimated and validated against body weight when the seals returned to the colony. A similar, albeit more complex, framework was developed for coastal dolphin population case studies and will be implemented over the next year. The working group is happy to continue reporting to the Scientific Committee on progress.

It was noted that the motivational state-space approach to the PCAD framework was creative; however, the PCAD working group needs to acknowledge the limitations of the original US National Research Council model. For example, it has been shown that behavioural responses cannot reliably be used to infer disturbance impact in animals without extensive contextual information, which has not been fully incorporated into the framework. While energetic condition and related concepts such as hunger are included in the working framework, almost no consideration has been given to psychological condition. Anxiety, cognitive bias and other stress-related conditions will greatly affect motivation, behavioural responses to disturbance and the ultimate impact on vital rates. Furthermore, overall psychological condition may be influenced by non-behavioural consequences of acoustic exposure, including masking, which are also missing from the framework.

While it was noted that this is just a framework and simplicity is valuable, these omissions may have serious implications for the accuracy and widespread application of the PCAD framework and should be explicitly recognised to avoid any mis-application, especially in management settings. In response, Lusseau noted that the modelling approach was flexible enough to incorporate the type of alternative pathways mentioned. The group was currently focusing on energetic pathways because it meant that parameters could be estimated by fitting the state space frameworks to existing behavioural and demographic data. However, this did not preclude extending frameworks in the future when more information becomes available. Importantly, this approach will allow constructing contrasting frameworks and testing or validating them against observations. This is a significant step in developing quantitative methods to address non-lethal effects of disturbances. The SWG encouraged the work of the PCAD working group and looks forward to receiving updates in the future.

In SC/62/SH12 passive acoustic monitoring was used to document the temporal and spatial distributions of singing humpback whales off the coast of northern Angola, off the Congo River outflow, and test for impacts of seismic survey activity on the number of singing whales. Two Marine Autonomous Recording Units (MARUs) were deployed between March and December 2008, in the offshore environment (at 15km and 24km offshore). Numbers of humpback whale singers per hour were counted for the period from 24 May to 1 December Application of General Additive Mixed Models (GAMMs) indicated significant seasonal and diel variation. Seismic survey activity was heard regularly during two separate periods during the deployments, during July and later in the season during mid-October/November. Assessment of a measure of Received Level (RL), Peak Power, of seismic survey pulses as an effect on the number of singers yielded a significant impact: in GAMMs for both MARUs, the number of singers significantly decreased with increasing RL of seismic survey pulses. This suggests that the breeding display of humpback whales is disrupted by seismic survey activity, and thus merits further attention and study.

The SWG welcomed this study and others examining potential changes in whale acoustic behaviour in response to anthropogenic noise. In studies like these, the SWG **recommended** that the detectability of whale calls during exposure and non-exposure periods be quantified.

Gedamke discussed the recently funded project 'Behavioral Response Study with Australian humpback whales and seismic air guns'. This large scale, five-year research programme has been jointly funded by the E and P Sound and Marine Life Joint Industry Programme (JIP) and US Minerals Management Service. This project aims to provide information that will reduce the uncertainty in evaluating impacts of seismic surveys on humpback whales. It will also assess the effectiveness of ramp-up as a mitigation measure, with the potential to improve design of ramp-up. There will be two experimental regimes and two study sites: one offshore of Western Australia and one inshore on the east coast of Australia. One experimental regime, used only at the offshore site, will be the exposure of whales to a commercial seismic airgun array. The second regime will involve controlled exposure of whales to components of ramp-up, and will be used at both sites to compare responses to the same stimuli between sites. The inshore site allows detailed and high resolution observations by using land-based observations and thus provides a larger amount of whale response information and a higher degree of experimental control than possible at the offshore site; while the offshore site will allow for examination of reactions to a full-scale commercial seismic array. Research is planned to commence in September 2010.

The SWG welcomed this as a well-designed study that has the potential to greatly inform the discussion. The authors were encouraged to bring results of the work to the sub-committee as the study is undertaken and completed. Further, it was noted that the nested block design to control for a wide variety of variables is also being used in impact studies being considered by others, such as the LaWE being designed by the whalewatching sub-committee. Hence, the authors were requested to also present any power analysis that helps inform necessary sample sizes to reach appropriate conclusions, since they may be useful across the Scientific Committee.

9.4 Progress in reducing low frequency sounds from shipping

Over the past 50 years, the world's commercial shipping fleet has roughly tripled and vessels have become much larger. Concomitantly, low-frequency ambient noise in many especially coastal areas of the ocean has increased at a rate of roughly 3dB/decade. Although there is variability among regions this has resulted in an estimated overall average increase of at least 20dB from pre-industrial conditions to the present (Hildebrand, 2009).

The recognition of noise from commercial shipping as an important component to this increase in ambient noise has been recognised by scientists for roughly 40 years, but has been brought to the attention of industry only recently. Specifically, the US National Oceanic and Atmospheric Administration (NOAA) convened workshops in 2004 and 2007 to engage representatives of the international shipping industry, as well as scientists, engineers, environmentalists and government representatives in cooperative dialogue regarding incidental noise radiated from vessels and potential impacts on marine life. Engineers and specialists in vessel quieting participated in both workshops and concluded that the most promising initial target for vessel quieting were propulsion systems, primarily retrofit or redesign of propellers.

A key outcome of the 2007 workshop was the submission of an information paper 'Shipping Noise and Marine Mammals' by the US delegation to the International Maritime Organization (IMO MEPC, 2007). In 2008, Okeanos hosted a follow-on symposium in Hamburg, Germany (Wright and Okeanos Foundation for the Sea, 2008) - available at *http://www.sound-in-the-sea.org/download/ship2008_en.pdf*) that resulted in the provision of a specific goal of noise reduction from commercial shipping (i.e. sound in the 10-300Hz frequency band) of 3dB in 10 years and 10dB in 30 years. This goal was subsequently endorsed by the Scientific Committee (IWC, 2009). Later that year and resulting from the combined efforts of the NOAA symposia and the Okeanos workshop, a specific proposal was made by the US delegation to the IMO Marine Environment Protection Committee (MEPC) for the formation of a Correspondence Group (CG) to:

> 'identify and address ways to minimise the introduction of incidental noise into the marine environment from commercial shipping to reduce the potential adverse impact on marine life, in particular develop non-mandatory technical guidelines for ship-quieting technologies as well as potential navigation and operational practices.'

The resulting CG, which included representatives from 17 nations and 12 non-governmental organisations, consulted with hull and propeller design engineers and, in 2009, submitted two reports focused on technical and practical aspects of vessel quieting. A third report from the CG, providing additional recommendations on vessel quieting is anticipated for the 61st meeting of the IMO in September 2010.

Additional recent efforts with regard to the impact of shipping noise on the marine environment include the completion by the Arctic Council of the Arctic Marine Shipping Assessment (AMSA; see *http://arctic-council.org*) and the development of standards for the measurement of vessel noise (Bahtiarian, 2009). While the focus of the AMSA is marine safety and marine environmental protection, the SWG noted particularly one recommendation (of 17) given as:

> 'Addressing impacts on marine mammals: that the Arctic states decide to engage with relevant international organisations to further assess the effects on marine mammals due to ship noise, disturbance and strikes in Arctic waters; and consider, where needed, to work with the IMO in developing and implementing mitigation strategies.'

This recommendation further emphasises the central nature of the IMO with regard to efforts to mitigate the effects of shipping noise (and strikes) on whales. Lastly, the SWG noted the upcoming Sustainable Ocean Summit (SOS), hosted by the World Ocean Council (WOC), which aims to bring together industries that use and impact the oceans (e.g. shipping, oil and gas, dredging, offshore renewable energy, fishing aquaculture and tourism) to catalyse collaboration among these sectors to address cross-cutting marine environmental issues including ocean noise from commercial shipping and other human activities.

The IMO MEPC has had 'Noise from commercial shipping and its adverse impact on marine life' on its programme since 2008 (IWC/62/4). In 2009, the General Assembly of the IMO granted the IWC observer status when it approved the proposed Agreement of Co-operation between IMO and IWC. This provides an unprecedented opportunity for both organisations to advance the overarching goal of reducing noise from commercial shipping worldwide. With reference to the IWC's awareness of the critical nature of acoustic communication to whales and that interference, or masking, of this communication is to some extent preventable, the SWG **strongly recommended** that:

(1) the goal of noise reduction from shipping advanced in 2008 (i.e. 3dB in 10 years; 10dB in 30 years in the 10-300Hz band) be actively pursued;
(2) new and retro-fit designs to reduce noise from ship propulsion be advanced within the goals of the IMO, when and wherever practicable; and
(3) the IWC and IMO continue to work collaboratively to advance the goal of worldwide reduction of noise from commercial shipping when and whereever practicable including reporting progress on noise measurements and implementing noise reduction measures.

10. REVIEW PROGRESS ON WORK FROM THE SECOND CLIMATE CHANGE WORKSHOP

The Second Climate Change Workshop (IWC, 2010) resulted in a series of recommendations summarised under three headings corresponding to working groups established at the workshop: Arctic, Southern Ocean and Small Cetaceans. Recommendations from the workshop were reviewed and endorsed by the SWG at last year's meeting, and subsequently adopted by the full Scientific Committee at last year's meeting. Progress on those recommendations is summarised below.

With regard to the Arctic, three study themes were endorsed: (a) Single Species-Regional Contrast; (b) Trophic Comparison; and (c) Distribution Shift. It was thought that work must be undertaken within each of these categories before specific recommendations on analytical methods and modelling can be made. With regard to theme (a), planning discussions have been completed for a comparison of physical indicators of climate change and available data on population dynamics and behavioural ecology of the B-C-B and HB-DS populations of bowhead whales. There are extensive, but not always corresponding, data for both populations, each of which occupies habitats undergoing rapid physical alterations with regard to changes to seasonal sea ice and (potentially) other bio-physical parameters. A list of available physical and biological datasets is being assembled, after which a formal outline and timeline for completion of the proposed study will be developed.

Brandon and Simmonds presented Alter *et al*. (2010) noting that last year the Scientific Committee recommended that countries should pay more attention to the tertiary concerns arising from climate change – the topic of the paper and something that was also emphasised, but not fully developed, at the IWC's Second Climate Change Workshop. The context to this is that while climate change is expected to affect cetaceans primarily via loss of habitat and changes in prey availability, additional consequences may result from climate-driven shifts in human behaviours and economic activities.

Vulnerability scores were calculated for each species of cetacean taking into account potential shifts in climate-driven human behaviour. The greatest identified threat across species would be an increase in fisheries effort at higher latitudes. Bycatch is one of the biggest conservation issues for cetaceans and fisheries expansion would affect most, if not all species outside the tropics. At the species level, gray whales received the highest cumulative vulnerability score. This is due to their wide latitudinal range and generally coastal habitats. Not surprisingly, polar species were also identified as vulnerable. Increases in shipping, oil and gas exploration and fishing due to the loss of Arctic sea ice are highly likely to exacerbate acoustic disturbance, ship strikes, bycatch and prey depletion for Arctic cetaceans.

However, while concerns about impacts of climate change on cetaceans have largely focused to date on polar species, the evidence presented in Alter *et al*. (2010) suggests that tropical coastal and riverine cetaceans are also particularly vulnerable to those aspects of climate change that are mediated by changes in human behaviour. This category includes many species that are already threatened or endangered, such as the South Asian river dolphin, Indo-Pacific humpback dolphin, Irrawaddy dolphin and finless porpoise.

The recommendations from this research include the following: (1) information about cetacean populations should be incorporated into national, regional and international climate adaptation decisions wherever possible; and (2) human-mediated impacts of climate change should be included in cetacean conservation and management plans. The Management Procedures and *Implementation Reviews* of the IWC can provide a working model for other conservation organisations. Such scheduled scientific reviews will be a necessary ingredient in providing effective conservation advice during coming years and decades, given the potential for rapid and not always predictable human behavioural responses to climate change.

Simmonds presented an update of plans for the small cetaceans and climate change Workshop and its draft agenda. This is a follow up to the IWC's Second Workshop on Climate Change held in Siena in 2009. Fuller details are in the report of last year's Scientific Committee and it was felt last year that it would be helpful to give further consideration to this topic via a small workshop. This suggestion was taken to the Commission and a number of countries committed to support it, including Austria who offered to host it in Vienna. However, it was not confirmed that adequate funds to hold the workshop were available until late last year and the convener, in consultation with the steering group, decided it would be better to postpone it until after IWC/62. Simmonds noted that the steering group recommended two main focal points and one minor one:

- restricted habitats – estuaries, reefs, environmental discontinuities, rivers and shallow waters;
- range changes – i.e. evidence of changes in distributions, reasons and consequences; and
- the Arctic Region (to be considered via a presented review).

Plans will be finalised via the steering group and the workshop is likely to be held in Vienna in November.

The SWG welcomed the information as it relates to small cetaceans and climate change and suggested that the Steering Group used a broad definition of restricted habitat.

The Report from the Second Workshop on Cetaceans and Climate Change in Siena, February 2009 (IWC, 2010) recommended that studies on southern right whales with distributions off South Georgia, the Antarctic Peninsula and the eastern Antarctic be developed with a focus on determining measurable responses to climate change. The SWG provided an update on the responses of the southern right whale population of Península Valdés, Argentina to climate driven changes on their feeding grounds off South Georgia. The Patagonian right whale population has been surveyed annually since 1970 (Payne, 1986). Most right whales give birth once every three years. Calving intervals of 2, 4 and 5 years indicate calving failures (Knowlton *et al.*, 1994). The first 30 years of the study showed that females had fewer calves than expected (experienced calving failures) following years of low krill abundance on the whales' feeding ground off South Georgia (Leaper *et al.*, 2006). Increasing climate variability at South Georgia since 1990 has limited krill abundance and increased fur seal mortalities and pupping failures (Forcada *et al.*, 2008) and could be having similar effects for other krill predators including southern right whales.

Beginning in 2005, the Patagonian right whale population began to experience a succession of high mortality events on their nursery ground at Península Valdés with 322 whales dying over a five-year period including 291 calves (90%). No common cause has been found for the deaths despite intensive efforts of the Southern Right Whale Health Monitoring Program in Argentina. The Southern Right Whale Die-Off Workshop (SC/62/Rep1) identified three possible hypotheses to explain the peaks in calf mortalities: 'a decline in food availability, biotoxin exposure and infectious disease' and 'acknowledged that some combination of factors may be involved.' The possibility that the deaths could have been caused by low food abundance or biotoxins could indicate a possible relationship to changes in sea surface temperatures and climate change. Analysis in Leaper *et al*. (2006) showed the Patagonian right whales' sensitivity to changes in krill abundance and was based on results from the most recent population model reported in Cooke *et al*. (2003) that included aerial survey data from 1971-2000. Aerial surveys continued to be conducted every year since 2000 and analysis of the survey data is complete

Table 1
Some potential impacts to cetaceans during the lifetime of marine renewable energy technologies (from Dolman and Simmonds, 2010).

Wind	Tidal	Wave
Construction		
1. Pile driving (physical damage and noise disturbance/displacement) 2. Similar problems from other forms of attachment 3. Increased vessel movements/associated pollution risk.	1. Pile driving (physical damage and noise disturbance/displacement) 2. Similar problems from other forms of attachment 3. Increased vessel movements/associated pollution risk.	1. Pile driving (physical damage and noise disturbance/displacement) 2. Similar problems from other forms of attachment 3. Increased vessel movements/associated pollution risk.
Operation		
1. Habitat degradation and individual/population displacement 2. Operational noise	1. Habitat degradation and individual/population displacement 2. Operational noise 3. Collisions with exposed blades	1. Habitat degradation and individual/population displacement 2. Operational noise 3. Collisions with structures 4. Entanglements with mooring lines
Maintenance		
1. Anti-fouling releases 2. Increased vessel activity	1. Anti-fouling releases 2.Increased vessel activity	1. Anti-fouling releases 2. Increased vessel activity
Decommissioning		
1. Use of explosives or noisy techniques 2. Fate of decommissioned plants	1. Use of explosives or noisy techniques 2. Fate of decommissioned plants	1. Use of explosives or noisy techniques 2. Fate of decommissioned plants

up to 2008. Cooke is working on a model to cover the whole period from 1971-2008 and once that model is completed Leaper will update his analysis of the relationship between changes in sea surface temperature and calving success. Resighting data of known females with calves across the years with high calf mortalities has shown an increase in 2 and 4-year intervals (indicating calving failures) but the data have to be modelled to see if these changes are significant.

11. OTHER HABITAT RELATED ISSUES

11.1 Marine renewable energy development

SC/62/E7 provides an update to papers previously provided to the Scientific Committee on this theme. There has been a rapid expansion of marine renewable energy devices (MREDs) in European seas as governments strive to meet renewable energy commitments. Today there are some 89 such sites in various stages of development (most of these are wind farms), representing a five-fold increase in numbers since 2000, and a concomitant major increase in the size of planned developments. This paper charts the rapid expansion of MREDs in Europe, including the very large new wind parks planned in UK waters which are far larger in extent than anything that has gone before them and significantly further out to sea.

Dolman and Simmonds (2010) considered marine renewables in a Scottish context. They noted that the UK aims to generate a total of 33GW (gigawatts) of offshore wind energy. Its implementation strategy includes the development of ten offshore wind farms within Scottish territorial waters. In addition, the Scottish Government's target of meeting 50% of Scotland's whole electricity demand from renewable energy by 2020 means that marine wind, wave and tidal farms will be developed along Scottish coastlines, and also out into deeper offshore waters as technology develops. Development on such a scale could have impacts on populations of marine species including baleen whales, such as fin and minke whales; deep diving species such as sperm whales; and white-beaked dolphins, common dolphins and white-sided dolphins, whose distributions, abundances and population trends are relatively little known in Scottish waters. Dolman and Simmonds (2010) identified a series of concerns (Table 1).

Some underwater devices will also be large (for example, the turbines of one device have a diameter of approximately 15 to 20m) and may be positioned in arrays across the habitats that cetaceans frequent. The consequences of encounters between cetaceans and such devices are as yet unknown. Dolman and Simmonds (2010) recommend that the Scottish Government complete full and transparent Marine Spatial Planning, including consideration of cumulative impacts, before moving to license appropriate sites.

SC/62/E8 makes an initial assessment of the possible benefits and disadvantages of marine renewable energy developments, further to a request for such consideration made at last year's Scientific Committee meeting. For example (in addition to the benefit of moving away from exclusive dependency on fossil fuel energy generation) it has been suggested that, if appropriately managed and designed, MREDs may increase local biodiversity and potentially benefit the wider marine environment by acting as both artificial reefs and fish aggregation devices. They might also act as *de facto* marine-protected areas. The extent to which marine renewable sites may cause fisheries to be excluded (or encouraged) currently seems to be unclear. Other matters that remain particularly unclear include the costs of maintenance visits to installations at sea; the collision and entanglement risk created by devices at sea and so forth. This paper concludes that given the demand for renewable energy, engineering and policy decisions made in this field in the near future will have a significant impact on the state of the marine environment. The industry is still in its infancy and so the evidence-base for its impacts is currently poorly developed. Hence there is a need for all stakeholders to engage in wide-ranging ecologically-orientated research to help more fully understand and mitigate undesirable impacts of MREDs and aid good decision making. In conclusion, Simmonds noted that the scale of marine renewable developments, the speed of their development and the many questions about their impacts, both good and bad, mean that the Scientific Committee could usefully help to define the research needed to move this issue along and might usefully review this matter further.

The SWG thanked the authors for their impressive work and extensive list of potential impacts of wind farms.

Given concerns about the impacts of marine renewable developments discussed this year – and especially at this time relating to the pile driving used to anchor wind turbines – and that neighbouring countries may be simultaneously operating pile driving in adjacent sea areas (e.g. in the North Sea) without any coordinated attempt to reduce combined noise levels and disturbance, the SWG **strongly recommended** that countries cooperate to limit impacts on marine wildlife from marine renewable development. The SWG also recommended that the relevant national authorities should seek and immediately deploy effective mitigation measures that should evolve as new information becomes available through an open and flexible adaptive management process. This should include precautionary thresholds agreed between neighbouring countries for the sound energy emitted during pile driving and/or timely coordination of the building action, as well as the monitoring of existing vessel traffic, the electromagnetic field surrounding the infrastructure related to the wind farms, and the possible pollution (e.g. from hydraulic fluid and antifouling treatments) in their subsequent operation. It was commented that recent studies have shown that impacts of wind farm related pile-driving could be quite substantial. For example, Tougaard *et al*. (2009) reported displacement of harbour porpoises to a distance of at least 20km, and a survey of harbour porpoise habitat in relation to proposed wind farm sites finding that nearly 40% of German EEZ harbour porpoise stock could be impacted by wind farm construction (Gilles *et al.*, 2009). The SWG also noted that oil rigs often involve pile driving, like wind farms, and vibrations and sounds are produced during rig operation. A recent study noted porpoises clustering and feeding around an offshore gas extraction rig (Todd *et al.*, 2009), which seemed to be acting like an 'artificial reef', although such clustering behaviour around oil and gas rigs may mean that these animals are exposed to chronic noise and are at risk from spills during rig operation.

The SWG discussed one point of the ICES WGMME Terms of Reference in the 2010 report that was to 'review the effects of wind farm construction and operation on marine mammals and provide advice on monitoring and mitigation schemes'. It was noted that the ICES mitigation recommendations sought to find the levels of acute noise that animals could tolerate and mitigate based on these levels. It was emphasised that tolerance of noise is not equivalent to there being no impacts of noise, as animals may 'tolerate' a stressor because a habitat is essential for example, or because external effects are subtle. Animals exhibiting 'tolerance' could still be negatively impacted in a way that could be biologically significant (e.g. suffering stress). The SWG **endorsed** the recommendations of the ICES WGMME.

11.2 Other habitat studies

In order to establish a baseline map of cetaceans and other pelagic megafauna (sirenians, seabirds, sea turtles, large fish, large sharks and rays, etc.) across the French EEZ, the French Agency for Marine Protected Areas (AAMP) conducted a series of surveys allowing hotspots of abundance and diversity to be identified and a future monitoring scheme to be established. SC/62/E14 described the general design, current progress and future perspectives of the Recensements des Mammiferes Marins et autre Megafaune Pelagique par Observation Aerienne (REMMOA) project. This paper is intended to help exchange information with scientists and stakeholders that would be interested in participating in these regional scale cooperations.

A dedicated aerial survey methodology, following standard protocols, was preferred to ship surveys for its cost-effectiveness. The general design corresponds to published protocols prepared for small cetaceans, but data for other marine mammals (large whales, sirenians), seabirds, sea-turtles, large teleosts and large elasmobranchs, as well as human activities (fishing vessels, boating and merchant ships, marine debris >0.5m size), were collected.

The first surveys were conducted from February-March 2008 across the EEZ of Martinique and Guadeloupe (Caribbean; 123,000km², 8,400km or 71h of effort) and in October 2008 off Guiana (138,000km², 7,800km or 63h of effort). From December 2009 to April 2010, a survey was conducted in the southwest Indian Ocean region. It was designed and implemented regionally under the framework provided by the Indian Ocean Commission (IOC; a regional agreement including Comoros, France/Réunion, Madagascar, Mauritius, Seychelles), i.e. a study region of approximately 5,000,000km² where we deployed about 90,000km or 500h of effort. During the Caribbean survey, a total of 55 sightings of cetaceans were collected, including 12 different taxa. In the Guiana survey, 140 sightings of cetaceans were collected that included 10 different taxa. In the southwest Indian Ocean, 1,274 sightings of cetaceans were collected on effort, including 17 different taxa.

In the near future, the South Pacific regions will be surveyed during 2010-11 (French Polynesia) and 2011-12 (southwest Pacific Ocean around New Caledonia and Wallis and Futuna). Finally, the Atlantic survey is planned for 2012-13. Given the surface areas to be covered for these highly mobile pelagic organisms, a regional approach is highly recommended. To build the conditions for such cooperations, contacts have to be established with these countries and regional agreements identified to act as frameworks for these collaborations. The study areas will ultimately include all sectors of the French EEZ in the tropical Atlantic (French Caribbean and Guiana), Indian (Reunion Island, Mayotte and the Scattered Islands) and south Pacific (French Polynesia, New Caledonia, Wallis and Futuna) Oceans. The general aim of the analyses carried out so far was to map regional diversity and relative abundance of cetaceans and other megafauna across oceanic regions and identify zones where hotspots of abundance or biodiversity overlap with hotspots of human activities. The analytical strategy was exemplified from the Caribbean survey, but must be considered as provisional since analytical effort will develop and diversify as new surveys become available.

Panigada informed the SWG about similar systematic monitoring of density and abundance, conducted through aerial survey effort, of the most common cetacean species of the Pelagos Sanctuary and the seas surrounding Italy (plus other large megafauna, including elasmobranchs and turtles).

Aims of these programmes, funded by the Italian Government, are to inform conservation measures throughout the Mediterranean Basin and are priority actions in a number of other international bodies (e.g. the Sanctuary Management Plan, ACCOBAMS, the Specially Protected Areas and Biodiversity Protocol under the Barcelona Convention, the EU Habitat Directive and the Convention on Biological Diversity).

As part of this effort, a series of aerial surveys has been conducted throughout the Pelagos Sanctuary in winter and summer 2009 and in the Ionian Sea. Other surveys are planned in the Tyrrhenian Sea and the Sea of Sardinia, plus another survey covering the whole Pelagos Sanctuary area.

The SWG **commended** the authors' study and noted the impressive advancements of current methodologies giving the authors the ability to correlate cetaceans with specific habitats as well as other megafauna. The author clarified that this study was conducted out of the tradewind season to ensure favourable sea state conditions, but eliminated the possibility of observing large whales in their breeding grounds. The SWG also urged the authors to expand their study to include a passive acoustic component.

11.3 Update on 2008 Madagascar stranding

Following on from the update presented in last year's sub-committee meeting on the 2008 Madagascar Mass Stranding Event (MMSE), progress has been limited since the change in Government just over a year ago. Two potential scenarios to move forward with an Independent Scientific Review Panel (ISRP) are given below.

(1) National Office of the Environment (ONE) would be an appropriate body to request and oversee the establishment of the ISRP. It is part of their mandate as the parastatal organisation responsible for ensuring compliance with environmental impact assessments. They could be supported by an independent body – such as IUCN – in the oversight of this panel.
(2) The Environmental Governance Commission could potentially serve as a venue to bring up with the Government and/or ONE the need for the establishment of the ISRP to assess the results of the MMSE.

The SWG welcomed this update and thanked The Wildlife Conservation Society and its partners' continuing efforts to bring the results of the MMSE to an appropriate conclusion through an ISRP process, as well as keeping the SWG updated on the current challenges and progress. Given the international importance of drawing some conclusions about the MMSE, the SWG **encouraged** that all efforts to convene the ISRP are considered, and recommended that all parties continue to support and contribute relevant information to an ISRP.

12. WORK PLAN

12.1 SOCER (State of the Cetacean Environment Report)

(1) Receive the SOCER: focus area = Southern Ocean.

12.2 POLLUTION

(2) Review progress on recommendations from the 2010 Workshop (SC/62/Rep4).
(3) Review new information on impact of oil and dispersants on cetaceans.
(4) Review outcomes from new work.

12.3 CERD (Cetacean Emerging and Resurging Disease)

(5) Review progress of the CERD Working Group.

12.4 Anthropogenic sound

(6) Review progress on recommendations from 2010 focus sessions on masking sound.
(7) Focus topic: sounds from pile installation.
(8) Review approaches as available from other international forums (e.g. Report from European Union) with regard to mitigation of effects of anthropogenic sound on cetaceans.

12.5 Climate

(9) Review report from Climate Change-Small Cetaceans Workshop.
(10) Review progress on work from the Second Climate Change Workshop.

12.6 Other habitat related issues

(11) Focus topic: marine renewable energy development (MREDS), global review.

The SWG agreed to keep these items in its work plan for next year. The SWG also thanked Moore for chairing the group.

13. ADOPTION OF REPORT

The report was adopted at 09:20 on 7 June 2010.

REFERENCES

Alter, S.E., Simmonds, M.P. and Brandon, J.R. 2010. Forecasting the consequences of climate-driven shifts in human behavior on cetaceans. *Mar. Policy*. 34(5): 943-954.

Bahtiarian, M.A. 2009. ASA standard goes underwater. *Acoustic Today* 4: 30-36.

Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., van Parijs, S.M., Frankel, A. and Ponirakis, D. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implication. *Mar. Ecol. Prog. Ser.* 395: 201-22.

Cooke, J., Rowntree, V. and Payne, R. 2003. Analysis of inter-annual variation in reproductive success of South Atlantic right whales (*Eubalaena australis*) from photo-identification of calving females observed off Península Valdés, Argentina, during 1971-2000. Paper SC/55/O23 presented to the IWC Scientific Committee, May 2003, Berlin (unpublished). 16pp. [Paper available from the Office of this Journal].

Dolman, S. and Simmonds, M.P. 2010. Towards best environmental practice for cetacean conservation in developing Scotland's marine renewable energy. *Mar. Policy* 34: 1021-27.

Dunlop, R.A., Cato, D.H. and Noad, M.J. In press. Your attention please: increasing ambient noise levels elicits a change in communication behaviour in humpback whales (*Megaptera novaeangliae*). *Proceedings of the Royal Society B*.

Forcada, J., Trathan, P.N. and Murphy, E.J. 2008. Life history buffering in Antarctic mammals and birds against changing patterns of climate and environmental variation. *Global Change Biology* 14: 2473-88.

Gilles, A., Scheidat, M. and Siebert, U. 2009. Seasonal distribution of harbour porpoises and possible interference of offshore wind farms in the German North Sea. *Mar. Ecol. Prog. Ser.* 383: 295-307.

Hildebrand, J.A. 2009. Anthropogenic and natural sources of ambient noise in the ocean. *Mar. Ecol. Prog. Ser.* 395: 5-20.

International Maritime Organization Marine Environment Protection Committee. 2007. Any other business - shipping noise and marine mammals, submitted by the United States. 6pp. MEPC 57/INF.4.

International Whaling Commission. 2005. Report of the Scientific Committee. Annex K. Report of the Standing Working Group on Environmental Concerns. *J. Cetacean Res. Manage. (Suppl.)* 7:267-81.

International Whaling Commission. 2006. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 8:1-65.

International Whaling Commission. 2009. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 11:1-74.

International Whaling Commission. 2010. Report of the Workshop on Cetaceans and Climate Change, 21-25 February 2009, Siena, Italy. *J. Cetacean Res. Manage. (Suppl.)* 11(2):451-80.

Jensen, F.H., Bejder, L., Wahlberg, M., Aguilar Soto, N., Johnson, M. and Madsen, P.T. 2009. Vessel noise effects on delphinid communication. *Mar. Ecol. Prog. Ser.* 395: 161-75.

Knowlton, A.R., Kraus, S.D. and Kenney, R.D. 1994. Reproduction in North Atlantic right whales (*Eubalaena glacialis*). *Can. J. Zool.* 72(7): 1,297-305.

Leaper, R., Cooke, J., Trathan, P., Reid, K. and Rowntree, V. 2006. Global climate change drives southern right whales (*Eubalaena australis*) population dynamics. *Biology Letters* 2: 289-92.

Omata, Y., Hammond, T., Itoh, K. and Koichi Murata, K. 2005. Antibodies against *Toxoplasma gondii* in the Pacific bottlenose dolphin *(Tursiops aduncus*) from the Solomon Islands. *J. Parasitol.* 91: 965-67.

Payne, R. 1986. Long term behavioral studies of the southern right whale (*Eubalaena australis*). *Rep. int. Whal. Commn (special issue)* 10: 161-67.

Stachowitsch, M., Parsons, E.C.M. and Rose, N.A. 2008. State of the cetacean environment report (SOCER) 2008. Paper SC/60/E1 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 24pp. [Paper available from the Office of this Journal].
Tachibana, M., Watanabe, K., Kim, S., Omata, Y., Murata, K., Hammond, T. and Watari, M. 2006. Antibodies to *Brucella* spp. in Pacific bottlenose dolphins from the Solomon Islands. *J. Wildl. Dis.* 42: 412-14.
Todd, V.L.G., Pearse, W.D., Tregenza, N.C., Lepper, P.A. and Todd, I.B. 2009. Diel echolocation activity of harbour porpoises (*Phocoena phocoena*) around North Sea offshore gas installations. *ICES J. Mar. Sci* 66: 734-45.
Tougaard, J., Carstensen, J., Teilmann, J., Skiv, H. and Rasmussen, P. 2009. Pile driving zone of responsiveness extends beyond 20km for harbour porpoises (*Phocoena phocoena* (L.)). *J. Acoust. Soc. Am.* 126: 11-14.
Weilgart, L.S. 2010. *Report of the Workshop on Alternative Technologies to Seismic Airgun Surveys for Oil and Gas Exploration and their Potential for Reducing Impacts on Marine Mammals, held by Okeanos - Foundation for the Sea, Monterey, California, USA, 31st August-1st September 2009*. Okeanos - Foundation for the Sea, Auf der Marienhole 15, D-64297 Darmstadt. 29pp.
Williams, R. and O'Hara, P. 2010. Modelling ship strike risk to fin, humpback and killer whales in British Columbia, Canada. *J. Cetacean Res. Manage.* 11(1): 1-8.
Wright, A.J. and Okeanos Foundation for the Sea. 2008. *International Workshop on Shipping Noise and Marine Mammals, held by Okeanos - Foundation for the Sea, Hamburg, Germany, 21st-24th April 2008*. Okeanos - Foundation for the Sea, Auf der Marienhole 15, D-64297 Darmstadt. 34pp.

Appendix 1

AGENDA

1. Convenor's opening remarks
2. Election of Chair
3. Adoption of Agenda
4. Appointment of rapporteurs
5. Review available documents
6. Receive the State of the Cetacean Environment Report, SOCER
7. Review progress in planning for the POLLUTION 2000+ Phase II
   - 7.1 Workshop report
   - 7.2 Update on oil spill in the Gulf of Mexico
8. Review progress of CERD Working Group
9. Review new information on anthropogenic sound and cetaceans, focusing on masking sounds (e.g. noise from shipping and other low frequency sources)
   - 9.1 Concerns related to anthropogenic masking of low-frequency sounds
   - 9.2 Other factors related to masking
   - 9.3 Case studies
   - 9.4 Progress in reducing low frequency sounds from shipping
   - 9.5 Recommendations
10. Review progress on work from the Second Climate Change Workshop
11. Other habitat related issues
    - 11.1 Marine renewable energy development
    - 11.2 Mapping diversity of cetaceans and other pelagic megafauna
    - 11.3 Update on 2008 Madagascar stranding
12. Work plan
13. Review and adopt report

Appendix 2

POLLUTION 2000+ WORK PLAN PROPOSAL

Based on the Phase II Intersessional IWC POLLUTION 2000+ Workshop results, the Steering Committee recommends the following two tasks.

I. Complete the chemical prioritisation survey and analyses

The Workshop had developed a 'prioritisation hazard identification framework' to evaluate the broad number of environmental pollutants of concern to cetaceans. It also agreed that the most appropriate way to use this framework is to undertake an international prioritisation survey of the appropriate experts in marine mammals and/or toxicology.

The desired outcomes from this survey are:

(1) a prioritised list of chemicals of concern;
(2) a prioritised list of species at risk; and
(3) identification of potential hot spots.

To achieve this, each Workshop participant will distribute the survey to 2-3 subject matter experts, with a cover letter from the Steering Committee and request their part in the survey. Experts will have expertise in marine mammals, toxicology or analytical chemistry and the list of such experts will be developed by the Steering Committee. The survey will be sent to the appropriate experts, the results compiled and a final report submitted to the 2011 Annual Meeting.

II. Risk assessment modelling to determine the impact of pollutants on cetacean populations

We propose that modelling exercises be undertaken following the recommendations of the Phase II Intersessional IWC Pollution 2000+ Workshop (IWC/62/Rep4). This will involve the development and implementation of two demonstration projects, using the risk assessment framework (based on an individual based model approach) outlined by Hall and Schwacke (Hall *et al*., 2006). Work will require the assistance of a post-doctoral research assistant for a period of two years, under the direct supervision of Schwacke and Hall with input and guidance from the POLLUTION 2000+ Steering Committee.

This work will be a two-year project. The Steering Group will provide a progress report to the 2011 Annual Meeting and a final report to the 2013 Annual Meeting.

Completion of this work will allow the Scientific Committee to make substantial progress on four modelling recommendations of the Workshop as follows.

(1) *Improve the existing concentration-response (CR) function for PCB-related reproductive effects in cetaceans*. This involves re-initiating efforts to derive a CR function based on surrogate species for reproductive effects in relation to PCB exposure. The CR component will be improved by conducting a literature search and integrating additional data into the model from recent studies.
(2) *Derive additional CR functions to address other endpoints (i.e. survival) in relation to PCB exposure.* This requires a multi-stage modelling approach, e.g. a series of functions that provide a connection from PCB exposure → functional immune endpoints → increased pathogen susceptibility → increased likelihood of mortality.
(3) *Integrate improved concentration-response components into a population risk model (i.e. individual-based model) for two case study species: bottlenose dolphin and humpback whale.* This is the primary deliverable for the study. These two species have been chosen as demonstration projects since they represent a small and large cetacean species for which sufficient relevant data already exist on both exposure and vital rates for specifically defined populations. The model will be developed with a user-friendly interface such that it can be distributed throughout the scientific community for use and development for other species and endpoints where sufficient life history, contaminant exposure and vital rate data exist. The overall objective is to determine the magnitude of the risk to a population (as measured, for example, by potential population growth rate) from contaminant exposure at various levels, which would ultimately allow the 'pollution risk' to be compared with other population-level risks faced by these species (e.g. the impact of bycatch or prey availability).
(4) *Implement a CR component for at least one additional Contaminant of Concern (COC).* The COC would be determined by the steering committee based on given knowledge for likelihood of exposure and toxicity. This will involve a literature search to parameterise the additional CR component and investigate changes in model outcome assuming both additive and synergistic effects.

Budget

The overall cost of the project would be £123,168. This assumes that the postdoctoral position will be shared between Sea Mammal Research Unit (SMRU), St Andrews, Scotland and NOAA, Charleston, SC, USA. A steering committee meeting will be held at SMRU at the end of Year 1 to review progress of the project and to prioritise contaminants of concern for inclusion in the framework.

Total budget for two-year project [UK £ pounds]

Total budget for two-year project (£).

Budget item	Justification	Cost
Postdoctoral salary	£55,356/year for 2 years	£110,713
Travel to SMRU	£2,076 for travel x 2 trips	£4,152
POLLUTION 2000+ Committee Review	Travel for 4 persons to SMRU for 3-4 days work	£8,303
Total		£123,168

Total budget for year one

Postdoctoral salary: £55,356
Travel to SMRU: £2,076

Total budget for year two

Postdoctoral salary: £55,356
Travel to SMRU: £2,076
Travel (for four persons) to SMRU for POLLUTION 2000+ Committee Review: £8,303

REFERENCE

Hall, A.J., McConnell, B.J., Rowles, T.K., Aguilar, A., Borrell, A., Schwacke, L., Reijnders, P.J.H. and Wells, R.S. 2006. Population consequences of polychlorinated biphenyl exposure in bottlenose dolphins - an individual based model approach. *Environ. Health Perspect*. 114, Suppl. 1:60-64.

Appendix 3

CERD WORK PLAN

Proposed work plan for the CERD Working Group to be performed for IWC/63 through intersessional e-mail and conference call participation.

(1) The skin disease subgroup (Rosa [Chair], Brownell, Carlson, Galletti, Marcondes, Mattila, Robbins, Rosa, Rowles and Weller) will continue progress for web-based access.

(2) Utilising the fields developed for diagnostic laboratories, the Working Group will complete the identification of diagnostic laboratories by region, ocean basin or country.

(3) Building on a One Health concept, coordinate with other wildlife disease surveillance efforts such as USAID Emerging Pandemic Threats programme, OIE Working Group on Wildlife Diseases, or other national, regional or international efforts for capacity building, training and outbreak investigations.

(4) Complete the prioritisation of pathogens survey and analyses and provide a report at next year's meeting.

(5) Expand the emergency response steering committee (Fernandez [Chair], Brownell, Jepson, Marcondes, Rosa, Rowles, Uhart and Urban):
   (a) coordinate with International Union for the Conservation of Nature (IUCN), ICES and other international response-planning efforts;
   (b) develop response coordination plan using a regional approach;
   (c) identification of potential funding sources for preparedness and response for international marine mammal die-off, mass stranding responders or other emergency responses; and
   (d) coordinate responses as needed or requested.

(6) Enhance capacities and communications between stranding networks:
   (a) finalise a web-based database of stranding networks that integrates the ICES, ship strike and emergency response databases and provide access for periodic updates; and
   (b) take advantage of opportunities to host national, regional and international stranding network training workshops and capacity-building efforts in those areas in which they are needed.

(7) Provide scientific advice and experts for investigations of die-offs or outbreaks across and within national and regional boundaries (Marcondes [Chair], Brownell, Rowles and Uhart):
   (a) coordinate and assist with mortality investigations of large whales in the Southern Hemisphere.

(8) Create a CERD website that will include the following items previously listed in last year's work plan [*this item has been deferred to 2012 until after some of the above are developed*].

No funding is requested from IWC at this time.

Appendix 4

STATE OF THE CETACEAN ENVIRONMENT REPORT (SOCER) 2010

Editors: M. Stachowitsch*, N.A. Rose** and E.C.M. Parsons+

INTRODUCTION

Several resolutions of the International Whaling Commission, including Resolutions 1997-7 (IWC, 1998) and 1998-5 (IWC, 1999), directed the Scientific Committee to provide regular updates on environmental matters that affect cetaceans. After submission of a prototype State of the Cetacean Environment Report (SOCER), Resolution 2000-7 (IWC, 2001) welcomed the concept of the SOCER at the 52nd Annual Meeting in Adelaide, Australia, and 'request[ed] the annual submission of this report to the Commission'. The first full SOCER (Stachowitsch *et al.*, 2003) was submitted in 2003 and focused on the Mediterranean and Black Seas and the Atlantic Ocean. Subsequent SOCERs have focused on the Pacific Ocean, the polar seas and the Indian Ocean. This cycle has been continued, with each SOCER also including a Global section addressing the newest information that applies generally to the cetacean environment. SC/62/E1 (SOCER 2010) focuses on the Arctic Ocean, summarising key papers and articles that have been published from 2008 through 2010 to date.

ARCTIC OCEAN

General

BELUGA WHALES IN ALASKA LISTED AS ENDANGERED

The Cook Inlet beluga whale population near Anchorage, Alaska, has been listed as an endangered species under the US Endangered Species Act because the population is not recovering despite protection measures. The population declined by nearly 50% between 1994 and 1998, with current numbers between 3-400. Recovery has apparently been hindered by strandings, developments along the inlet, oil and gas exploration, industrial activities, disease and predation by killer whales.

(SOURCE: News-in-Brief. 2008. *Mar. Pollut. Bull.* 56: 1,962.)

Habitat protection/degradation

General

THREATS TO ARCTIC MARINE MAMMAL SPECIES

Threats to Arctic marine mammal species include climate change, environmental contaminants, offshore oil and gas activities, shipping, hunting and commercial fisheries. Oil and gas exploration is occurring in Baffin Bay and the Barents, Beaufort and Chukchi Seas, with additional upcoming exploration in Eurasia, increasing the potential for oil spills from extraction or shipping and transfer accidents. Fisheries in Arctic waters have been limited, but fisheries bodies are preparing for the opening of new fisheries in the near future as a result of easier Arctic access as sea ice recedes. Fishing in the Arctic could lead to conflict between marine mammals and fisheries, if marine mammal prey species are taken (as targeted catch or bycatch). The projected impacts of climate change are numerous: '*Climate change has reduced arctic sea ice, lengthened periods of open water, and raised water temperatures in marginal seas; changes that are expected to continue or even accelerate…Loss of sea ice means fewer habitats for ice-dependent or ice-associated marine mammals...Changes in water temperature will undoubtedly alter primary productivity, the resulting food web, and prey fields for marine mammals...Warmer waters and changed distributions of marine mammals will affect disease prevalence and spread...Furthermore, as sea ice recedes, human activity will increase in the region because shipping and offshore development become economically feasible and advantageous*'.

(SOURCE: Huntington, H.P. 2009. A preliminary assessment of threats to arctic marine mammals and their conservation in the coming decades. *Marine Policy* 33: 77-82.)

CHANGES IN ARCTIC ECOSYSTEMS

A review of changes in Arctic ecosystems warns of the effects of changing geochemical cycles, shifts in distributions, invasive species and an increase in extreme environmental events. It highlights that '*some of the most rapid ecological changes associated with warming have occurred in marine and freshwater environments, associated with changes in sea ice dynamics and external nutrient loading*'. It discusses the lack of research and understanding of Arctic ecosystems, which are often ignored by managers as these systems are relatively species-poor. The review concludes that the '*extensive changes in living components of the Arctic associated with recent climate change documented here have been rapid and widespread across terrestrial, freshwater, and marine systems. Foreseeing and mitigating the ecological consequences of future climate change will require more intensive, multidisciplinary monitoring of both the physical drivers of these systems and biological responses to them*'.

(SOURCE: Post, E., Forchhammer, M.C., Bret-Harte, M.S., Callaghan, T.V., Christensen, T.R., Elberling, B., Fox, A.D., Gilg, O., Hik, D.S., Høye, T.T., Ims, R.A., Jeppesen, E., Klein, D.R., Madsen, J., McGuire, D., Rysgaard, S., Schindler, D.E., Stirling, I., Tamstorf, M.P., Tyler, N.J.C., van der Wal, R., Welker, J., Wookey, P.A., Schmidt, N.M. and Aastrup, P. 2009. Ecological dynamics across the Arctic associated with recent climate change. *Science* 325: 1,355-1,358.)

CURRENT STATUS OF POLAR SEA ICE

There has been a decreasing trend in summer sea ice cover for the past several decades. The minimum extent of summer sea ice in 2009 was 5.36 million km^2, 690,000 km^2 more than the second lowest sea ice extent ever recorded in 2008, and 1.06 million km^2 greater than the record minimum sea ice extent recorded in 2007. Nonetheless, ice extent was the third lowest recorded, and 1.68 million km^2 below the average extent recorded for 1979-2000, a decline of 11.2% per decade relative to this average value. Satellite image data also show a thinning of sea ice, with a decrease of nearly 0.7m between 2004 and 2008.

(SOURCES: Ray, G.C., Hufford, G.L., Krupnik, I.I. and Overland, J.E. 2008. Diminishing sea ice. *Science* 321: 1,443-1,444; Kerr, R.A. 2009. Arctic summer sea ice could vanish soon but not suddenly. *Science* 323: 1,655; National snow and ice data center. 2009. Arctic sea ice extent remains low; 2009 sees third-lowest mark. 6 October 2009, *http://nsidc.org/news/press/20091005_minimumpr.html*; Kwok, R. and Rothrock, D.A. 2009. Decline in Arctic sea ice thickness from submarine and ICESat records: 1958-2008. *Geophys. Res. Lett.* 36: L15501.)

*Department of Marine Biology, Faculty of Life Sciences, University of Vienna, Austria.
**Humane Society International, Washington, DC, USA.
+University Marine Biological Station Millport (University of London), Great Cumbrae, Scotland and Department of Environmental Science and Policy, George Mason University, Fairfax, Virginia, USA.

RATE OF ICE LOSS IN ANTARCTICA AND GREENLAND IS ACCELERATING

Between 1990 and 2000, melting of both the Greenland and Antarctic ice sheets accelerated. A recent satellite data evaluation of ice sheet loss suggests that this loss is increasing even faster. The mass of both Antarctica and Greenland have decreased, with the rate of ice mass loss doubling in Greenland, and more than doubling in Antarctica between 2002 and 2009. The edges of the ice sheets in both locations were shown to be thinning, which is linked to accelerating flow.

(SOURCES; Velicogna, I. 2009. Increasing rates of ice mass loss from the Greenland and Antarctic ice sheets revealed by GRACE. *Geophys. Res. Let.* 36: L19503; Kerr, R.A. 2009. Both of the world's ice sheets may be shrinking faster and faster. *Science* 326: 217; Pritchard, H.D., Arthern, R.J., Vaughan, D.G. and Edwards, L.A. 2009. Extensive dynamic thinning on the margins of the Greenland and Antarctic ice sheets. *Nature* 561: 971-975.)

Marine debris

MARINE PLASTIC DEBRIS AN ISSUE EVEN IN ARCTIC WATERS

Of 102 birds (fulmars) collected in the Canadian high Arctic, 31% had pieces of plastic in their digestive system; 2% of the items was 'industrial' (beads/pre-production pellets), while 98% was 'user' ('post-consumer') plastic. Although the incidence here was lower than the 79-100% occurrence reported in the North Pacific, North Atlantic or North Sea, the proportion represented an increase over the past three decades. The Arctic marine ecosystem is therefore also affected by the worldwide pattern of increasing pollution from marine plastic debris.

(SOURCE: Mallory, M.L. 2008. Marine plastic debris in northern fulmars from the Canadian high Arctic. *Mar. Pollut. Bull.* 56: 1,501-1,504.)

ENTANGLEMENT OF MARINE MAMMALS IN MARINE DEBRIS IN SOUTHEAST ALASKA

Entanglement in marine debris is a contributing factor to Steller sea lion injury and mortality in southeast Alaska and northern British Columbia. Packing bands, rubber bands, nets, ropes and monofilament line were the most common neck entangling items, whereas the most commonly ingested fishing gear were lures, longline gear, hook and line, spinners/spoons and bait hooks. Marine debris is clearly a threat even in remote waters, and such items are also known to affect cetaceans.

(SOURCE: Raum-Suryan, K.L., Jemison, L.A. and Pitcher, K.W. 2009. Entanglement of Steller sea lions (*Eumetopias jubatus*) in marine debris: Identifying causes and finding solutions. *Mar. Pollut. Bull.* 58: 1,487-95.)

Chemical pollution

ANTHROPOGENIC SOURCES: A STRONG CONTRIBUTOR TO MERCURY LEVELS IN ARCTIC WILDLIFE

A comparison of mercury (Hg) levels in historical and pre-industrial *versus* present-day tissue samples from Arctic species showed that the median man-made contribution today is over 92%. The steep onset of mercury exposure began in the latter half of the 19th century and represents an order-of-magnitude increase. The analysis of beluga whale teeth showed that the large 20th century effect on this species occurred mostly before 1960, when man-made Hg had already attained 75% of the total. Older animals exhibited a larger man-made percentage than younger animals, which was predicted because of the multiplicative effects of lifetime bioaccumulation of Hg. In a second study, the Hg contents of Beaufort Sea beluga whales were linked to the Hg contents of their prey: highest Hg levels in the whales matched highest food web Hg levels. This points to a variation in dietary Hg uptake and underlines the importance of examining Hg sources at the bottom of the food web along with food web length.

(SOURCES: Dietz, R., Outridge, P.M. and Hobson, K.A. 2009. Anthropogenic contributions to mercury levels in present-day Arctic animals – a review. *Sci. Total Environ.* 407: 6,120-31; Loseto, L.L., Stern, G.A., Deibel, D., Connelly, T.L., Prokopowicz, A. Lean, D.R.S., Fortier, L. and Ferguson, S.H. 2009. Linking mercury exposure to habitat and feeding behaviour in Beaufort Sea beluga whales. *J. Mar. Syst.* 74: 1,012-1,024.)

POLAR COD SUGGESTED AS A SPECIES TO MONITOR FUTURE OIL POLLUTION IN THE ARCTIC

Arctic waters are predicted to open as a trade route and site of oil and gas exploration due to climate-related loss of ice. This would be associated with an increased risk of oil pollution, as the Arctic is subject to a specific set of additional risk factors such as rough weather conditions and drifting icebergs. Spilled petroleum hydrocarbons persist longer at the low temperatures here and cleaning up spills in such remote regions is difficult, posing an additional potential threat to cetaceans. Due to the high abundance and circumpolar distribution of polar cod, these fish are suggested to be well-suited organisms to monitor oil pollution.

(SOURCE: Jonsson, H., Sundt, R.C., Aas, E. and Sanni, S. 2010. The Arctic is no longer put on ice: Evaluation of Polar cod (*Boreogadus saida*) as a monitoring species of oil pollution in cold waters. *Mar. Pollut. Bull.* 60: 390-395.).

INSUFFICIENT FUNDING AND RESEARCH ON OIL SPILLS IN THE ARCTIC

One of the predicted effects of global warming is increased boat traffic and oil exploration in the Arctic. This increases the risk of oil pollution in these waters. The logistics of combating oil spills here are more difficult than elsewhere: oil degrades much more slowly in cold waters, the Arctic has fewer locations from which to launch cleanup efforts, and the fate and recoverability of oil under ice is unknown. Elsewhere, under ideal conditions, cleanup crews can recover 30% of spilled oil. That figure would be much lower in the Arctic, making it virtually certain that most of the oil will remain in the environment. The US national oil-spill research plan has not been updated in over a decade and the funds spent to study spills in the Arctic are inadequate here compared to Norway, for example.

(SOURCE: Torrice, M. 2010. Science lags on saving the Arctic from oil spills. *Science* 325: 1,335.)

Climate change

IMPORTANT ROLE OF ARCTIC SEA ICE IN PUMPING CARBON DIOXIDE INTO THE OCEANS

Arctic sea ice apparently plays a much larger role than previously recognised in capturing and removing carbon dioxide from the atmosphere and storing it in the world's oceans. Current climate models do not factor in the role of sea ice, which increases the seasonal uptake of CO_2 in the region by 50%. The predicted total loss of summer sea ice from the Arctic within the next few decades may have dramatic effects on this role, leading to further increases in CO_2 in the atmosphere and thus further altering key cetacean habitats.

(SOURCE: News. 2009. *Mar. Pollut. Bull.* 58: 1,593.)

NEW EVIDENCE INDICATES AN ICE-FREE ARCTIC WITHIN A DECADE

Ice thickness was measured in early 2009 along a 450km route across the northern Beaufort Sea by the Catlin Arctic Survey and analysed by the Polar Ocean Physics Group, University of Cambridge. The data show that the ice layer consisted of relatively thin 'first year ice' rather than the normal, thicker, multi-year ice. These data support the emerging thinking that the Arctic Ocean will be largely ice-free in summer within a decade. Beyond the broad climate feedbacks that this may set in motion, increasing ship traffic across this ocean would pose a potential threat (e.g. ship strikes, noise, pollution) to cetaceans and other marine mammals. In the USA, the North Pacific Fishery Management Council has banned fishing trawlers from following the retreating Arctic ice and fishing in previously ice covered waters.

(SOURCES: News. 2009. *Mar. Pollut. Bull.* 58: 1,770; News. 2009. *Mar. Poll. Bull.* 58: 462.)

ARCTIC MAY REMAIN ICE-COVERED IN WINTER DESPITE WARMING

The late Cretaceous period (65-99 million years ago) is often regarded as a possible indicator of what a world with elevated carbon dioxide levels could look like. Carbon dioxide levels were in excess of 1,000 ppm (possibly four times current concentrations). Temperatures in the Arctic Ocean are estimated to have been up to 15°C during this period and the pole was probably ice free. However, a new study analysing sediment deposition patterns has suggested that there may have been thin, seasonal ice cover in the winter. This suggests that even with atmospheric CO_2 levels much higher than present, winter sea ice may still occur, although in much smaller amounts, with subsequent implications for Arctic ecosystems.

(SOURCE: Davies, A., Kemp, A.E.S. and Pike, J. 2009. Late Cretaceous seasonal ocean variability from the Arctic. *Nature* 460: 254-259.)

TWO THOUSAND YEARS OF ARCTIC CLIMATE DATA SHOW COOLING TREND, THEN ABRUPT WARMING IN PAST 50 YEARS

An extensive analysis of climate proxy data over a 2,000 year period indicated a long-term cooling trend in the Arctic. During the 20th century, following that trend, temperatures should have continued to cool, but this trend was reversed; the last half of the 20th century was the warmest in the 2,000 year proxy data record. The researchers conclude that '*our synthesis, together with the instrumental record, suggests that the most recent 10-year interval (1999-2008) was the warmest of the past 200 decades. Temperatures were about 1.4°C higher than the projected value based on the linear cooling trend and were even more anomalous than previously documented*'.

(SOURCE: Kaufman, D.S., Schneider, D.P., McKay, N.P., Ammann, C.M., Bradley, R.S., Briffa, K.R., Miller, G.H. and Otto-Bliesner, B.L., Overpeck, J.T. and Vinther, B.M. 2009. Recent warming reverses long-term Arctic cooling. *Science* 325: 1,236-1,239.)

CLIMATE CHANGE IMPACTS ON ARCTIC SEALS AND WHALES

In a warmer Arctic, endemic marine mammal species will face extreme levels of habitat change, most notably a dramatic reduction in sea ice. The authors identify three cetacean species as 'ice-loving' (pagophilic) – bowhead whales, white whales and narwhals – based on, among other factors, their lack of dorsal fins, their thick blubber and their ability to break young ice with their backs. Altered distributions and foraging are predicted for bowheads and white whales, which are also vulnerable to increases in pollution levels. Narwhals, which are less numerous, have a significantly more restricted distribution, are less flexible in their choice of habitats and food types, and are ranked among the three most sensitive species to climate change among Arctic endemics. For dolphins, porpoises and migrating whales, a range of potential effects are cited, among them range expansions and mis-matched migrations; i.e. timing of arrival will not match prey peaks. Finally, all of these changes could substantially alter predator-prey dynamics throughout the region.

(SOURCE: Kovacs, K.M. and Lydersen, C. 2009. Climate change impacts on seals and whales in the North Atlantic Arctic and adjacent shelf seas. *Sci. Progr.* 91: 117-150.)

CHANGING ARCTIC OCEAN CONDITIONS CAUSING A SHIFT IN PHYTOPLANKTON COMPOSITION

Warming temperatures, increasing freshwater inputs from melting ice, increased direct sunlight, increasing precipitation, and less ice coverage are changing the nature of the Arctic Ocean. An analysis of the effects of these changes on phytoplankton concluded that, although total plankton biomass stayed roughly the same, '*the smallest phytoplankton cells thrive but larger cells languish*', with a net shift to smaller phytoplankton size, and a change in species composition. The authors state that '*[p]icoplankton-based systems tend not to support large exports of biogenic carbon…for extraction (*e.g. *harvest)*'. This means that the carrying capacity of this changing system for marine mammal populations, and also human fisheries, would likely be diminished.

(SOURCE: Li, W.K.W., McLaughlin, F.A., Lovejoy, C. and Carmack, E.C. 2009. Smallest algae thrive as the Arctic Ocean freshens. *Science* 326: 539.)

INCREASED CATCHES OF NARWHALS IN GREENLAND ATTRIBUTED TO CLIMATE CHANGE

Catch statistics show a significant increase in narwhal catches by hunters in Siorapaluk, the northernmost community in Greenland, after 2002. Hunters attribute this to changes in sea-ice conditions providing boat access to the hunting area earlier in the season. This calls for collaborative management schemes and sustainable quotas for this stock. The goals are local acceptance of regulations and the ability to respond rapidly to climate change. The developments here could serve as a template for climate-change-induced effects on other hunted Arctic whale species.

(SOURCE: Nielson, M.R. 2009. Is climate change causing the increasing narwhal (*Monodon monoceros*) catches in Smith Sound, Greenland? *Polar Res.* 28: 238-245.)

ABRUPT CLIMATIC CHANGE COULD OCCUR IN THE ARCTIC WITHIN A COUPLE OF YEARS

Ice core data from Greenland suggest that the warming periods succeeding the previous two glacial periods may have been even more dramatic than previously thought, with changes in the ice cores indicating dramatic shifts in atmospheric circulation patterns within just a 1- to 3-year period. This ultimately led to warming of air temperatures over a 50-year period. The study '*confirms the potential for extremely abrupt reorganizations of the Arctic atmospheric circulation, whether going from cold to warm or vice versa*' and that major and abrupt changes in Arctic climate have occurred before, leading to air temperature increases of as much as 10°C.

(SOURCE: Steffensen, J.P., Andersen, K.K., Bigler, M., Clausen, H.B., Dahl-Jensen, D., Fischer, H., Goto-Azuma, K., Hansson, M., Johnsen, S.J., Jouzel, J., Masson-Delmotte, V., Popp, T., Rasmussen, S.O., Röthlisberger, R., Ruth, U., Stauffer, B., Siggaard-Andersen, M.-L., Sveinbjörnsdóttir, Á.E., Svensson, A. and White, J.W.C. 2008. High-resolution Greenland ice core data show abrupt climate change happens in few years. *Science* 321: 680-684.)

OCEAN ACIDIFICATION AND ICE MELTWATER REDUCES ARCTIC CALCIUM CARBONATE, AFFECTING PHYTO-PLANKTON

The decreasing pH due to increased carbon dioxide dissolved in seawater, and an increased input of freshwater from melting ice sheets, have decreased levels of a soluble form of calcium carbonate (aragonite). Because this calcium carbonate is essential for marine phytoplankton in the Arctic (especially diatoms), this reduction '*will affect both planktonic and benthic calcifying biota and therefore the composition of the Arctic ecosystem*'. As a result, the authors warn that '*the Arctic ecosystem may be at risk and requires* *observation in order to predict future possible impacts on marine organisms, fisheries*'.

(SOURCE: Yamamoto-Kawai, M., McLaughlin, F.A., Carmack, E.C., Nishino, S. and Shimada, K. 2009. Aragonite undersaturation in the Arctic Ocean: Effects of ocean acidification and sea ice melt. *Science* 326: 1,098-1,100.)

Noise impacts

General

UNDERWATER NOISE FROM ARTIFICIAL ISLAND FOR OIL AND GAS DEVELOPMENT TRAVELS 7KM UNDERWATER

Northstar Island is a manmade island for oil and gas development in the Beaufort Sea, 5km offshore in 12m of water. Sounds were recorded during ice-auguring, pumping, backhoe trenching the seafloor and pile driving at substantial distances from the site, with pile driving producing the loudest sounds. Sound levels were above ambient for a distance of up to 7.5km from the site. Levels of sound transmitted by ice were also measured and these were above ambient for a distance of up to 10km from the site (and levels were above ambient in air up to 3km from the island).

(SOURCE: Greene, C.R., Blackwell, S.B. and McLennan, M.W. 2008. Sounds and vibrations in the frozen Beaufort Sea during gravel island construction. *J. Acoust. Soc. Am.* 123: 687-695.)

GLOBAL

General

CONSERVATION PAPERS TAKE THREE TIMES LONGER TO BE PUBLISHED THAN PAPERS IN OTHER BIOLOGY FIELDS

A review of time taken to publish papers found that conservation scientists can take more than three times longer to submit manuscripts and have papers published than other biology specialists. The delay between last data collection and submission for conservation papers was 696 days (i.e. nearly two years), compared to just 189 days for evolution papers. Rejection rates were also much higher for conservation papers. The longer time did not reflect editorial processes, the number of authors on a paper or the time spent being rejected from other journals. The delay is probably because of: (a) lack of competition among conservation biologists, making publication less urgent; (b) lack of funding and conservation biologists being involved in other (income-generating) activities, with publishing taking a lower priority; or (c) conservation research being conducted by a different demographic compared to other biological fields, for example, by government scientists, who may require papers to be vetted by their agencies before publication. The researchers conclude that '*[t]he cause for the excess submission delay in conservation papers must be determined and addressed; research that is critical for conservation of our planet's biodiversity is being delayed before it even reaches the desks of journal editors*'. This has implications for reviews such as the State of the Cetacean Environment Report, which review publications on a cyclical basis.

(SOURCE: O'Donnell, R.P., Supp, S.R. and Cobbold, S.M. 2010. Hindrance of conservation biology by delays in the submission of manuscripts. *Conservation Biology* 24: 615-620.)

Habitat protection/degradation

General

ABSENCE OF REACTION IS NOT ABSENCE OF IMPACT

It is sometimes claimed that cetaceans will eventually habituate to a disturbance (such as underwater noise), or if animals appear to have habituated to a disturbance, then it is not having an adverse impact. True habituation is defined as a learning process that occurs over time. What many refer to as habituation is in fact 'tolerance'. Sensitive animals may be the first to be displaced from a population as the result of disturbance, leaving 'tolerant' animals. This could lead to the mistaken conclusion that no adverse impact has occurred if a study is conducted after the disturbance is in place. Moreover, many factors could potentially cause animals to tolerate disturbance: the importance of a disturbed area for feeding or breeding, the investment an animal has made in a site (e.g. establishing a territory, learning information about local resources), lack of appropriate habitat to move to, or increased competition or predation outside of the current habitat. Therefore, lack of displacement does not indicate lack of disturbance. Moreover, physiological factors (e.g. increased 'stress' responses) can affect the fitness of animals even when no behavioural response is observed. In summary, with respect to disturbance, absence of evidence (such as displacement or behavioural changes) is not evidence of absence (of a negative effect on cetaceans). Managers should therefore be precautionary in their decisions.

(SOURCE: Bejder, L., Samuels, A., Whitehead, H., Finn, H. and Allen, S. 2009. Impact assessment research: use and misuse of habituation, sensitization and tolerance in describing wildlife responses to anthropogenic stimuli. *Mar. Ecol. Prog. Ser.* 395: 177-185.)

OFFSHORE WIND FARMS A POTENTIAL THREAT TO CETACEANS

Offshore wind farms are a highly propagated form of renewable energy production. They can potentially affect cetaceans in two ways: by noise from construction, operation, and decommissioning and by creating physical structures in the animals' habitat. The authors begin by pointing out the difficulty in determining potential impacts due to uncertainties about cetacean distribution. They then demonstrate that a protected population of bottlenose dolphins would have been injured by the noise of pile-driving within 100m of this activity (wind turbine installation) and that behavioural disturbance (modified behaviour) could have occurred up to 50km away.

(SOURCES: Thompson, P.M., Lusseau, D., Barton, T., Simmons, D. Rusin, J. and Bailey, H. 2010. Assessing the responses of coastal cetaceans to the construction of offshore wind turbines. *Mar. Pollut. Bull.*, In press, doi:10.1016/j.marpolbul.2010.03.030; Bailey, H., Senior, B., Simmons, D., Rusin, J., Picken, G. and Thompson, P.M. 2010. Assessing underwater noise levels during pile-driving at an offshore windfarm and its potential effects on marine mammals. *Mar. Pollut. Bull.*, In press, doi:10.1016/j.marpolbul.2010.01.003.)

WATER QUALITY STANDARDS FOR CETACEANS

Cetaceans are potentially vulnerable to a wide range of human and livestock disease agents, and sewage effluents are a key route by which such pathogens can be transferred. The EU Habitats Directive requires Member States to consider the potential impact of sewage discharges on protected wildlife populations. There is ongoing discussion whether water quality standards for human bathers can be applied to develop standards for coastal dolphins. Considering that the standards for human bathers are based on extremely limited scientific data, and that the relevant data collection from wild populations of dolphins would be nearly impossible, the author argues that more precautionary measures should be introduced to reduce disease risks to cetaceans.

(SOURCE: Thompson, P.M. 2007. Developing water quality standards for coastal dolphins. *Mar. Pollut. Bull.* 54: 123-127.)

Fisheries interactions

BUBBLE LESIONS FOUND IN OTHER MARINE MAMMAL SPECIES – LINKED TO EFFECTS OF BYCATCH

Gas bubble lesions were discovered in short-beaked common and Atlantic white-sided dolphins and harbour porpoises, as well as harbour, gray and harp seals, that had been bycaught in fishing gear. In total, 15 out of 25 bycaught animals exhibited bubble lesions. This pertained especially to those animals that had a longer time from collection to necropsy, were brought to the surface faster or from greater depths, and which had higher body core temperatures. Forty-one stranded animals of various species were also examined and only one animal, a Cuvier's beaked whale, possessed bubble lesions. Bubbles were found in brain, heart, liver, lung, spleen, pancreas, gonad, intestinal and lymph node tissues, as well as skeletal tissues, blood and even in the eye. It was suggested that normal diving behaviour allows animals to offload gases through anatomical and physiological adaptations, while entanglement in fishing gear prevents this natural behaviour and leads to bubble lesions. The authors stress '*when gas bubbles are encountered in beached animals, serious consideration should be given to these findings and any resultant pathology, because it seems that animals that have been able to surface normally blow off supersaturated gases, and for bubbles to persist, this may represent a pathologic condition perhaps reflecting stressors that have precluded behaviours that normally manage gas tensions to keep bubble growth to a minimum*'. One relevant aspect of this information is that bubble lesions in bycaught animals may affect the survivorship of such animals that are released.

(SOURCE: Moore, M.J., Bogomolni, A.L., Dennison, S.E., Early, G., Garner, M.M., Hayward, B.A., Lentell, B.J. and Rotstein, D.S. 2009. Gas bubbles in seals, dolphins, and porpoises entangled and drowned at depth in gillnets. *Vet. Pathol.* 46: 536-547.)

Marine debris

FLOATING NET DEBRIS FATAL TO SPERM WHALES

The cause of death of two stranded male sperm whales off the northern California coast was determined to be plastic fishing net pieces and rope. The stomachs of the two animals contained 134 different types of nets ranging in size from $10cm^2$ to $16m^2$. The size and age of the pieces suggested that the material was ingested from the surface as debris and not bitten off from active gear. In addition to well-documented entanglements, ingestion of marine debris can be fatal to large whales.

(SOURCE: Jacobsen, J.K., Massey, L. and Gulland, F. 2010. Fatal ingestion of floating net debris by two sperm whales (*Physeter macrocephalus*). *Mar. Pollut. Bull.*, In press, doi:10.1016/j.marpolbul.2010.03. 008.)

PLASTIC MARINE DEBRIS COLLECTS AND DISTRIBUTES PERSISTENT ORGANIC POLLUTANTS

Beyond the negative impacts of plastic debris with regard to ingestion and entanglement of marine organisms, such plastic has now been shown to accumulate a wide range of persistent organic pollutants (POPs). Preproduction thermoplastic resin pellets (which are melted and formed into inexpensive consumer goods) and post-consumer plastic fragments collected at the North Pacific Gyre, California, Hawaii and Guadelupe Island, Mexico, contained PCBs, DDT and PAHs. Plastic can therefore adsorb, accumulate and transport POPs over great distances, and these pollutants enter the food web when marine organisms consume such debris.

(SOURCE: Rios, L.M., Moore, C and Jones, P.R. 2007. Persistent organic pollutants carried by synthetic polymers in the ocean environment. *Mar. Pollut. Bull.* 54(8): 1,230-1,237.)

Marine Protected Areas

VOLUNTARY SHIPPING AVOIDANCE AREA SHOWS HIGH COMPLIANCE AND REDUCES SHIP STRIKE RISK

The International Maritime Organization adopted the Roseway Basin Area on the Scotian Shelf in the northwest Atlantic as a voluntary avoidance area to reduce the risk of vessel strikes to North Atlantic right whales. Vessel positions were monitored 12 months before and 6 months after the area's designation; vessel-operator compliance stabilised at 71% within the first 5 months of implementation. It was estimated that the risk of vessel strikes in the area was reduced by 82% overall. It was concluded that such shipping avoidance areas, even if voluntary, could play a role in decreasing risk to cetaceans from ship strikes. Such areas provide yet another useful strategy, beyond conservation areas, traffic separation schemes and mandatory vessel speed reductions, to protect endangered whales.

(SOURCE: Vanderlaan, A.S.M. and Taggart, C.T. 2009. Efficacy of a voluntary area to be avoided to reduce risk of lethal vessel strikes to endangered whales. *Conserv. Biol.* 23: 1,467-1,474.)

WHALE MANAGEMENT MAY REQUIRE LARGER PROTECTED AREAS

Human disturbances can have significant impacts on cetaceans. One mechanism is the repeated activation of stress responses, e.g. by noise, leading to chronic stress. Deep-diving and coastal species, as well as those targeted by whalewatching, may be particularly vulnerable. This calls for management attention, with one strategy being the establishment of protected areas. The authors argue that the lack of recovery of some species may be because such protected areas are too small. They call for larger exclusion zones, including acoustic buffer zones around Marine Protected Areas (MPAs), and for excluding sonar exercises from known or likely beaked whale habitats and their surroundings.

(SOURCE: Wright, A.J., Deak, T. and Parsons, E.C.M. In press. Size matters: Management of stress responses and chronic stress in beaked whales and other marine mammals may require larger exclusion zones. *Mar. Pollut. Bull.*, In press.)

Chemical pollution

CONTAMINANTS DECREASE FIRST-YEAR SURVIVORSHIP RATES IN MARINE MAMMALS

Although not specifically directed at cetaceans, this study tracing survivorship patterns in grey seals produced information that demonstrates impacts of contaminants on marine mammal recruitment. Capture-recapture methods were used in conjunction with tags to estimate first-year survivorship. Higher levels of contaminants decreased likelihood of survival, with PBDE levels, followed by DDT and then PCB levels, being the classes of contaminants with the greatest impact. Although the mechanisms by which these contaminants cause mortality are unknown, their influence on recruitment rates demonstrates that they should be considered in cetacean population modelling.

(SOURCE: Hall, A.J., Thomas, G.O. and McConnell, B.J. 2009. Exposure to persistent organic pollutants and first-year survival probability in gray seal pups. *Environ. Sci. Tech.* 43: 6,364-6,369.)

Disease and mortality events

Disease

DOLPHINS' HEALTH SHEDS LIGHT ON HUMAN AND OCEAN HEALTH

Diseases in dolphins are similar to human diseases, and bottlenose dolphins may be the first natural animal model for type II diabetes. At least 50 new viruses have been discovered in dolphins, including the human papillomavirus. Coastal dolphin populations and human communities share the same seafood resources. Such a similar exposure with regard to diet, coupled with their much stronger exposure to ocean health threats (e.g. toxic algae, poor water quality) could make dolphins an important 'sentinel' species to provide information about the state of ocean health and warning of how human health may be affected by exposure to contaminated coastal water or seafood.

(SOURCE: News. 2010. *Mar. Pollut. Bull.* 60: 491.)

SIGNIFICANT POPULATION-LEVEL IMPACTS PREDICTED OF EMERGING DISEASES

A review on diseases in cetaceans included potential impacts on populations, the impact of environmental stressors and possible zoonotic effects. Some pathogens can reduce reproductive rates, cause mortality directly, or cause mortality indirectly by synergistically increasing the severity of other infections. Such pathogens include morbilliviruses, papillomaviruses and the pathogens *Brucella* spp. and *Toxoplasma gondii*. Fungal infection, such as lobomycosis and lobomycosis-like disease (LLD), might also contribute to cetacean mortality. Contamination by environmental pollutants or other anthropogenic stressors probably increases the severity and hence mortality or morbidity resulting from these pathogens. The risks to human health resulting from zoonotic transfer of *Brucella* and *Toxoplasma* from cetacean carcasses and products may be much higher than assumed, because of the low likelihood of diagnosis of infection by these pathogens, particularly in developing countries.

(SOURCE: Van Bressem, M.F., Raga, J.A., Di Guardo, G., Jepson, P.D., Duignan, P.J., Siebert, U., Barrett, T., Santos, M.C.d.O., Moreno, I.B., Siciliano, S., Aguilar, A. and Van Waerebeek, K. 2009. Emerging infectious diseases in cetaceans worldwide and the possible role of environmental stressors. *Diseases Aquat. Org.* 86: 143-157.)

Stress

WHISTLE RATE AN INDICATOR OF STRESS IN COMMON BOTTLENOSE DOLPHINS

The rate of whistle production in common bottlenose dolphins was significantly higher during a capture-release operation on wild dolphins in Florida. Females with dependent calves produced higher whistle frequencies than females without calves. Whistling rate also decreased with repeated captures. The conclusion is that these whistles are indicators of stress and as such, '*acoustic monitoring holds promise as a non-invasive means of assessing the impact of potentially stressful situations on bottlenose dolphins*'.

(SOURCE: Esch, H.C., Sayigh, L.S., Blum, J.E. and Wells, R.S. 2009. Whistles as potential indicators of stress in bottlenose dolphin (*Tursiops truncatus*). *J. Mammal.* 90: 638-650.)

Climate change

HISTORICAL SEA LEVEL RECONSTRUCTION SUGGESTS WEST ANTARCTIC ICE SHELF COLLAPSE AND 7M+ SEA LEVEL RISE

To predict the potential effects of increasing global temperature, many researchers have looked to the last interglacial period (125,000 years ago), a period with comparable temperatures to those envisaged for the near future (+3-5°C). A recent study re-examined sea level estimates for this period, taking into account various geological and planetary processes, and estimated an interglacial sea level of at least 6.6m above present, relatively speaking, and perhaps as much as 9.4m above. Melting ice sheets in Greenland and Antarctica would have effectively contributed at least 2.5m of this rise apiece. It was postulated that, because of the volume of increase contributed by Antarctica, the west Antarctic ice sheet collapsed in its entirety. In summary, the imminent predicted increase in global temperatures (1.5-2°C) could lead to a higher sea level rise than previously thought.

(SOURCES: Kopp, R.E., Simons, F.J., Mitrovica, J.X., Maloof, A.C. and Oppenheimer, M. 2009. Probabilistic assessment of sea level during the last interglacial stage. *Nature* 462: 863-867; Clark, P.U. and Huybers, H. 2009. Interglacial and future sea level. *Nature* 462: 856-857.)

THE IMPACT OF OCEAN ACIDIFICATION ON IRON AND MARINE PRODUCTIVITY

There has been concern over the impacts of ocean acidification, resulting from increased levels of carbon dioxide dissolved in seawater, on corals and the tests of calcareous plankton (such as diatoms). A new study highlights the potential impact of acidification on levels of iron in the ocean. Iron is a major limiting nutrient for marine productivity. The study experimentally examined the effect that decreased pH, as predicted by projected CO_2 levels for 2100, would have on iron uptake by diatoms. The study suggested '*a lowering of the ocean water pH from increasing CO_2 may decrease iron availability to phytoplankton*' (Sunda). This could affect the ocean's ability to absorb more carbon dioxide and thus cause a positive feedback loop that may effectively increase carbon dioxide levels in the atmosphere. Marine productivity in general may also be impacted, which would have wide ecological effects.

(SOURCES: Shi, D., Xu, Y., Hopkinson, B.M. and Morel, F.M.M. 2010. Effect of ocean acidification on iron availability to marine phytoplankton. *Science* 327: 676-679; Sunda, W.G. 2010. Iron and the carbon pump. *Science* 327: 654-655.)

IMPACTS OF CLIMATE CHANGE ON CETACEANS FROM CHANGES IN HUMAN BEHAVIOUR

The increasing focus on the effects of climate change on cetaceans reveals consequences not only for polar species, but also potentially for tropical coastal and riverine species. Beyond the expected physical habitat and prey changes, climate change will also alter human behaviour in some regions to the detriment of cetaceans. This contribution presents a comprehensive table identifying the specific aspects of climate change that are relevant for 82 cetacean species. The authors note that addressing direct and human-mediated threats from climate change will require: (1) integrating knowledge about cetacean populations into climate adaptation decisions; and (2) including projections about how climate change may influence human behaviours into cetacean-specific management plans.

(SOURCE: 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.* doi:10.1016/j.marpol.2010.01.026.)

NEW TYPE OF EL NIÑO EVENT MAY INCREASE WITH GLOBAL WARMING

The El Niño event causes periodic shifts in climate every 3-8 years in the Pacific, resulting in warmer surface waters off the western coast of South America and the 'capping' of a cool water upwelling that normally brings nutrients to the surface. This has major effects on marine productivity here. Since the 1970s, events with high sea surface temperatures have occurred in the central Pacific, with cooler temperatures being reported in the east and west Pacific. This warming event is unlike the east Pacific warming apparent during an El Niño event, and has been called many names, including 'pseudo' or 'central' El Niño. A new climate modelling exercise concluded that this central El Niño is the result of anthropogenic warming and, as temperatures increase, will become more marked and prevalent, at the expense of the eastern, or typical, El Niño event. If this is correct, it could lead to major changes in weather patterns along with oceanographic processes and marine ecosystems in the Pacific.

(SOURCES: Yeh, S.W., Kug, J.S., Dewitte, B., Kwon, M.H., Kirtman, B.P. and Jin, F.F. 2009. El Niño in a changing climate. *Nature* 461, 511-514; Ashok, K. and Toshio Yamagata, T. 2009. The El Niño with a difference. *Nature* 461:481-484.)

Noise impacts

General

NEW WAY OF MEASURING NOISE IMPACT: COMMUNICATION SPACE

'Communication space' was posited as a new way of measuring the potential biological impacts of underwater noise on cetaceans. Cetacean calls can only be heard when they rise above ambient levels of sound in the environment; underwater noise can mask these calls. The area over which calls can be heard therefore decreases with increasing noise levels, reducing the ability of cetaceans to communicate with each other. Communication space was modelled for fin whales, right whales and humpback whales when commercial shipping vessels passed a specific location. The researchers determined that '*acoustic communication space for at least one species of baleen whale, the highly endangered North Atlantic right whale, is seriously compromised by noise from commercial shipping traffic*'.

(SOURCE: Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., Van Parijs, S.M., Frankel, A. and Ponirakis, D. 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implication. *Mar. Ecol. Prog. Ser.* 395: 201-222.)

MARINE PROTECTED AREAS AND POSSIBILITIES FOR UNDERWATER NOISE MANAGEMENT

This review on the management of underwater noise identified several costs to marine mammals with consequences for fitness: '*compromised physiological function, diversion of time and energy, failure to detect important cues, impaired acoustical advertisement and communication, and reduced utilization of important habitats or resources*'. The authors criticised the attention focused on '*acute and immediate effects of intense noise exposures: hearing loss, injury, and death*', which examine individuals rather than populations, and they emphasise the need to consider the impacts of chronic noise even though sources are more diffuse and less easy to identify. The review concludes that MPAs could help to manage underwater noise and, due to the wide-ranging effects of anthropogenic sound, this may require establishing buffer zones around these areas. A case study of particular significance with respect to cetaceans is the Stellwagen Bank Marine Sanctuary, where anthropogenic noise levels from shipping '*were >82 dB 50% of the day and as high as 110 dB 5% of the day*'. To help remedy the problem, the authors called for: increased acoustic monitoring; incorporation of noise into environmental impact assessments via new tools (such as software showing visual representations of noise levels); new noise metrics and modelling techniques; better coordination between government agencies; and increased public education and outreach. They conclude that '*[t]he quietest marine and terrestrial environments must be vigorously protected, as they are the most vulnerable to noise intrusions. Exceptional environments for hearing natural sounds are also exceptional for detecting noise. Very little noise energy is required to substantially degrade listening conditions when the natural sound levels are very low. Like other crucial and endangered resources, quiet merits the highest standards for preservation and restoration*'.

(SOURCE: Hatch, L.T. and Fristrup, K.M. 2009. No barrier at the boundaries: implementing regional frameworks for noise management in protected areas. *Mar. Ecol. Prog. Ser.* 395: 223-244.)

REVIEW OF ANTHROPOGENIC SOUND IN THE OCEANS

A review of multiple anthropogenic noise sources in the oceans concludes that, for low frequencies, shipping is the dominant source, although seismic surveys, especially in deep water exploration, are also a major contributor. Airgun sounds could be heard in the North Atlantic almost continuously during summer months, at distances greater than 3,000km. For mid-frequency sound, sonar systems from about 300 vessels were a major contributor. Sonar is used by these vessels '*about 10% of the time these vessels are at sea*'. Acoustic harassment devices (seal scrammers) and multi-beam echosounders also contribute noise at mid-frequencies. Recreational and small boat traffic can also contribute substantial mid-frequency noise: '*[o]ver 17 million small boats are owned in the United States alone. Many of these boats use mid-frequency and high-frequency sonar for echolocation, also contributing to local ambient noise*'. At higher frequencies, depth sounders from ships are a major contributor. The potential reach of these sounds ranges from tens of metres (for high frequencies) to entire ocean basins (for low frequencies). The review calls for increased research into noise generation, in particular the characteristics of shipping noise affected by vessel size, speed, density and other factors.

(SOURCE: Hildebrand, J.A. 2009. Anthropogenic and natural sources of ambient noise in the ocean. *Mar. Ecol. Prog. Ser.* 395: 5-20.)

SOUND EXPOSURE LEVELS NOT AN OPTIMAL MEASURE TO PREDICT NOISE IMPACTS

One way to measure sound level, in particular with respect to its impacts on cetaceans, is sound exposure level (SEL). This metric combines both the sound intensity and the exposure duration, to derive the total amount of energy; i.e. two sounds can have the same total energy when one has a higher intensity but a proportionately shorter duration. Such a metric would theoretically make regulating sound impacts easier because there are many different types of sound (continuous such as shipping, single impulses such as explosions, or multiple pulses such as seismic survey airguns or sonar pings). In practise, however, SEL has drawbacks. When common bottlenose dolphins were exposed to sounds with identical SELs, but varying duration and intensity, temporary threshold shifts (TTS) were more likely to occur in animals exposed for longer periods. This study emphasises the importance of knowing the properties of the sound to which animals are exposed, as sounds of different types may not be easily and directly comparable when predicting possible impacts on cetaceans. The researchers also note that '*longer duration exposures will often induce greater amounts of TTS, which concurrently requires a greater amount of time for recovery*'.

(SOURCE: Mooney, T.A., Nachtigall, P.E., Breese, M., Vlachos, S. and Au, W.W.L. 2009. Predicting temporary threshold shifts in a bottlenose dolphin (*Tursiops truncatus*): The effects of noise level and duration. *J. Acoust. Soc. Am.* 125: 1,816-1,826.)

MILITARY FUNDING APPEARS TO RESULT IN REPORTING BIAS IN UNDERWATER SOUND REVIEWS

Concerns have been raised that the US Navy provides 50% of the global research funds for marine mammal research (and 70% of underwater noise impact research), potentially influencing scientific reporting of impacts of underwater noise. An analysis of six reviews documenting effects of anthropogenic noise on marine mammals found that '*these reviews cite references showing noise has no effect on marine mammals at an increasing frequency as their funding moves from a conservation organization to independent to partial US military sources*'. The likelihood of a paper concluding that there is no effect of noise on cetaceans more than doubles if the researchers obtained funds from the US Navy. The researchers conclude that '*conflicts of interest may have led to a misrepresentation of the effects of noise on marine mammals in both the primary and secondary literature, and thus misinform public policy decisions*'.

(SOURCE: Wade, L., Whitehead, H. and Weilgart, L. 2010. Conflict of interest in research on anthropogenic noise and marine mammals: Does funding bias conclusions? *Mar. Pol.* 34: 320-327.)

Cetacean hearing

BEAKED WHALE HEARING SENSITIVITY CURVE APPEARS TO BE SIMILAR TO DELPHINIDS

One hypothesis why beaked whales appear to be more sensitive to underwater noise than other cetacean taxa has been that they are generally more sensitive to sound. However, when the hearing sensitivity of a stranded Gervais' beaked whale was opportunistically tested via auditory evoked potentials, its hearing sensitivity curve was similar to that of studied delphinids. The animal could detect sounds to a frequency of at least 80kHz (with greatest sensitivity at 40kHz).

(SOURCE; Finneran, J.J., Houser, D.S., Base-Guthrie, B., Ewing, R.Y. and Lingenfelser, R.G. 2009. Auditory evoked potentials in a stranded Gervais' beaked whale (*Mesoplodon europaeus*). *J. Acoust. Soc. Am.* 126: 484-490.)

Seismic surveys

HARBOUR PORPOISE TEMPORARY THRESHOLD SHIFTS (TTS) MEASURED IN RESPONSE TO SINGLE AIRGUN PULSES

A captive male harbour porpoise held in a sea pen was exposed to sound from a seismic survey airgun (20 cubic inches) placed at decreasing distance to the porpoise (150-14m). The airgun's sound predominated in lower frequencies (below 1kHz), but the porpoise was also exposed to higher frequencies (i.e. 2-5kHz; up to 150dB SPL). Auditory evoked potentials were measured in response to single pulses of the airgun, and the sound level at which TTS occurred was recorded. Aversive behaviour at 4kHz was observed at a SEL of approximately 20dB lower than that at which TTS occurred and the animal avoided the testing location for the rest of the 4½ month testing period. Recovery from TTS was slow for the porpoise, taking up to 55 hours. The levels of exposure at which TTS occurred were substantially lower than levels considered to have no effect under, for example, current US regulations. Moreover, this study measured the effects of single pulses: bearing in mind the long recovery period of the porpoise, the effect of normal airgun operation (repeated pulses) would probably be greater. Although it examined only one captive animal, the study illustrates the higher than expected sensitivity of porpoises to seismic survey noise.

(SOURCE: Lucke, K., Seibert, U., Lepper, P.A. and Blanchet, M.A. 2009. Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. *J. Acoust. Soc. Am.* 125: 4,060-4,070.)

TAGGED SPERM WHALES REDUCE FORAGING BEHAVIOUR IN RESPONSE TO SEISMIC SURVEYS

Eight sperm whales (7 foraging and 1 resting) in the Gulf of Mexico were exposed to seismic surveys and their behaviour recorded via tags. There was no significant change in behaviour state in the whales as the result of exposure, although the one resting animal began to forage immediately after the cessation of the seismic surveys, '*possibly indicating a delay in foraging during exposure*'. There was no apparent horizontal avoidance of the airguns; this raises doubt as to whether the current practice of 'ramping-up' (increasing sound levels gradually to allow animals to leave an area) is effective. Swimming behaviour did change, and acoustic behaviour associated with foraging decreased 19% during seismic exposure. This substantive change in underwater behaviour would not have been detected without the use of tags, and surface observations alone would not have recorded any noticeable change. The researchers state that '*our tag data indicate that exposure to airgun sounds may affect the foraging behavior of sperm whales at exposure levels well below the current 160 dB re1 μPa (rms) threshold used by [the US Government] to predict disruption of behaviour*'.

(SOURCE: Miller, P.J.O., Johnson, M.P., Madsen, P.T., Biassoni, N., Quero, M. and Tyack, P.L. 2009. Using at-sea experiments to study the effects of airguns on the foraging behavior of sperm whales in the Gulf of Mexico. *Deep Sea Research I* 56: 1,168-1,181.)

Shipping

MASKING EFFECTS OF SMALL OUTBOARD BOATS AND IMPLICATIONS FOR WHALEWATCHING GUIDELINES

Digital acoustic tags were first used to demonstrate that free-ranging delphinids in a coastal deepwater habitat are subjected to varying and occasionally intense levels of vessel noise. Vessel noise and sound propagation measurements from a shallow-water habitat were then used to model the potential impact of high sound levels from small vessels (2-stroke and 4-stroke outboard motor boats) on delphinid communication in both shallow and deep habitats, with bottlenose dolphins and short-finned pilot whales as model organisms. At 50m (a standard maximum approach distance for many whalewatching guidelines) and a boat speed of 5 knots, communication ranges for pilot whales were reduced by 58% and for bottlenose dolphins by 26%. At 2.5 knots, however, there was little masking noise. At 10 knots there was approximately a 70% decrease in communication distance for both species at 200m from the boats. At 50m, communication reduction was over 90% for pilot whales and over 80% for bottlenose dolphins. The boats emitted a loud broadband sound when they changed gears, which could occur several times a minute when manoeuvring around the cetacean groups (up to 200dB re 1 μPa pk-pk). Minimising gear changes would help reduce this boat disturbance. Multiple vessels near cetaceans could have additional impacts, as could following groups for long periods of time. This also has implications for researchers – following focal groups, at a close distance in a small boat, is a common method to study small cetacean behaviour. The authors warn that '*the behaviour and noise profiles of research vessels may be a source of potential bias in studies of free-ranging delphinids and should be considered when designing field experiments*'.

(SOURCE: Jensen, F.H., Bejder, L., Wahlberg, M., Aguilar Soto, N., Johnson, M. and Madsen, P.T. 2009. Vessel noise effects on delphinid communication. *Mar. Ecol. Prog. Ser.* 395: 161-175.)

Sonar

US GOVERNMENT PLEDGES TO INCREASE CETACEAN SURVEYS AND FURTHER INVESTIGATE UNDERWATER NOISE MITIGATION MEASURES

The US National Oceanic and Atmospheric Administration (NOAA), in response to a request from the US Council for Environmental Quality, has reviewed and revised its policy on underwater noise and will require more fine-scale boat-based and aerial surveys for cetaceans to gain a better understanding of the number of cetaceans that might be impacted by noise-producing activities (in particular military exercises). Moreover, NOAA will host two workshops. One will discuss the concept of an ocean noise budget, which will include discussion of areas where marine noise from human activities is elevated. A second workshop will work towards identifying marine mammal 'hotspots' and thus recognise important habitats. NOAA will also participate in discussing and negotiating mitigation measures during naval activities.

(SOURCE: Letter from Jane Lubchenco, NOAA Administrator to the US Council for Environmental Quality, 19 January 2010. *http://www.nmfs.noaa.gov/pr/pdfs/permits/lubchenco_letter.pdf.*)

BEAKED WHALE MASS STRANDINGS LINKED WITH NAVAL ACTIVITIES

Several papers in the journal *Aquatic Mammals* addressed beaked whale mass strandings coincident with naval exercises. One study found significant correlations between mass strandings and military exercises both in the Mediterranean and Caribbean. No such relationship was found for mass strandings in Japan or California. A second study, however, noted that 10 mass stranding events in Japan occurred close to a naval facility, even if they did not coincide with a specific exercise. An 11th Japanese stranding was also noted adjacent to a different military facility. The paper listed two stranding events that were definitively linked to sonar use during military exercises (Greece in 1996 and Bahamas in 2000) and 10 mass strandings with coincident naval exercises, although more exact details were not available (Greece in 1997, Italy in 1963, Spain in 1996, Madeira in 2000, and the Canary Islands in 1988, 1989, 1991, 2000, 2002, 2004). Twenty-seven mass stranding events occurred either at the same time naval vessels that could have been using sonar were sighted (Italy in 1963 and 1967, Canary Islands in 1985) or adjacent to naval facilities (the 11 Japanese strandings noted above, six mass strandings in Alaska, four in Puerto Rico, and one each in Hawaii, southern California and Key West, Florida). Eighty-one beaked whale mass strandings could not be associated with US naval bases or military exercises, although other military sonar sources could not be ruled out. Most (126 out of 136) beaked whale mass stranding events recorded since 1874 have occurred since the development of mid-frequency sonar. A third paper investigated gray whale stranding in relation to naval exercises off the Californian coast. Of a total of 180 stranding events identified between 1982 and 2007, approximately 40 coincided with naval exercises (*c.* 22%), but statistical analysis showed that stranding rates during naval exercises involving anti-submarine warfare were not significantly different from those during non-exercise periods.

(SOURCES: D'Amico, A.D., Gisiner, R.C., Ketten, D.R., Hammock, J.A., Johnson, C., Tyack, P.L. and Mead, J. 2009. Beaked whale strandings and naval exercises. *Aquat. Mamm*. 35: 452-472; Filadelfo, R., Mintz, J., Michlovich, E., D'Amico, A.D., Tyack, P.L. and Ketten, D.R. 2009. Correlating military sonar use with beaked whale strandings: what do the historical data show? *Aquat. Mamm*. 35: 435-444; Filadelfo, R., Pinelis, Y.K., Davis, S., Chase, R., Mintz, J., Wolfganger, J., Tyack, P.L., Ketten, D.R. and D'Amico, A.D. 2009. Correlating whale strandings with navy exercises off Southern California. *Aquat. Mamm*. 35: 445-451.)

BEAKED WHALES MORE LIKELY VULNERABLE TO NITROGEN-RELATED PATHOLOGIES THAN OTHER SPECIES

A model based on known physiological data was used to predict nitrogen levels in blood and tissues in three beaked whale species (Blainville's and Cuvier's beaked whales, and northern bottlenose whales). Dive length and diving lung volume had a large effect on nitrogen levels at the end of a dive; these species may generally have high levels of dissolved nitrogen in their tissues, making them vulnerable to decompression sickness, or the bends. Thus, nitrogen levels in tissues may end beaked whale dives before a lack of oxygen does. Moreover, the diving behaviour of Cuvier's beaked whales resulted in higher nitrogen levels, potentially explaining why this species in particular has been associated with strandings coincident with military exercises. Another paper examined the hypothesis that high levels of dissolved nitrogen (i.e. supersaturation) in cetacean blood leads to gas emboli or 'bubble lesion' formation when ascending into shallow waters. A trained common bottlenose dolphin performed 10-12 serial dives in a row with one minute gaps between dives, to depths of 30, 50, 70 and 100m, with the dolphin staying at each depth for 90 seconds. Blood samples and ultrasounds of blood vessels revealed no significant change. The results '*do not support the hypothesis that [nitrogen] supersaturation during repetitive dives contributes to [gas emboli] formation in the dolphin*', at least for bottlenose dolphins during normal diving behaviour. In the case of beaked whale strandings and cetaceans caught in nets, however, a rapid ascent may be one cause of bubble lesions.

(SOURCES: Hooker, S.K., Baird, R.W. and Fahlman, A. 2009. Could beaked whales get the bends? Effect of diving behaviour and physiology on modelled gas exchange for three species: *Ziphius cavirostris*, *Mesoplodon densirostris* and *Hyperoodon ampullatus*. *Respir. Phys. Neurobiol*. 167: 235-246; Houser, D.S., Dankiewicz-Talmadge, L.A., Stockard, T.K. and Ponganis, P.J. 2010. Investigation of the potential for vascular bubble formation in a repetitively diving dolphin. *J. Exp. Biol.* 213: 52-62.)

TEMPORARY THRESHOLD SHIFTS FROM SONAR EXPOSURE IN A CAPTIVE COMMON BOTTLENOSE DOLPHIN

A study using actual recordings of mid-frequency sonar sound resulted in TTS lasting 20-40 minutes in a trained, captive common bottlenose dolphin at a SPL of 203dB (rms) or a SEL of 214dB re: 1 μPa^2 s. Considering the source level of standard mid-frequency sonar systems, this animal would had to have been 40m from the sound source for approximately 2 minutes for TTS to be induced. If the animal was closer, then TTS would have been induced within a shorter period, and conversely if further away a proportionately longer sound exposure would have been required. It was concluded that '*mid-frequency sonar can induce at least temporary physiological hearing loss in odontocete cetaceans, although repeated exposures are necessary to generate effects*'. However, the authors note '[*t*]*he results do not preclude other noise or sonar-induced effects on marine mammals, which may occur at lower sound levels*'.

(SOURCE: Mooney, T.A., Nachtigall, P.E. and Vlachos, S. 2009. Sonar-induced temporary hearing loss in dolphins. *Biol. Lett.* 5: 565-567.)

Offshore wind farms

HARBOUR PORPOISES LIKELY DISPLACED BEYOND 20KM FROM WIND FARM CONSTRUCTION SITE

The possible acoustic impacts of wind farms were assessed with regard to pile-driving during turbine construction. Acoustic recording devices (T-PODs) were placed at 7 and 20km from the construction site. During pile driving, acoustic detections of harbour porpoises decreased. There was no significant difference in the detection rates at 7 *versus* 20km. The '*size of the zone of responsiveness could not be inferred as no grading in response was observed with distance from the pile driving site but must have exceeded 21km*'. Porpoises were detected within the wind farm area during pile driving (although detection rates of porpoises within the farm were much lower than outside, whether pile driving was occurring or not). This suggested habituated/noise-tolerant harbour porpoises within the wind farm area.

(SOURCE: Tougaard, J., Carstensen, J., Teilmann, J., Skiv, H. and Rasmussen, P. 2009. Pile driving zone of responsiveness extends beyond 20km for harbor porpoises (*Phocoena phocoena* (L.)). *J. Acoust. Soc. Am.* 126: 11-14.)

IMPACTS OF WIND TURBINE NOISE PROBABLY MINIMAL

A study measuring the noise from three types of offshore wind turbines concluded that noise from rotating turbine blades would not adversely impact marine mammals, including harbour porpoises, because virtually all of the in-air noise would reflect off the ocean's surface. However, vibrations generated by machinery would likely be transmitted via the seabed and out into the water. Ambient noise masked most of the sound so generated, except for frequencies below 500Hz (with SPLs of 109-127dB re 1μPa rms at a distance of 14-20m from the turbines' foundations). Harbour porpoise audiograms indicate that wind turbine sounds would be audible at 20-70m (potentially several kilometres for harbour seals). It was concluded that acoustic masking would be unlikely and that sound levels would not be high enough to cause significant acoustic impact (e.g. TTS), although behavioural changes might occur close to the turbines.

(SOURCE: Tougaard, J., Henriksen, O.D. and Miller, L.A. 2009. Underwater noise from three types of offshore wind turbines: Estimation of impact zones for harbor porpoises and harbor seals. *J. Acoust. Soc. Am.* 125: 3,766-3,773.)

Masking

HUMPBACK WHALES IN NOISY ENVIRONMENTS CHANGE BEHAVIOUR

If ambient noise increased (in this example, due to increasing wind speeds), humpback whales in Australia adopted more surface active behaviour. It was suggested that this behaviour (e.g. breaching) allowed communication in noisier environments. This has implications with regard to anthropogenic noise – humpback whales might adopt more surface active behaviour during breeding, which could have an energetic cost.

(SOURCE: Dunlop, R.A., Cato, D.H. and Noad, M.J. 2009. Your attention please: increasing ambient noise levels elicits a change in communication behaviour in humpback whales (*Megaptera novaeangliae*). *Proc. Royal. Soc. B*: In press.)

VARYING LEVELS OF NOISE ALONG RIGHT WHALE MIGRATION ROUTE COULD AFFECT BREEDING SUCCESS

'Pop up' acoustic recorders monitored ambient noise levels and calls of North Atlantic right whales in three areas along the whale's migration route: the Bay of Fundy, Cape Cod and Georgia. When whales produced louder calls, it was related more to peak noise levels than to the average ambient noise level in an area. Ambient levels were over 105dB re 1μPa in the frequency range of right whale calls (i.e. 50-350Hz) 20-30% of the time in Georgia (winter) and 53-63% of the time in Cape Cod, with the loudest location, the Bay of Fundy, having this level 85-95% of the time (summer). This high level in summer might affect reproduction by masking communication calls.

(SOURCE: Parks, S.E., Urazghildiiev, I. and Clark, C.W. 2009. Variability in ambient noise levels and call parameters of North Atlantic right whales in three habitat areas. *J. Acoust. Soc. Am.* 125: 1,230-1,239.)

Species glossary

Atlantic white-sided dolphin	*Lagenorhynchus acutus*
Beluga (white) whale	*Delphinapterus leucas*
Blainville's beaked whale	*Mesoplodon densirostris*
Bowhead whale	*Balaena mysticetus*
Common bottlenose dolphin	*Tursiops truncatus*
Common dolphin, short-beaked	*Delphinus delphis*
Cuvier's beaked whale	*Ziphius cavirostris*
Fin whale	*Balaenoptera physalus*
Gervais' beaked whale	*Mesoplodon europaeus*
Gray whale	*Eschrichtius robustus*
Harbour porpoise	*Phocoena phocoena*
Humpback whale	*Megaptera novaeangliae*
Killer whale	*Orcinus orca*
Narwhal	*Monodon monoceros*
North Atlantic right whale	*Eubalaena glacialis*
Northern bottlenose whale	*Hyperoodon ampullatus*
Pilot whale, short-finned	*Globicephala macrorhynchus*
Sperm whale	*Physeter macrocephalus*
Grey seal	*Halichoerus grypus*
Harbour seal	*Phoca vitulina*
Harp seal	*Pagophilus groenlandicus*
Steller sea lion	*Eumetopias jubatus*
Northern fulmar	*Fulmarus glacialis*
Polar cod	*Boreogadus saida*

Glossary of terms

Auditory evoked potential: An electrical response recorded from the auditory nerves following presentation of an acoustic stimulus.

Benthic: Of or related to the bottom level of the ocean, including the sediment or ocean floor.

Bioaccumulation: Increase in concentration of a pollutant within an organism over time.

Biogenic: Resulting from biological activity or living organisms.

Biomass: The total mass of living organisms in an area or ecosystem.

Biota: The plant and animal life of a region.

Brucella: Various species of bacteria that cause the disease brucellosis.

Calcareous: Mostly or partly composed of calcium carbonate.

Carrying capacity: The maximum population number of a species that an ecosystem can sustain indefinitely.

dB: Decibel – a logarithmic measure of sound pressure level.

DDT: The organochlorine pesticide dichlorodiphenyl-trichloroethane that tends to accumulate in the ecosystem and in the blubber and certain internal organs of cetaceans.

Delphinid: Of the family *Delphinidae* (dolphins).

Diatom: Common type of phytoplankton, a one-celled alga encased in a silica cell wall.

Emboli: Plural of embolus, a clot (of blood or other material) in a blood vessel leading to circulation blockage.

Endemic: Found only in a particular geographic region.

Hg: Mercury.

Hz: Hertz, a measure of sound frequency (pitch), in wave cycles per second (kHz = 1,000 Hertz).

Lobomycosis: A chronic fungal infection of the skin affecting humans in South America and two species of dolphins.

Masking: A phenomenon wherein the frequency and intensity of ambient noise covers up or 'masks' a biologically important signal, making it undetectable by a receiver.

Morbillivirus: A family of viruses that are typically highly infectious and pathogenic – the family includes measles, dog distemper and dolphin morbillivirus. A number of mass mortality events have been associated with viruses from this family.

MPA: A marine protected area.

Organochlorine: Organic compounds that contain chlorine. Many are toxic and used as pesticides. Most of these compounds persist in the environment (are not biodegradable) and also tend to accumulate in fatty tissue (e.g. blubber) of cetaceans and other marine organisms.

PAHs: Polycyclic aromatic hydrocarbons, which occur in oil, coal and tar deposits, and are produced as byproducts of fuel burning.

Papillomavirus: A family of viruses that can cause warts and may be a causative factor in some cancers.

Pathogen: A disease-causing agent (e.g. bacterium, virus).

PBDE: Polybrominated diphenyl ether(s), a widely used class of flame retardants in textiles, furniture upholstery and plastics.

PCB: Polychlorinated biphenyls (209 different forms that contain differing numbers of chlorine atoms arranged in various positions on the aromatic rings) are industrial organochlorines that were manufactured to be used in electrical transformers and other applications. These man-made chemicals do not occur naturally and all traces reflect pollution.

Phytoplankton: Free-floating marine plants (*versus* zooplankton – free-floating marine animals).

Picoplankton: Very small phytoplankton (less than 2μm in diameter).

POP: Persistent organic pollutants, organic compounds that are resistant to degradation and thus persist in the environment.

ppm: Parts per million.

Sound pressure level: A measure of the intensity of sound, in decibels.

Temporary threshold shift: Temporary hearing loss.

Toxoplasma gondii: A parasitic one-celled organism that causes the disease toxoplasmosis.

Zoonotic: Capable of zoonosis. Zoonoses are infectious diseases that can be transmitted from vertebrate animals to humans or in the reverse direction.

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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. Commn* 48:48-49.

International Whaling Commission. 1999. Chairman's Report of the Fiftieth Annual Meeting. Appendix 6. IWC Resolution 1998-5. Resolution on environmental changes and cetaceans. *Ann. Rep. Int. Whaling 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. Whaling 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].

Annex K1

Report of the Working Group on Ecosystem Modelling

Members: Ferguson (Convenor), Acquarone, Aruna, Baba, Bejder, Bjørge, Bravington, Butterworth, Campbell, Cañadas, Carvalho, Castellote, Charrassin, De Moor, De Stephanis, Edwards, Elvarsson, Ensor, Funahashi, Gales, Gallego, Goodman, Hammond, Jaramillo-Legorreta, Jérémie, Kasuya, Kitakado, Kelly, Kock, Leaper, Lehodey, Liebschner, Lovell, Luna, Lusseau, Lyrholm, Moore, Murase, Nelson, Øien, Okada, Okamura, Palka, Panigada, Podestá, Punt, Ridoux, Roel, Rojas-Bracho, Rowles, Stachowitsch, Uoya, Uozumi, Urbán, Víkingsson, Wade, Walløe, Weinrich, Werner, Williams, Yamakage, Yasokawa, Young, Zerbini.

1. CONVENOR'S OPENING REMARKS

Ferguson welcomed the members of the Ecosystem Modelling Working Group (hereafter, Working Group) and noted that the Committee had not received any primary ecosystem modelling papers this year. Therefore, the convenor, in collaboration with Gales, had taken this as an opportunity to propose a review of some ecosystem modelling approaches outside of the IWC. To motivate discussion the convenor invited Patrick Lehodey to present his ecosystem modelling research relating to tuna population dynamics and climate change, and also to provide an overview of the Climate Impacts on Oceanic Top Predators (CLIOTOP) project. Additionally, the convenor selected recently published papers on various aspects of marine ecosystem modelling to review and discuss. Item 13.2 from the Draft Scientific Committee Agenda ('Review issues related to functional responses') was not on the revised Working Group Agenda because the Committee had not received any relevant papers on the subject; nevertheless, this topic is still considered important for future discussions in this Working Group.

2. ELECTION OF CHAIR

Ferguson was elected Chair.

3. ADOPTION OF AGENDA

The Agenda is given as Appendix 1.

4. APPOINTMENT OF RAPPORTEURS

Leaper agreed to act as rapporteur.

5. REVIEW OF AVAILABLE DOCUMENTS

Documents considered for discussion were SC/62/EM1, Lehodey *et al.* (2008); Lehodey and Senina (2009); Allen and Fulton (2010); Buckley and Buckley (2010); Lehodey *et al.*(2010a; 2010b) and A'Mar *et al.* (2009).

6. REVIEW ECOSYSTEM MODELS RELEVANT TO THE COMMITTEE'S WORK

6.1 Ecosystem modelling of top marine predators

A general presentation of recent developments and applications of the SEAPODYM model was provided by Lehodey. SEAPODYM was developed for prediction and analysis of spatio-temporal dynamics of tuna populations under the influence of environment and fishing pressure (Lehodey *et al.*, 2008). It has been applied to skipjack, bigeye, yellowfin and albacore in the Pacific Ocean (Lehodey and Senina, 2009).

The first model component, the Mid-Trophic Level (MTL) model (Lehodey *et al.*, 2010a) provides key variables to investigate and model the feeding and spawning habitat of large oceanic species, tuna in particular. These habitats are defined in SEAPODYM and used with the temperature and oceanic currents to control population dynamical processes (both spatial and temporal) such as movement to the feeding or spawning grounds, natural mortality and predation. There is ongoing work to develop acoustic data in the MTL model and thus to optimise the parameterisation of energy transfer coefficients between primary production and the functional groups.

The feeding habitat index is computed based on the accessibility of species (by life stage) to the different functional groups of forage, and the physical conditions (temperature and oxygen) of the vertical layers inhabited by these groups during day and night. The habitat is used to constrain the movement of animals with a system of diffusion-advection equations simulating random and directed movements. A simplified version (i.e. for a single cohort) of the habitat and movement sub-models has been developed using likelihood approaches to obtain the best estimates of feeding habitat and movement parameters based on electronic tagging data in the model. A first application has been successfully conducted with bluefin tuna in the North Atlantic. A further development will be to combine this likelihood component to those associated to catch and length frequency data that are already used to achieve optimal parameter estimates in applications to the whole population dynamics and fisheries (Senina *et al.*, 2008). The current parameter estimation approach consists of minimising a cost function (i.e. a negative log-likelihood) that includes both predicted and observed catch on the original resolution (usually 1x1 degrees for pole-and-line and purse-seine fisheries and 5x5 degrees for long liners), as well as sampled *versus* computed relative length frequencies available at a more coarse resolution (5x5 degrees up to 10x20 degrees).

The type of results produced with applications for the entire spatial population dynamics of a given species were described using the cases of Pacific skipjack and bigeye tuna. To evaluate the capacity of the model to capture the essential features of the dynamics of the tuna species, hindcast simulations back to the early 1960s were carried out with the fixed 'best-parameterisation' achieved from optimisation experiments in a different time period. Predicted catches based on observed fishing effort were compared to observed catches. Predicted biomass trends were also compared to the estimates from the stock assessment model (MULTIFAN-CL) used for tuna stock assessment studies by the WCPFC. Finally, projections based on future oceanic conditions can be simulated once the optimal parameterisation has been achieved and evaluated.

The discussion focused on the general issues of model fits and validation. Some members noted that previous attempts to link environmental variability to recruitment had generally been unsuccessful. Where short-term relationships between environment and recruitment had been found, these had not persisted through longer time series. They suggested a need for a statistical evaluation of recruitment deviations and cross-validation for the type of modelling approach described. In response, Lehodey noted that optimisation was an issue but that the approach had produced parameter estimates for a number of species that were plausible. The relatively simple mechanisms within the model had allowed sensitivity tests to initial parameterisation through small perturbations of the initial inputs. A number of features were noted that might make the trophic level approach that was applied to tuna more difficult to apply to whales. The movement models rely on a response to parameter gradients. The wider envelope of whales' tolerance to physical factors and their ability to store large amounts of energy in blubber likely make whales less responsive to such gradients. In addition, movement data for whales are still difficult to obtain despite advances in telemetry in recent years.

The group also considered Buckley and Buckley (2010) which contrasted phenomenological and mechanistic ecosystem models. The authors asserted that 'the success of phenomenological models relies on constancy in the processes that produce the described pattern,' and that 'environmental change is likely to drive deviations from this assumption, lending imperatives to developing more mechanistic approaches.' Furthermore, the authors highlighted the importance of individual species' ability to adapt and to find 'loopholes' to 'get around the rules' of biology, and they questioned whether scaling laws or allometric relationships can adequately describe the dynamics of a species or community. They concluded by saying that understanding the critical processes and mechanisms underlying the dynamics of marine populations is necessary in order to advance the rate of progress in modelling those dynamics.

One member believed that current understanding was insufficient for mechanistic models to have a high chance of success and that empirical methods are more likely to yield results of relevance to management. He also suggested that fitting models to data was preferable to the approach of attempting to quantify uncertainty by selecting parameters from distributions.

Selecting an appropriate level of complexity has been a fundamental issue for a number of modelling approaches considered by the Committee in previous years. Two papers examining the trade-offs related to different levels of complexity were considered by the group.

Hannah *et al*. (2010) advocated the use of marine ecosystem models of intermediate complexity. Drawing from the field of complexity theory, the authors asserted that one promising approach to marine ecosystem modelling is founded on the philosophy of 'a willingness to sacrifice process detail in order to increase the number of interacting components.' The authors added that ecosystem models should be judged not only by the accuracy of their predictions but also by their ability to provide ecological insight. Finally, the authors suggested that validation of complex models, such as marine ecosystem models, should shift away from a comparison of point data and move towards determining whether the models capture the main features and statistics of the ecosystem structure.

Allen and Fulton (2010) provided a critique of the intermediate model approach described by Hannah *et al*. (2010) to model marine ecosystems. Specifically, Allen and Fulton (2010) stated that the 'fundamental weakness of the intermediate model approach is that it may end up producing models that are over general and therefore not useful.' They recommended following the middle-out (or rhomboid) approach, in which the greatest resolution (spatial, temporal, ecological) is allocated to the trophic resolution of interest, and the rest of the ecosystem is modelled with less resolution via a hierarchical approach. In short, the authors stated that 'the crux of the issue is that models should be constructed at an appropriate level of complexity to address the hypothesis being tested and the data available to support it.'

6.2 Review status of papers from the joint CCAMLR-IWC Workshop

The IWC and CCAMLR held a joint Workshop to review input data for Antarctic marine ecosystem models at the CCAMLR headquarters in Hobart, Australia in August 2008 (IWC and CCAMLR, 2010). The terms of reference for the workshop were to consider the types, relative importance and uncertainties associated with input data for models of the Antarctic marine ecosystem that could be developed for providing management and conservation advice relevant to CCAMLR and the IWC. Prior to the workshop, expert groups had been assembled to prepare thorough reviews of existing data on the physical and biological components of the ecosystem for a number of taxa (including toothed and baleen whales), sea ice and ocean processes. It had been decided not to produce a book of the proceedings but that they should be published in the appropriate journals of CCAMLR and IWC. There were two papers on whales, a review of baleen whales and a review of odontocetes. Both were submitted to the IWC journal and one is in press.

7. CLIOTOP (CLIMATE IMPACTS ON OCEANIC TOP PREDATORS)

7.1 Introduction to CLIOTOP

CLIOTOP is a global project that functions on a regional scale, and is implemented under the IGBP international research programmes GLOBEC (*http://www.globec.org*) and IMBER (*http://www.imber.info/regional_activities.html*). It is a unique initiative to facilitate international research between academic institutions and fishing regional management authorities in the framework of well-known international organisations (GLOBEC, IMBER, IGBP, SCOR, IOC) to enhance the understanding of oceanic top predators in their ecosystems in the context of both climate change and fishing, and to develop new tools leading to the evaluation of management strategies. The programme is piloted by a Steering Committee that meets annually.

The project was organised initially around five working groups focused on key processes and scales to be studied:

(1) top predators' early life history;
(2) physiology, behaviour and distribution of top predators;
(3) trophic pathways in open ocean pelagic ecosystems;
(4) synthesis and modelling, prediction of ecosystem states and management indicators; and
(5) socio-economic aspects and management strategies.

A new technical working group has been established to promote the development of Mid-Trophic Automatic Acoustic Sampling (MAAS) to obtain critical missing information on the forage organisms of oceanic top predators.

A preliminary simulation of the impact of climate change based on the IPCC A2 scenario for Pacific skipjack and bigeye tuna had been tested using the modelling approach described by Lehodey in section 6.1 (Lehodey *et al.*, 2010b).

CLIOTOP held its mid-term workshop in Paris, in February 2010, to review the functioning and the achievements of the programme during its first five-year phase (2004-09) and to define the implementation strategy for its second phase (2010-14) under the IMBER programme. This second phase will put more emphasis on developing scenarios of the evolution of oceanic ecosystems under anthropogenic and natural forces in the 21st century in support of international governance. This will necessitate bridging the gaps between climate, ocean physics, biogeochemistry, ecosystems, predators, fisheries, markets and governance. Based on these efforts, quantitative indicators that characterise ecosystem status and the ongoing performance of fishery management systems are required. Only a large international collaborative effort can help in achieving such an ambitious plan. CLIOTOP will thus search to establish links with other related programmes (including other IMBER programmes) and the RFMOs, including the IWC and CCAMLR.

Lehodey suggested that CLIOTOP and IWC share many common interests and both would benefit in the development of collaborations either through formal links between CLIOTOP and a group of RFMOs representatives, or by individual participation of members of the Committee in CLIOTOP activities. Common scientific interests include: study of behaviour of large predators, movements and definition of their feeding habitat, new technological developments in electronic devices for animal tracking, food consumption rates, predation and competition by/between large predators, acoustic monitoring and modelling of prey fields, standardisations of methods and development of easily accessible global databases, various modelling approaches from individual-based models, environmentally explicit stock assessment models, spatially explicit but trophically aggregated models coupled with Ocean-General-Circulation-Models (OGCMs) and Nutrient-Phytoplankton-Zooplankton-Detritus (NPZD) type models. Management issues such as bycatch are also a common interest with IWC.

The Committee welcomed the presentation on CLIOTOP and stressed the importance of the development of collaborative links between multidisciplinary organisations of this type and the IWC Scientific Committee. In particular, the Committee noted the important context that an improved understanding of the effects of changing climate to the higher predators brings to the IWC. The Committee **encouraged** the establishment of collaborations between the IWC and CLIOTOP.

In another study (A'Mar *et al.*, 2009), management strategy evaluation was used to examine the impact of regime shifts in average recruitment on the performance of management strategies for the fishery for walleye pollock (*Theragra chalcogramma*), in the Gulf of Alaska. The current and four alternative management strategies were evaluated. The alternatives included management strategies with different definitions of the average recruitment used when calculating management reference points. The current management strategy, which ignores the possibility of future regime shifts, kept the spawning biomass higher relative to the target level than the other management strategies and had the lowest risk of fishing mortality exceeding the overfishing limit. The sliding-window management strategy achieved the highest catches and the lowest inter-annual variation in catch, although at the cost of a higher risk of the fishing mortality exceeding the overfishing limit.

This study suggested that management strategies relying on empirical data through fisheries statistics appeared to offer better performance than ones that tried to incorporate ecological information. There was some discussion about whether detecting regime shifts might be more useful for species with other life histories, such as whales. Regime shifts may affect recruitment or survival. For whale populations with long time series of data, it has proven possible to detect variations in recruitment, but measuring survival is very difficult. In the context of the RMP, the *CLA* appears to respond adequately to regime shifts. Compared to some fisheries data, the *CLA* has the advantage of a time series of absolute abundance of the exploited population rather than having to make inferences about total numbers from other data. It was suggested that ecological data were of value in constructing and constraining the range of ecosystem models and that such models could be used to inform the operating models used in management strategy evaluations.

It was noted that many of the global climate change models do not produce reliable predictions at the finer spatial scales of fisheries models. Within the CLIOTOP project, there are efforts to develop climate models at finer spatial scales and to connect climate models to biological models. A distinction was made between the general use of such models to understand the overall likely impacts of climate change and models used to provide fisheries management advice. CLIOTOP had attempted to encourage a range of different approaches to ecosystem modelling. The next stage is to define boundaries of realistic modelling predictions across a number of scenarios in order to examine the plausibility of the different approaches.

Linking projects with large data networks in a standardised form, for example telemetry projects for a range of pelagic predators across ocean basins, is critical for this type of modelling work. There are fewer data on movements of individual whales compared to other top predators because of the difficulties of tag attachment. Furthermore, for many whale populations, the location of breeding grounds is still unknown. Whale distribution patterns may also be inferred from passive acoustic monitoring showing the presence of calling animals. Acoustic networks of monitoring devices are being developed within CLIOTOP and also through whale focused programmes such as the Southern Ocean Research Partnerships (SORP).

8. RECOMMENDATIONS ON THE ROLE OF THIS WORKING GROUP WITHIN THE SCIENTIFIC COMMITTEE

The Chair summarised SC/62/EM1, which was intended to start discussion on the role of the Ecosystem Modelling Working Group within the Scientific Committee. She reiterated the distinction between 'tactical' models (e.g. used to set catch limits or make other management advice) and 'strategic' models (e.g. used to simulate an environment in which to test simpler models), pointed to some of the ecological and analytical issues that have been recurrent in Committee discussions to date, and, most importantly, listed several recommendations towards enabling the Committee to evaluate ecosystem models, given the numerous uncertainties inherent in the modelling process. The recommendations are as follows.

(1) Standardised templates should be developed for documenting metadata and analytical techniques.
(2) Performance criteria should be established, including testing model fit to historic or present data and assessing its ability to generate ecologically reasonable predictions into the future.
(3) Sensitivity analyses should be conducted to quantify and perhaps better understand the importance of model inputs (which can guide data collection priorities) and assumptions on model outputs.
(4) The IWC should allow all Scientific Committee members access to the code and relevant background information of ecosystem models considered in informing management decisions. This access would be achieved via the Secretariat.
(5) Ecosystems are complex and dynamic; therefore, the Scientific Committee should explore different ecosystem modelling approaches for a system in order to compare performance across models.
(6) Intersessional meetings should be used, when necessary, to allow in-depth examination of competing models.
(7) Finally, the Working Group should continue to convene every year, or as needed, at the Annual Scientific Committee Meetings to address issues relevant to the Scientific Committee.

The Working Group agreed to these recommendations with the following points of clarification. It was agreed that the full mathematical specification of all models considered in informing management decisions should be made available, but there were some concerns that making code available could impinge upon intellectual property rights. It was noted that the list of recommendations was ambitious and the Working Group should prioritise a subset of items in its work plan. It was suggested that the Working Group should continue to meet annually in order to ensure the Committee remains informed about new developments in the ecosystem modelling field in general and ecosystem models relevant to the management of large whales in particular. It was **emphasised** that the Working Group is an important forum for evaluating ecosystem model inputs, structure, assumptions and predictions related to the work of the Committee. In addition, it is the appropriate body within the Committee for reviewing the ecosystem aspects of ongoing Special Permit whaling programmes.

It was suggested that the activities of the Working Group could be structured around the timetable of upcoming RMP assessments and *Implementations*, such that ecosystem models relevant to a specific stock being assessed will be reviewed prior to the assessment. With this recommendation in mind, the Working Group should consider ecosystem models relevant to North Pacific sei whales, southern hemisphere minke whales and North Pacific minke whales to be of primary importance. The Working Group identified the North Pacific as the region of emphasis for next year's meeting.

It was noted that NAMMCO has initiated a project to compare four different modelling approaches in two areas of the North Atlantic. One of the objectives was to examine the robustness of conclusions across different models. Although still at the planning stage, the Working Group encouraged a paper describing the status of this work to be presented at next year's meeting.

Two additional issues were identified for discussion next year, if primary papers can be prepared in advance: (1) a review of functional responses; and (2) a review of methods for evaluating ecosystem models. The goal for the latter is to develop a document detailing the framework that the Committee will use to guide future ecosystem model evaluations. The aim is to provide model developers with specific details regarding the information required to determine whether the input data and parameters, the model and the resulting predictions should be considered acceptable to inform the work of the Committee.

Several researchers outside the IWC were identified as potential Invited Participants for future meetings based on their expertise in ecosystem modelling. The Working Group agreed to try to engage in informal intersessional discussions with key researchers involved in the ecosystem modelling efforts of the International Council for the Exploration of the Sea (ICES) and the North Atlantic Marine Mammal Commission (NAMMCO), which focus on North Atlantic ecosystems; the Pacific ICES (PICES) and the North Pacific Research Board (North Pacific ecosystems); and CCAMLR (Southern Ocean ecosystems). The goals of these discussions would be to establish a channel for communicating the state of ecosystem modelling science and its feedback into management among these diverse institutions, and to solicit expert feedback from outside the Committee on how ecosystem models could inform management decisions within the IWC.

9. OTHER ECOSYSTEM MODELLING RELATED ISSUES

There were no issues raised under this Agenda Item.

10. WORK PLAN

(1) Review ecosystem models from the North Pacific that may be relevant to assessments and RMP *Implementations*.
(2) Review other issues relevant to ecosystem modelling within the Committee:
    (a) aspects of the report of the 2010 IWC Small Cetaceans and Climate Change Workshop that are relevant to ecosystem modelling;
    (b) status of Southern Ocean ecosystem modelling efforts arising from the 2009 Second Climate Change Workshop; and
    (c) status of Arctic ecosystem modelling efforts arising from the 2009 Second Climate Change Workshop.
(3) Review ecosystem modelling efforts undertaken outside the IWC:
    (a) introduction to NAMMCO ecosystem modelling efforts: description of the ecosystems studied and overview of modelling approaches.

11. REVIEW AND ADOPT REPORT

The report was adopted on 6 June 2010.

REFERENCES

A'Mar, Z.T., Punt, A.E. and Dorn, M.W. 2009. The impact of regime shifts on the performance of management strategies for the Gulf of Alaska walleye pollock (*Thereagra chalcogramma*) fishery. *Can. J. Fish. Aquat. Sci.* 66: 2222-42.

Allen, J.J. and Fulton, E.A. 2010. Top-down, bottom-up or middle-out? Avoiding extraneous detail and over-generality in marine ecosystem models. *Prog. Oceanogr.* 84: 129-33.

Buckley, L.J. and Buckley, L.B. 2010. Towards linking ocean models to fish population dynamics. *Prog. Oceanogr.* 84: 85-88.

Hannah, C., Vezina, A. and StJohn, M. 2010. The case for marine ecosystem models of intermediate complexity. *Prog. Oceanogr.* 84: 121-28.
International Whaling Commission and CCAMLR. 2010. Report of the Joint CCAMLR-IWC Workshop to Review Input Data for Antarctic Marine Ecosystem Models,11-15 August 2008, Hobart, Australia. *J. Cetacean Res. Manage. (Suppl.)* 11(2):541-86.
Lehodey, P., Murtugudde, R. and Senini, L. 2010a. Bridging the gap from ocean models to population dynamics of large marine predators: a model of mid-trophic functional groups. *Prog. Oceanogr.* 84: 69-84.
Lehodey, P. and Senina, I. 2009. An update of recent developments and applications of the SEAPODYM model. Fifth regular session of the Scientific Committee of the Western and Central Pacific Fisheries Commission, 10-21 August 2009, Port Vila, Vanuatu, WCPFC-SC5-2009/EB-WP-10. 44pp.
Lehodey, P., Senina, I. and Murtugudde, R. 2008. A spatial ecosystem and populations dynamics model (SEAPODYM) - modelling of tuna and tuna-like populations. *Prog. Oceanogr.* 78: 304-18.
Lehodey, P., Senini, L., Sibert, J., Bopp, L., Calmettes, B., Hampton, J. and Murtugudde, R. 2010b. Preliminary forecasts of Pacific bigeye tuna population trends under the A2 IPCC scenario. *Prog. Oceanogr.* In press: 14pp.
Senina, I., Sibert, J. and Lehodey, P. 2008. Parameter estimation for basin-scale ecosystem-linked population models of large pelagic predators: application to skipjack tuna. *Prog. Oceanogr.* 78: 319-35.

Appendix 1

AGENDA

1. Convenor's opening remarks
2. Election of Chair
3. Adoption of Agenda
4. Appointment of rapporteurs
5. Review available documents
6. Review ecosystem models relevant to the Committee's work
   - 6.1 Ecosystem modelling of top marine predators
   - 6.2 Review status of papers from the Joint CCAMLR-IWC Workshop
7. CLIOTOP (CLimate Impacts on Oceanic TOp Predators)
   - 7.1 Introduction to CLIOTOP
   - 7.2 Review ecosystem model related to CLIOTOP
   - 7.3 Discuss how the IWC and CLIOTOP might be able to interact in the future
8. Recommendations on the role of this Working Group within the Committee
9. Other ecosystem modelling related issues
10. Work plan
11. Review and adopt report

Annex L

Report of the Sub-Committee on Small Cetaceans

Members: Fortuna (Chair), Amaral, Bamy, Bejder, Bjørge, Brito, Brockington, Brownell, Campbell, Cañadas, Carvalho, Castellote, Cerchio, Chilvers, Choi, Cipriano, Collins, Cozzi, Davies, de Stephanis, Deimer-Schüette, Donoghue, Edwards, Flores, Fossi, Frasier, Funahashi, Gallego, Hammond, Hoelzel, Holm, Hughes, Iñíguez, Jaramillo-Legorreta, Kasuya, Kock, Lang, Larsen, Lauriano, Lens, Liebschner, Lovell, Lusseau, Marcondes, Moore, Muller, Nelson, Ofori-Danson, Palacios, Palka, Panigada, Parsons, Perrin, Podestá, Reeves, Ridoux, Ritter, Roel, Rojas-Bracho, Rosenbaum, Rowles, Simmonds, Solarin, Stachowitsch, Stephane, Štrbenac, Suydam, Taylor, Tchibozo, Tiedemann, Urbán, Vazquez, Vély, Weller, Werner, Williams, Ylitalo, Young, Zerbini.

1. OPENING REMARKS

Fortuna welcomed participants to the meeting noting that, given its location, the priority topic for the sub-committee this year was the review of the status of small cetaceans of northwestern African and eastern tropical Atlantic waters (Fig. 1 and Table 1).

2. ELECTION OF CHAIR

Fortuna was elected Chair.

3. ADOPTION OF AGENDA

The adopted Agenda is given in Appendix 1.

4. APPOINTMENT OF RAPPORTEURS

Reeves acted as main rapporteur, supported by Amaral.

5. REVIEW OF AVAILABLE DOCUMENTS

Documents available for the work of the sub-committee were: SC/62/SM1-12; SC/62/WW4; SC/62/BC6 (only small cetaceans); National Progress Reports; Weir (2006; 2007; 2008; 2009; 2010); Smit *et al.* (2010); Picanço *et al.* (2009); Bamy *et al.* (2010); Van Waerebeek *et al.* (2008a; 2004); Murphy *et al.* (1997); Richard *et al.* (2010); Fertl *et al.* (2003); Flores (2008); Santos *et al.* (2009); Tavares *et al.* (2010); and De Boer (2010a; 2010b).

6. REVIEW OF THE STATUS OF SMALL CETACEANS OF NORTHWESTERN AFRICA AND THE EASTERN TROPICAL ATLANTIC

The West Africa region encompasses 16 countries distributed over an area of approximately 5 million km^2, including the coastlines of Morocco, Mauritania, Senegal, Gambia, Guinea-Bissau, Guinea and Sierra Leone. Further south, the oceanic border of the Gulf of Guinea extends from Cape Palmas in Liberia to Cape Lopez in Gabon (Anon., 1953) and includes the coastlines of 11 countries from Côte d'Ivoire south to Angola and two offshore island states, St Helena (UK) and the Democratic Republic of São Tomé and Príncipe (Weir, 2010). This region features a wide variety of habitat types, from rocky cliffs, broad sandy beaches and extensive seagrass beds in the north, to dense mangrove forests and large deltas and estuaries further south. Coral reefs and powerful coastal upwellings of cold water characterise the Canary and Benguela current systems (Anon., 2008).

The Eastern Tropical Atlantic (ETA) and sub-tropical regions are characterised by complex oceanographic and topographic features. There are a number of oceanographic provinces, encompassing contrasting ecosystems, such as upwelling regions and oligotrophic subtropical gyres. The ETA is the wider province. The ETA extends from Cap Vert peninsula (Dakar, Senegal) south to the Cunene River (southern Angola) and includes the tropical offshore islands. The Benguela Current, which originates in the central Atlantic and Indian Oceans, brings cold, nutrient-rich water northwards along the coasts of Namibia and South Africa (Hardman-Mountford *et al.*, 2003).

Weir and Van Waerebeek both prepared documents for this meeting and are authors/co-authors of many relevant published papers but were unable to attend the meeting, so their contributions were summarised by other participants. The sub-committee was pleased to have the benefit of participation by scientists from Nigeria (Solarin), Ghana (Ofori-Danson) and Benin (Tchibozo). Unfortunately Segniagbeto (Togo) and Uwagbae (Nigeria) were not able to attend, but they did send information on the occurrence of cetaceans in Togo and Nigeria.

Weir (2010) reviewed cetacean occurrence (sightings, strandings, direct captures, bycatch) in West African waters from the Gulf of Guinea to Angola based mainly on the published literature, providing an update of the 1997 review by Jefferson *et al*. (1997). At least 21 odontocetes (including at least 17 delphinids) have been documented in the study region. A warm temperate and tropical deep-water cetacean community dominates the area. Cooler water from the Benguela Current influences southern Angola (16°S latitude). Angola, with 21 confirmed species, appears to have the most diverse cetacean community in the region. Only three or fewer species have been confirmed in the waters of Togo, Nigeria, Cameroon and the Democratic Republic of Congo. Seventeen or more species have been documented in Ghana, Gabon and Angola, where dedicated cetacean research projects have been initiated in recent years. Common bottlenose dolphins and Atlantic spotted dolphins have been recorded in more than half of the countries. Weir (2010) stressed that West Africa's cetacean fauna faces a number of threats including bycatch and direct capture for human utilisation (e.g. in Ghana and Togo) as well as potential effects of oil and gas development on them and their habitats.

SC/62/SM9 reviewed recent information on humpback dolphins in Gabon and Republic of Congo. Between Port Gentil, Gabon and the Congo border with Cabinda (Angola) the coast is exposed and generally uniform with a few minor capes and embayments providing shelter from prevailing south-westerly swells. Large inshore lagoon systems are prominent and these typically open to the sea via narrow and dynamic tidal inlets that occasionally close. The lagoon systems include mangrove and seasonally flooded swamp forests and provide excellent nursery habitat for fishes and crustaceans. Gabon and Congo have large and diverse national park systems that include protected coastal habitat. Four of these parks have a marine component, including the exclusively marine Mayumba National Park and the Conkouati-Douli National Park (CDNP) in Congo.

Dedicated small boat surveys for humpback dolphins were completed between 2004 and 2006 in the environs of Libreville and Mayumba National Park. These were always of short duration (a few days) and conducted using a variety of small boats. Initial efforts focused on areas considered favourable for humpback dolphins based on published reports. A dual focus beach survey design facilitated both fisheries and dolphin-specific sightings data to be collected. Observers walked predefined sections of the shore and made dedicated searches approximately every 500m from the highest available point (typically the beach crest or backshore) using the naked eye and binoculars. They also searched whilst walking between stations. Observers focused on the area from the beach to approximately 500m offshore and recorded any marine mammals sighted. The boat surveys covered over 5,000km but only yielded five sightings of *Sousa*. A sighting of 30-40 individuals was made on 16 November 2003 near Petit Loango, Gabon. Beach surveys from March to December 2009 resulted in a total of 136 hours of dedicated search effort, of which 16 hours were spent watching dolphins. A total of 38 humpback dolphin sightings were reported during the nine month survey period (total individuals=408, average=13, median=10, maximum=35). Sighting rates, when compared to boat-based work, were much higher and included an apparent peak in sighting rates during July and August. Large groups were also observed from shore. All sightings made during this work were within 1km of shore and, thus, the animals would be at least nominally protected by either the coastal fisheries buffer exclusion zone or the national park rules. The degree to which the species is afforded protection within these areas, however, remains uncertain. Given the low human population densities and the extent of relatively undisturbed habitat in Gabon and northern Congo, this region may represent a stronghold for the species. The relatively high sighting rate is encouraging, as are occasional sightings of large groups. However, bycatch and evidence of dolphins in the bushmeat trade give cause for concern, particularly as the demand for fish in cities increases. Review of the available control post logbooks for bushmeat at CDNP revealed four separate incidents of dolphin bushmeat seizures. Since the meat was smoked in each case, the species identification and precise provenance of each item could not be reliably ascertained.

However, the beach observation team found four bottlenose dolphin carcasses and one Atlantic humpback dolphin carcass. The latter had been captured at the coastal fishing village of Paris and was seen being butchered and distributed amongst fishermen for consumption almost as soon as it was landed.

The sub-committee commended the authors for their efforts in the Gabon-Congo area and **recommended** that research, monitoring and conservation efforts for humpback dolphins along the coast of Gabon and Congo continue.

SC/62/SM12 presented a general overview of fisheries in Nigeria and some information on confirmed presence of cetacean species there. Cetaceans occur throughout Nigerian coastal waters in the Gulf of Guinea, but there has been little directed cetacean research and much of what is known comes from opportunistic observations by marine mammal observers aboard fishing vessels. The rich and diverse marine fish and shellfish populations in Nigerian coastal waters show signs of over-exploitation out to depths of about 50m where trawl fisheries are concentrated. Manatees (*Trichechus senegalensis*) and sea turtles are intensively exploited by artisanal fishermen. The manatees are taken in gillnets and trigger traps and the sea turtles in gillnets or while on the beach during nesting. The industrial shrimp trawl nets are fitted with turtle excluder devices, which according to Solarin, prevent the capture of turtles, large fish and cetaceans. Uncontrolled trawling operations contribute to habitat degradation. Also the high volume of solid waste and debris in trawl nets towed at depths of up to 100m signifies the indiscriminate dumping of non-biodegradable nylon and plastic products and household items. Governments are installing some facilities to encourage the recycling of domestic waste, especially pure water sachets.

Solarin stated that it would be desirable to have a multipurpose fisheries and oceanographic vessel for research in both the territorial and high seas. International and regional collaboration should be encouraged for resource surveys. A uniform regime of enforcement is needed in the region and this would be more achievable if compatible vessel monitoring systems were in place. Solarin emphasised that poaching should be curbed and that illegal, unregulated and unreported fishing practices should be deterred. An ultimate goal of fisheries management, according to Solarin, should be to achieve an ecosystem approach with participation by all stakeholders.

Solarin also drew the sub-committee's attention to a recent publication on bycatch of protected species carried out in the framework of a large-scale series of interview surveys in 2007 and 2008 in fishing communities from seven countries: Sierra Leone, Cameroon, Nigeria, Tanzania, Comoros, Malaysia and Jamaica (Moore *et al.*, 2010). During the interviews in Nigeria, no reported records on cetacean bycatch were obtained, whereas considerable information was obtained on bycatch of manatees and sea turtles. It was acknowledged that a zero bycatch rate in Nigeria was not credible, given that interview-based information from Nigerian fishermen obtained outside of the study indicated that cetacean bycatch does occur.

The sub-committee noted that the interview coverage in Nigeria was extremely low (only 648 fishermen were interviewed out of more than 700,000 existing full-time fishermen in the country).

Moore *et al.* (2010) provided information on reported cetacean bycatch in Sierra Leone (the unconfirmed list of species included *Sousa teuszii, Stenella* sp. *Tursiops truncatus, Steno bredanensis, Delphinus* sp. *Globicephala* sp. *Kogia* sp.) and Cameroon (species not identified).

SC/62/SM1 reported on an interview survey carried out in Nigeria among artisanal fishermen from Brass Island, Niger Delta, in 2008-09. This survey revealed, for the first time, regular takes of delphinids in Nigerian coastal waters. Three fishermen at Imbikiri, Brass Island, were identified as dedicated 'dolphin hunters'. One intentional catch of a bottlenose dolphin (*T. truncatus*) was documented. Average catch per dolphin hunting trip was reported as 25 adults, once every 12 weeks, with a dolphin selling for an equivalent of EUR 150-300. Under such a regime, a hunter could take more than a hundred dolphins each year. Most of the meat is used for human consumption. Boats are locally-manufactured open, wooden canoes powered by outboard engines. SC/62/SM1 concluded that considering the widespread consumption of bushmeat in West Africa, including cetaceans or so-called

Table 1

Occurrence of small cetacean species in the priority region.

Country name (north to south)	Cetacean species (see codes below) 1 *Pp*	2 *Pc*	3 *Fa*	4 *Oo*	5 *G me*	6 *G ma*	7 G sp	8 *Pe*	9 *Gg*	10 *Sb*	11 *St*	12 *Tt*	13 *Sa*	14 *Sf*	15 *Sl*	16 *Scl*	17 *Sc*	18 *Lh*	19 *Dd*	20 *Dc*	21 D sp	22 *Ks*	23 *Kb*	24 *Zc*	25 *Me*	Human utilisation^
Morocco	Y	Y	-	Y[7]	Y	Y[7]	-	-	Y	-	Y[7]	Y[7]	-	-	-	-	Y[7]	-	Y	-	Y	-	-	Y	Y[10]	
Canary Islands	Y[10]	Y[2]	-	Y[2]	Y[10]	Y[22]	-	-	Y[10]	Y[22]	-	Y[22]	-	Y[22]	Y[10]	-	Y[7]	Y[10]	Y[22]	-	-	Y[10]	Y[10]	Y[10]	Y[10]	
Mauritania	Y[8]	-	-	Y[8]	-	Y[8]	-	Y[8]	Y[8]	S	Y[8]	Y[8]	-	Y[9]	Y	Y[6, 8]	Y[8]	-	Y	Y	Y[8]	Y[8]	Y[8]	Y[8]	Y[8]	Yes[5, 13]
Cape Verde	-	Y[3]	-	Y	-	Y[3]	-	Y[3]	Y	Y[3]	-	Y	S	S[4]	Y	-	-	-	-	-	Y	-	-	Y	-	Yes[31]
Senegal	Y[11]	-	Y[11]	Y[11]	-	Y[11]	-	Y[11]	-	Y[11]	Y[11]	Y[11]	S[11]	S[11]	Y[11]	Y[6]	Y[11]	-	Y[11]	Y[11]	-	Y[11]	Y[11]	-	-	Yes[5, 13]
The Gambia	-	-	-	-	-	-	-	-	-	-	Y[12]	Y[12]	-	-	-	Y[12]	-	-	-	-	-	-	-	-	-	Yes[12, 13]
Guinea-Bissau	-	-	-	-	-	-	-	Y[3]	-	-	Y[5]	Y[13]	-	-	-	-	-	-	-	-	-	-	-	-	-	
Guinea-Conakry	-	-	Y[1]	-	-	Y[14]	-	-	-	Y[14]	Y[14]	Y[14]	S[14]	Y[14]	-	-	-	-	Y[14]	-	-	-	Y[14]	-	-	Yes[5, 13, 14]
Sierra Leone	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Liberia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Ivory Coast	-	Y[19]	-	-	-	-	-	-	-	-	-	Y[13]	-	Y[4]	-	-	-	-	-	-	-	-	-	-	-	Yes[13]
Ghana	-	Y[19]	Y[27]	Y[27]	-	Y[27]	-	Y[27]	Y[27]	Y[27]	-	Y[27]	Y[27]	Y[27]	Y[27]	Y[27]	-	Y[27]	S[27]	S[27]	Y[27]	Y[27]	-	Y[27]	-	Yes[5, 27]
Togo	-	-	-	Y[28]	-	-	Y[28]	-	-	-	-	Y[13]	Y[28]	S[4]	-	-	-	-	-	-	Y[28]	-	-	-	-	Yes[28]
Benin	-	Y[15]	-	-	-	-	-	-	-	-	-	Y[15]	-	Y[15]	-	-	-	-	-	-	Y[15]	-	-	-	-	
Nigeria	-	-	-	-	-	Y[24]	-	-	-	-	S[5]	Y[30]	U[5]	S[4]	-	S[5]	-	U[19]	Y[23]	-	-	S[5]	-	-	-	Yes[30]
São Tomé/Principe	-	-	-	Y[25]	-	-	Y[25]	-	-	-	-	Y[25]	Y[25]	Y[4]	-	-	-	-	-	-	-	-	-	-	-	
Cameroon	-	-	-	Y[18]	-	-	-	-	-	-	Y[29]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Equatorial Guinea	-	-	-	-	-	-	-	-	-	-	S[5]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Gabon	-	Y[16]	-	Y[18]	-	Y[23]	-	-	-	-	Y[29]	-	Y[16]	Y[16]	-	-	-	-	Y[16]	-	-	-	-	-	-	Yes[13]
Rep. of Congo	-	-	-	-	-	-	-	-	-	-	Y[29]	-	-	-	-	Y[20]	-	-	-	-	-	-	-	-	-	Yes[29]
Cabinde	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Dem. Rep. of Congo		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
St Helena	-	-	-	-	-	-	-	-	-	-	-	-	-	Y[27]	-	-	-	-	-	-	-	-	-	-	-	
Angola	-	Y[19]	S[19]	Y[18]	-	-	Y[19]	Y[19]	Y[19]	Y[19]	Y[26]	Y[26]	Y[23]	Y[23]	-	Y[20]	Y[23]	Y[19]	-	-	Y[20]	Y[23]	-	Y[23]	-	Yes[26]

Species codes and numbering

1. Harbour porpoise (*Phocoena phocoena*); 2. False killer whale (*Pseudorca crassidens*); 3. Pygmy killer whale (*Feresa attenuata*); 4. Killer whale (*Orcinus orca*); 5. Long-finned pilot whale (*Globicephala melas*); 6. Short-finned pilot whale (*Globicephala macrorhynchus*); 7. *Globicephala* sp.; 8. Melon-headed whale (*Peponocephala electra*); 9. Risso's dolphin (*Grampus griseus*); 10. Rough-tooth dolphin (*Steno bredanensis*); 11. Atlantic humpback dolphin (*Sousa teuszii*); 12. Common bottlenose dolphin (*Tursiops truncatus*); 13. Pantropical spotted dolphin (*Stenella attenuata*); 14. Atlantic spotted dolphin (*Stenella frontalis*); 15. Spinner dolphin (*Stenella longirostris*); 16. Clymene dolphin (*Stenella clymene*); 17. Striped dolphin (*Stenella coeruleoalba*); 18. Fraser's dolphin (*Lagenodelphis hosei*); 19. Short-beaked common dolphin (*Delphinus delphis*); 20. Long-beaked common dolphin (*Delphinus capensis*); 21. *Delphinus* sp.; 22. Dwarf sperm whale (*Kogia simus*); 23. Pygmy sperm whale (*Kogia breviceps*); 24. Cuvier's beaked whale (*Ziphius cavirostris*); 25. Gervais' beaked whale (*Mesoplodon europaeus*).

Key for occurrence

Y=confirmed presence; S=suspected presence; U=unconfirmed presence. ^Confirmed cases of human consumption, marketing or directed take.

Sources of information

[1]Bamy, pers. comm.; [2]Ritter, pers comm.; [3]Van Waerebeek *et al*. (2008b); [4]Perrin (2002); [5]Van Waerebeek *et al*. (2004); [6]Fertl *et al*. (2003); [7]Notarbartolo di Sciara *et al*. (1998); [8]Robineau and Vély (1998); [9]Nieri *et al*. (1999); [10]Vidal *et al*. (2009); [11]Van Waerebeek *et al*. (1997); [12]Murphy *et al*. (1997); [13]Van Waerebeek *et al*. (2008a); [14]Bamy *et al*. (2009); [15]Tchibozo and Van Waerebeek (2007); [16]Van Waerebeek and De Smet (1996); [17]Picanço *et al*. (2009); [18]Weir *et al*. (2010); [19]Weir (2010); [20]Weir (2006); [21]Weir (2009); [22]Smit *et al*. (2010); [23]Weir (2008); [24]SC/62/SM12; [25]SC/62/SM8; [26]SC/62/SM6; [27]SC/62/SM10; [28]SC/62/SM11; [29]SC/62/SM9; [30]SC/62/SM1; [31]Brito, pers. comm.

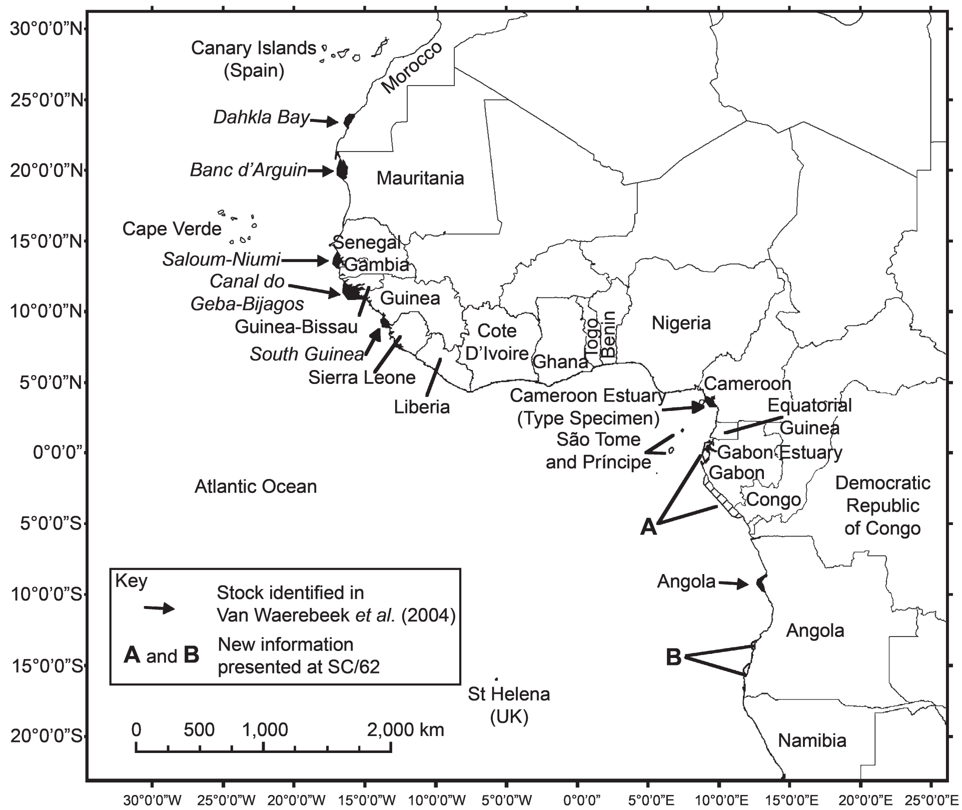

Fig. 1. Map of the northwestern and western African countries relevant to this review.
Key: A=information from SC/62/SM9; B=information from SC/62/SM6.

'marine bushmeat' (Clapham and van Waerebeek, 2007), and the regular catches of small cetaceans in nearby Ghana, e.g. see SC/62/SM10 and Van Waerebeek *et al.* (2008a) and Togo, there is no reason to think that small cetaceans are not also routinely exploited in Nigeria. The absence of monitoring may explain the lack of information. In this regard, Solarin pointed out that the Niger Delta region was only sparingly covered in the interview surveys reported by Moore *et al.* (2010) due to restiveness and militancy in the area.

SC/62/SM1 also reiterated the suggestion by Van Waerebeek *et al*. (2004) that Atlantic humpback dolphins (*S. teuszii*) inhabited the Niger Delta before large-scale oil exploration and extraction altered the coastal environment.

The sub-committee welcomed the new information in SC/62/SM1 and SC/62/SM12 and noted that Nigeria is one more country to add to the list of those in which directed hunts for small cetaceans have emerged over the last several decades, probably related to the growth of human population and decline of other available sources of food and income.

SC/62/SM10 summarised information on cetaceans of Ghana with emphasis on the capture of small cetaceans in artisanal fisheries, mainly using drift gillnets. Catches have been documented periodically from three fish landing ports (Axim, Dixcove and Apam), albeit on a limited scale, since 1995. Using photographs of 231 landed specimens (212 identifiable), 15 species have been identified. Video evidence recorded from a drilling platform in Ghana's Jubilee Field showed the capture of a small sperm whale by the crew of a large canoe and this adds the sperm whale as the 16th species documented as taken in artisanal fisheries, the great majority in gillnets and a few in set gillnets and purse-seines. The species most frequently bycaught are the Clymene dolphin (*S. clymene*; 24.5%), pantropical spotted dolphin (*S. attenuata*; 12.3%) and common bottlenose dolphin (*T. truncatus*; 12.3%). There is evidence of landings in other, unmonitored ports (e.g. two bottlenose dolphins at Jamestown in 1994, one Clymene dolphin at Winneba in 1998 and one Clymene dolphin at Ada-Foah in 2003), showing that catches recorded for the three monitored ports do not represent full accounting for the country.

Although aquatic mammals are on the first schedule of Ghana's 1971 Wildlife Conservation Regulations (Legal Instrument 685) and are protected by law, there are no explicit regulations concerning the use of cetaceans killed in nets. As a result, the use of dolphin meat as bait in shark fisheries and for human consumption is not considered illegal, which means that catch statistics can be obtained (i.e. catches are not concealed for fear of sanctions) and this makes it feasible to study trends and carry out biological studies based on carcass sampling protocols (e.g. morphology, growth and reproduction, feeding ecology, stock identification, genetics, parasitology, contaminant loads and pathology).

There was some discussion of the increasing trend suggested by the 1999-2010 catch series presented in SC/62/SM10. Specifically, there appears to have been an increase in the scale of landings beginning in 2002 or 2003. Ofori-Danson explained that although there had been some variability in monitoring effort through time, the impression is accurate that once the practice of catching and marketing cetacean products becomes established, it can escalate rapidly as implied in the existing catch series.

A question was raised concerning the statement in SC/62/SM10 that traditional taboos against catching dolphins were rapidly eroding in the Volta Delta region. Ofori-Danson explained that on the west coast this is not a taboo; whereas on the east coast it is and cetaceans traditionally have been returned to the sea or buried after traditional ceremonies. This seems to happen in some areas of Nigeria too. One important development is that the monetary value of a small cetacean is now roughly equivalent to that of a similar-sized large billfish. In fact, even more money can be earned by selling the cetacean carcass for shark bait; the export market in Asia for shark fins is lucrative and growing.

The sub-committee expressed appreciation to Ofori-Danson for bringing this information to the meeting and commended him and his colleagues in Ghana (with Van Waerebeek) for their efforts to document cetacean catches and use biological material to improve scientific understanding. It also noted that the evidently close cooperation with fisheries officials is especially encouraging.

Tchibozo summarised information on small cetaceans along the 124km coastline of Benin (Tchibozo and van Waerebeek, 2007). The presence of four species of small cetaceans has been confirmed: *Stenella frontalis*, *Tursiops truncatus*, *Pseudorca crassidens* and *Delphinus* sp. There have been no systematic studies on the distribution, abundance or ecology of small cetaceans in Benin. Although bycatch of cetaceans is known to occur in fisheries along the entire coast, a dedicated data collection programme is needed to quantify and characterise this. Small cetaceans are legally protected in Benin and the government has signed and ratified a number of international conservation agreements, including the CMS, IWRC and CBD.

Tchibozo emphasised the need for stronger regional collaboration among cetacean biologists, including joint research projects, and the need for training national fisheries observers in basic data recording protocols for cetacean sightings and catches. The fisheries department should collect such data as standard procedure.

SC/62/SM11 confirmed the presence of four small cetaceans in Togo's coastal waters: *Stenella attenuata*, *Delphinus* sp., *Globicephala cf. macrorhynchus* and *Orcinus orca*. There is no information concerning the abundance, natural history or ecology of small cetaceans in Togo. Cetaceans are legally protected and the government has signed and ratified a number of international conservation agreements, including the CMS, IWRC and CBD. The main potential threats are: (1) bycatch in fisheries, with the possibility that this has led or soon will lead to directed taking as has been observed elsewhere; and (2) severe chemical pollution due to mining phosphorites and discharge of phosphate-rich mud into coastal waters. There is a clear need for expanded field research on small cetaceans in Togo. It was suggested that a broad collaboration among the fisheries department, the wildlife department and Lomé University would enable pooling of resources and improve data collection. As in Benin, there is a need for training national fisheries observers in basic data recording protocols for cetacean sightings and catches and for the fisheries department to implement such data collection as standard procedure.

According to Bamy *et al*. (2010) four odontocete species are definitely known to occur along the 300km coastline of Guinea: *Tursiops truncatus*, *Sousa teuszii*, *Stenella frontalis* and *Kogia breviceps*. Three additional species have been reported and are probably present in Guinean waters, but there is insufficient evidence to confirm this unequivocally: *Globicephala macrorhynchus*, *Steno bredanensis* and *Delphinus* spp. This information comes mainly from observations during irregular, largely opportunistic surveys of fishing communities in 2001-03 by personnel from

Guinea's Centre National des Sciences Halieutiques de Boussoura (CNSHB). In 2001 the CNSHB embarked on an initial effort to collect basic field data, evaluate evidence from various sources and produce a first inventory of cetacean biodiversity. Although there was no evidence of substantial takes of small cetaceans, either directly or as bycatch (e.g. at the scale reported in Ghana), monitoring and reporting have been limited. There is evidence that bycaught small cetaceans and a stranded whale were used for human consumption. The authors expressed concern about even occasional catches of Atlantic humpback dolphins.

Guinean fisheries have developed rapidly in recent decades. In 1995 some 75,300MT of fish products were landed, and about 69% of those products came from artisanal fisheries involving some 2,300 canoes. In view of the intense fishing effort, it is likely that the handful of documented instances of cetacean bycatch is unrepresentative of the true scale of cetacean mortality. There are no trained observers, limited port surveillance and few incentives to report illegal landings. While there is no evidence for substantial dolphin landings, of the kind seen in Ghana for instance, better monitoring is needed. Fish, molluscs and other marine products may still largely satisfy local demand, but as soon as this changes, cetacean exploitation is likely to increase dramatically as it has in Ghana.

In discussion, Bamy cited the need for fishery observers stationed at ports and fish landing sites to report information on cetacean landings, bycatch and strandings as part of their normal duties (preferably with photographs as documentation). He emphasised that fishery officers should refrain from assessing fines or confiscating carcasses and instead carefully document the circumstances of takes, e.g. type of vessels and gear involved, utilisation (food, bait, medicine, etc.), destinations (local, hinterland, city market, movement across international border, etc.), processing (fresh, smoked, salted, etc.), levels of market demand and other factors that determine the dynamics of the 'marine bushmeat' trade (e.g. encompassing cetaceans, turtles and manatees).

During discussion, reference was made to the study by Brashares *et al*. (2004) on the relation between declining fish supplies in West African waters and the increase in hunting for 'bushmeat' and consequent declines in wildlife populations. This concept was extended by Clapham and Van Waerebeek (2007), who stated:

> '…often overlooked is the fact that such terrestrial hunting is either preceded or coincident with increased exploitation of marine wildlife. With the introduction of virtually indestructible nylon fishing nets in the 1960s, incidental catches of cetaceans, sea turtles and other marine fauna rose exponentially worldwide; while initially discarded by fishermen in some nations [including several in West Africa], these animals were subsequently sold as by-catch, then ultimately became the targets of directed hunting as fish landings plummeted'.

SC/62/SM8 elaborated on a recently published paper on small cetaceans off São Tomé and Príncipe (Picanço *et al*., 2009). The waters surrounding this archipelago in the Gulf of Guinea are inhabited by at least four species of small cetaceans, of which the common bottlenose dolphin and pantropical spotted dolphin are most numerous. During a pilot study conducted between July 2002 and September 2006, bottlenose dolphins were observed all along the coast whereas spotted dolphins were seen mainly in the deeper waters to the northeast of São Tomé. Bottlenose dolphins had the highest sighting rate and spotted dolphins had the greatest abundance. Killer whales were observed on six occasions and pilot whales (species uncertain) once (in a mixed group with bottlenose dolphins). The authors of SC/62/SM8 expressed concern about the potential for direct and incidental catches, for disturbance by unregulated dolphin-watching tourism and for ecosystem degradation from the expanding offshore oil industry in the Gulf of Guinea. This paper also corrected a misidentification of *Globicephala melas* contained in Picanço *et al*. (2009), which more correctly should be listed as *Globicephala* sp.

Brito and Carvalho brought to the sub-committee's attention the fact that several species of small cetaceans were hunted historically in the Cape Verde Islands using hand harpoons. Also, in spite of protective legislation (species are not specified), cetaceans are still captured occasionally and their meat is sold and consumed (Hazevoet and Wenzel, 2000; Reiner *et al*., 1996). There is some evidence that bones and skulls from small cetaceans (locally named as 'blackfish') are used in local handicrafts.

Vély informed the sub-committee on cetacean occurrence in Mauritania, including stranded animals, between 1987-93. This work was carried out on a voluntary basis when he was based at the Centre National d'Etudes et de Recherches Veterinaires (CNERV) in Nouakchott. Dedicated surveys were conducted from platforms of opportunity in two main areas, one along the Mauritanian beach between the southern border with Senegal and the village of Nouamghar at the northern entrance of the National Park of Banc d'Arguin (PNBA) and the other the entire PNBA. From 1993-95 the European Development Fund project 'Biodiversité du littoral mauritanian' implemented more dedicated and in-depth surveys of marine mammals in the two areas. Daniel Robineau (Grande plage) and Vély (PNBA) were involved as experts. Species observed at sea were *Tursiops truncatus, Sousa teuszii* and *Orcinus orca*. Stranded specimens included *Phocoena phocoena, Stenella clymene, Delphinus* sp., *Grampus griseus, Peponocephala electra, Globicephala macrorhynchus, Kogia breviceps, Kogia sima, Ziphius cavirostris* and *Mesoplodon europaeus.*

Smit *et al*. (2010) summarised current information on the presence and distribution of small cetaceans off the coast of La Gomera (Canary Islands), where numerous cetacean species can be sighted. From 1995 until 2007, cetaceans were monitored year round from whalewatching vessels. A total of 5,739 cetacean sightings of 21 species were made. The five most abundant species (87% of sightings) were common bottlenose dolphins (*T. truncatus*), short-finned pilot whales (*G. macrorhynchus*), Atlantic spotted dolphins (*S. frontalis*), short-beaked common dolphins (*D. delphis*) and rough-toothed dolphins (*S. bredanensis*). Distance to coast, depth and sea bottom slope showed significant inter-species differences. None of the most abundant species occurred exclusively alone. It appears that habitat selection by a given species is driven by a specific set of habitat characteristics together with the presence/absence of other cetacean species. Some of the species combinations were observed regularly, e.g. bottlenose dolphins with pilot whales. However the tendency of one species to mingle with another was variable; some species were generally not seen around other cetaceans.

6.1 Harbour porpoise (*Phocoena phocoena*)

No information was presented at this meeting on taxonomy, population structure, abundance, life history and ecology, including habitat and related issues, directed and incidental takes for this species.

This species has been reported to occur in Morocco, Mauritania (Vély) and Senegal (Van Waerebeek *et al*., 1997). Cadenat (1957) listed Guinea as a range state but did so on the basis of an unsubstantiated sighting by the crew of a tuna boat operating at latitude *ca* 08°30'N, off northern Sierra Leone. Bamy *et al*. (2010) rejected this record as unsubstantiated, noting that waters south and east of Senegal, bathed by the Guinea Current, are almost certainly too warm for this temperate-zone species.

The IUCN Red list status of the species is Least Concern. Given the scarcity of information, the sub-committee was not in a position to evaluate status in the region.

6.2 Rough-toothed dolphin (*Steno bredanensis*)

No information was presented at this meeting on taxonomy, population structure, abundance and incidental takes for this species. The species occurs in Côte d'Ivoire, Ghana, Gabon, Angola, Guinea and St Helena. See SC/62/SM10; Bamy *et al*. (2010); De Boer (2010a; 2010b) and Weir (2010).

Rough-toothed dolphins inhabit shelf-edge and deep oceanic waters. Sightings occurred in water depths of 402 to over 4,000m off Ghana, Gabon and Angola, as noted in SC/62/SM10, De Boer (2010a; 2010b) and Weir (2010), but close to shore off the island of St. Helena. Usually they are seen in groups of more than 20 animals although a pod of 40 was observed off Ghana. They are gregarious species, associating with bottlenose dolphins off Gabon and St Helena and with short-finned pilot whales off Angola and Gabon (De Boer, 2010a; Weir, 2010). An anomalously white rough-toothed dolphin was recorded off Gabon (De Boer, 2010b). In Ghana 6.1% of total landings are represented by this species (including a mixture of bycatch and direct catch) (SC/62/SM10), and three specimens were captured in Côte d'Ivoire (Weir, 2010).

The IUCN Red list status of the species is Least Concern. Given the scarcity of information, the sub-committee was not in a position to evaluate status in the region.

6.3 Atlantic humpback dolphin (*Sousa teuszii*)

Van Waerebeek *et al*. (2004) reviewed the state of knowledge on *S. teuszii* following the 2002 meeting of this sub-committee where the genus *Sousa* had been the priority topic but where discussions more centred on the animals in the Indo-Pacific (IWC, 2003).

Van Waerebeek *et al*. (2004) proposed eight provisional management stocks based on the fragmentary information available at the time of their study. Six of these stocks were confirmed as extant based on recent records: Dakhla Bay (Western Sahara), Banc d'Arguin (Mauritania), Saloum-Niumi (Senegal, Gambia), Canal do Gêba-Bijagos (Guinea-Bissau), South Guinea and Angola. The other two (Cameroon Estuary and Gabon) were considered historical. Those authors also noted the 'potential existence' of a western Togo stock. They concluded that there were nine confirmed range states: Morocco (including Western Sahara), Mauritania, Senegal, The Gambia, Guinea-Bissau, Guinea-Conakry, Cameroon, Gabon and Angola (Fig. 1).

6.3.1 Taxonomy and population structure

Taxonomy of the genus *Sousa* remains largely unresolved. Although three putative or nominal species have been widely discussed (*S. chinensis*, *S. plumbea* and *S. teuszii*), the IWC presently recognises only two, the Atlantic species *S. teuszii* and a geographically widespread Indo-Pacific species *S. chinensis*. Although there is general agreement on the validity of *S. teuszii*, e.g. on the basis of cranial characteristics, tooth counts and external features (Jefferson and Van Waerebeek, 2004), there has not been resolution on the number of species and their systematic relationships throughout the rest of the range of the genus *Sousa*.

Rosenbaum updated the sub-committee of the ongoing collaborative study to resolve these questions within the genus Sousa using nearly 300 samples from the major populations throughout their range from strandings, bycatch and biopsy. A multiple lines of evidence and combined analysis approach is nearing completion, which will provide the most definitive and comprehensive analysis and includes multiples sources of morphological and molecular datasets. Rosenbaum estimated that by the end of 2010, there should be a manuscript completed and submitted for peer-reviewed publication. Until the acceptance of this publication, the number of species should remain unchanged.

Rosenbaum also indicated that analysis of the few existing samples indicated that mtDNA variation was very low. Collins indicated that there are other samples throughout the region, but some facilitation of collection and exporting samples is needed. These few samples would be very useful for taxonomy questions for *Sousa* and the population variation in *S. teuszii*. Rosenbaum confirmed that if samples could be shipped soon, they could be included in these analyses.

The sub-committee **recommended** that efforts be made to provide any samples from *S. teuszii* as soon as possible so that they can be included in the ongoing efforts described above which are essential for resolving species questions in the genus *Sousa* and population variation questions for *S. teuszii*.

Bamy *et al*. (2010) considered the degree of distributional continuity and gene flow between the provisionally defined 'South Guinea stock' and other provisionally defined stocks (Van Waerebeek *et al.*, 2004) to be uncertain. As in Guinea-Bissau, most of Guinea's coastline has features suitable as humpback dolphin habitat: warm and shallow waters on a shelf extending up to 200km from shore, with extensive mangrove creeks around four main river mouths. The lack of sighting records must be partly due to the small amount of near-shore survey effort.

6.3.2 Abundance and distribution

The Atlantic humpback dolphin is endemic to the eastern Atlantic, limited to tropical and subtropical waters very near shore from Western Sahara in the north to Angola in the south (Van Waerebeek *et al.*, 2004). The distribution is patchy and limited to particular stretches of coastline separated by gaps of absence or very low density (Van Waerebeek *et al.*, 2004). In many cases it is unclear whether the absence of records from an area means the species naturally does not occur there, if it has been extirpated in the area, or if search effort and reporting have been insufficient (Van Waerebeek *et al.*, 2004).

S. teuszii was observed regularly between 1987 and 1995 in the channels of Banc d'Arguin and in the open waters of the Baie St Jean and the Baie d'Arguin. Strandings were common (Van Waerebeek *et al.*, 2004) within the PNBA. Some have been found on the beach south of Nouamghar (vicinity of the southern border of the PNBA). But only one has been found south of Nouakchott (about 200km south of the PNBA).

Weir (2009) investigated the distribution and behaviour of *S. teuszii* off Flamingos, southern Angola, during summer and winter 2008 using boat- and shore-based surveys. In all, 71 *S. teuszii* sightings were recorded, ranging from one to eight animals.

Although the species is thought to be widely distributed in Guinea, the only documented specimen was landed by artisanal fishermen at Dixinn, Baie de Sangaréah, in 2002 (Bamy *et al.*, 2010). No other recent sightings are known, but Cadenat (1956) stated that humpback dolphins were present in the 'silt-laden inshore waters' south of Conakry and Cadenat (1959) considered them 'very common' in Guinea. Fishermen interviewed in the Baie de Sangaréah in April 2006 described dolphins matching the diagnostic features of humpback dolphins as 'occasionally entangled in their nets' and a Dutch ornithologist sighted two humpback dolphins near Iles Tristao during a seabird survey in 2009, so the species is certainly still present in Guinean waters.

6.3.3 Life history and ecology, including habitat

The typical habitat of *S. teuszii* has been described conventionally as shallow coastal waters, especially estuaries, mangrove systems and sheltered bays (Van Waerebeek *et al.*, 2004).

Vély informed the sub-committee that in Mauritania groups of up to 10 humpback dolphins have been observed between Nouamghar and Regueiba (Baie St Jean). Dolphins were seen to feed regularly on mullet (*Mugil* sp.). The Imragen apparently have been fishing mullet for many years as these fish migrate along the coast to and from Senegal. This fishing was traditionally carried out with the 'help' of bottlenose dolphins and sometimes humpback dolphins associated with the bottlenose dolphin pods. The Imragen used to produce a very profitable product with dried mullet eggs called *poutargue* which was sold abroad. Since the late 1990s this product has been exploited on a more industrial basis, leading to a decline in the mullet migration into the PNBA. Vély suggested that it would be interesting to explore whether and how changes in the fishery have affected the local ecology and in turn the local population of humpback dolphins in the PNBA.

The *S. teuszii* off Flamingos (southern Angola) inhabited shallow, nearshore waters throughout the region, with the exception of southern areas adjacent to fishing villages. Small bays, sheltered waters behind reef-breaks and areas off dry river mouths were used for foraging/feeding behaviour, whereas most travelling occurred along exposed coast (Weir, 2009). In the area off Flamingos 10 individuals were photo-identified. Multiple resightings (and absence of unmarked animals) indicate that all individuals present at the time of the surveys were photo-captured, exhibited high site fidelity and had occurred year-round. Association indices of 0.77-1.0 indicated strong social affiliation between eight individuals, particularly in winter (Weir, 2009).

Collins pointed out that in Gabon and Congo and elsewhere in the southern range of the species, humpback dolphins are regularly observed on open coastlines that do not conform to their traditionally recognised habitat preference. Therefore, effort should not be limited to traditionally recognised areas.

The loss and fragmentation of habitat due to expanding coastal communities, coastal development, dredging, trawling, deforestation, mangrove destruction, pollution, eutrophication and oil spills also threaten this species. The species' preference for shallow, nearshore and estuarine habitat would render it particularly vulnerable to ubiquitous inshore set gillnets, beach seines and other anthropogenic disturbances. Alternatively, a natural distribution gap may exist off Ghana/Togo related to periodical cool upwelling. Evidence from Benin and Brass Island, Niger Delta, shows that inshore bottlenose dolphins are present in the Bight of Benin (SC/62/SM10).

The reliance of humpback dolphins on restricted nearshore waters in Namibe Province renders them especially vulnerable to habitat degradation, a threat that has also been identified for Atlantic humpback dolphins in Senegal (Van Waerebeek *et al.*, 2004). In Angola (SC/62/SM6), habitat degradation may result particularly from expanding coastal fishing communities, trawling, harbour construction and expansion (the Namibe Province study area is located between two major Angolan fishing ports and shipyards; Tombwa, located 5km to the south and Namibe, located 13km to the north), and offshore industry (e.g. construction of liquid natural gas plants, pipelines and coastal terminals).

6.3.4 Directed takes

SC/62/SM6 stated that specific accounts of directed takes of Atlantic humpback dolphins are scarce, but they are believed to occur with some regularity (Van Waerebeek and Perrin, 2007).

6.3.5 Incidental takes

Incidental capture in fishing gear is the main source of anthropogenic mortality for small cetaceans worldwide (Reeves *et al.*, 2003), including humpback dolphins in West Africa (Van Waerebeek *et al.*, 2004; Tim Collins, pers. comm.). One documented specimen, a 222cm male, was landed by artisanal fishermen in Guinea (Dixinn, Baie de Sangaréah) in 2002 (Bamy *et al.*, 2010). One Atlantic humpback dolphin was taken alive in a beach seine in Senegal (Van Waerebeek *et al.*, 2004). This species has been consistently absent from port surveillance records in Ghana (SC/62/SM10).

6.3.6 Conclusions and consideration of status

The sub-committee **agreed** that there was ample evidence for serious concern about the conservation status of this species (see SC/62/SM6, SC/62/SM9, SC/62/SM10). Although quantitative data or even good qualitative data (e.g. confirmation of species presence or absence) are lacking for much of the known or suspected range, the information available from areas where cetaceans have been consistently studied (e.g. Ghana and Guinea) indicates that the overall population is fragmented, bycatch (if not also directed catch) is occurring, and habitat conditions are deteriorating. Populations in Gabon and northern Congo appear healthy, but recently documented bycatches in Congo may be indicative of a growing reliance on non-fish marine wildlife, including dolphins.

The IUCN Red list status of the Atlantic humpback dolphin is Vulnerable.

Weir (2009) emphasised that the species occurs only in small numbers off Flamingos (Angola) and exhibits high site fidelity to a relatively small stretch of nearshore habitat, making it vulnerable to local extirpation.

Several members of the sub-committee noted that public awareness is lacking and needs to be a focus of conservation efforts. Also, any conservation initiative needs to be accompanied by consideration for social and economic circumstances. It was also noted that there are links between fishing intensity in West African coastal waters and the demand for fish and shellfish products in European markets. Therefore, the scope of conservation initiatives may need to extend beyond the local conditions and concerns.

Attention was drawn to the fact that humpback dolphins (*S. chinensis*) persist, although under serious threat, in parts of eastern Asia (e.g. Taiwan, Hong Kong) despite an incredible amount of habitat loss and modification of their habitat.

6.4 Risso's dolphin (*Grampus griseus*)

No information was presented at this meeting on taxonomy, population structure, abundance or directed takes for this species.

This species is considered relatively common along the entire West African coast. It is currently present in Ghana (SC/62/SM10), off Côte d'Ivoire, Gabón and Angola (De Boer, 2010a; Weir, 2007; 2010). An encounter rate of 0.02 animals/100min was recorded off northern Angola (2007) and 0.12 animals/100km off Gabon (De Boer, 2010a).

This species seems regularly present year-round in deep waters at least off Angola (mean depth=1,770m, SD=374.9) and there is a sighting record on the Gabon shelf at 225m (Weir, 2007; 2010). Group sizes are ≤ 15 animals (mean=8.3, SD=3.9) (Weir, 2007; 2010).

Ten specimens, positively identified through photographs, were bycaught in the artisanal fishing ports of Dixcove, Axim and Apam in Ghana since 1999. This represents the 4.7% of total landings (including a mixture of bycatch and direct catch (SC/62/SM10). Most captured cetaceans of all species are used either for human consumption or as shark bait (SC/62/SM10).

The IUCN Red list status of the species is Least Concern. Given the scarcity of information, the sub-committee was not in the position to evaluate status in the region.

6.5 Common bottlenose dolphin (*Tursiops truncatus*)

6.5.1 Taxonomy and population structure

Population structure and genetics have not been studied, however cranial morphology suggests that the West Africa bottlenose dolphins differ from North Sea dolphins (Van Waerebeek *et al.*, 2008a). A bycaught 340cm adult female landed in fresh condition at Bonfi, 200km northwest of Conakry, was the first documented bottlenose dolphin record for Guinea (Bamy *et al.*, 2010). Bottlenose dolphins in West Africa attain great body length, up to 368cm in Senegal. The hypothesis of a Mauritania/Senegal population linked to the NW African upwelling zone and characterised by a long rostrum and a relatively smaller neurocranium (Robineau and Vely, 1997) deserves further study. Bamy *et al*. (2010) considered that the Bonfi specimen could indicate that such a form has a wider distribution off western Africa than previously recognised.

Van Waerebeek *et al*. (2008a) noted that inshore bottlenose dolphins were targets of a live-capture fishery in the Gambia (past), Senegal (recent) and Guinea-Bissau (confirmed in the past).

6.5.2 Abundance and distribution

The species was confirmed for Côte d'Ivoire, Ghana, Benin Nigeria, Guinea, Guinea Bissau, Gambia, Gabon, Angola and St Helena (coastal and in an estuary). It also occurs in São Tomé Island (São Tomé and Príncipe) (SC/62/SM8) with a sighting per unit of effort (SPUE) of 0.065 (sightings/60min), and abundance per unit of effort (APUE) of 0.074 (individuals/60min). It also occurs in Gabon with a relative abundance of 0.65 individuals/100km (De Boer, 2010a) and in Angola with a relative abundance of 0.051 (individuals/100min) (Weir, 2010).

6.5.3 Life history and ecology, including habitat

The common bottlenose dolphin is widely distributed, both temporally and spatially along São Tomé Island (São Tomé and Príncipe), mostly at depths from 20 to 100m and at a wide range of sea surface temperatures (SSTs) (SC/62/SM8). Suggestion of year-round presence in both coastal and deep offshore waters off Gabon, at mean depths of 1,760m and mean SST of 27.5°C (De Boer, 2010a). Distributed off Angola all year round and occurring at mean depths of 1,187m and mean group size of 14.9 (Weir, 2010). Off Guinea-Bissau, the group sizes of inshore bottlenose dolphins are small and number of individuals has been decreasing (Van Waerebeek *et al.*, 2008a).

6.5.4 Directed takes

Direct takes occur in Nigeria (SC/62/SM1). In the past they were documented in Guinea Bissau, the Gambia, Senegal (Van Waerebeek *et al.*, 2008a) and Togo (SC/62/SM11). A small-scale live-capture operation took place in Senegal in 2003 and all five captured animals died (Van Waerebeek *et al.*, 2008a).

6.5.5 Incidental takes

This species represents 12.3% of total cetacean landings in Ghana (including a mixture of bycatch and direct catch (SC/62/SM10). There is evidence of bycatch in Guinea (Bamy *et al.*, 2010) and it is likely that incidental takes occur in Nigeria, Guinea-Bissau, São Tomé and Príncipe and Gambia.

6.5.6 Conclusions and consideration of status

The IUCN Red list status of the species is Least Concern. Given the scarcity of information, the sub-committee was not in a position to evaluate status in the region.

6.6 Atlantic spotted dolphin (*Stenella frontalis*) and pantropical spotted dolphin (*Stenella attenuata*)

6.6.1 Taxonomy and population structure

No information was presented at this meeting on taxonomy and population structure of Atlantic spotted dolphin (*Stenella frontalis*) or pantropical spotted dolphin (*Stenella attenuata*).

6.6.2 Abundance and distribution

The Atlantic spotted dolphin was confirmed in Mauritania, Senegal, Côte d'Ivoire, Ghana, Benin, Equatorial Guinea, Guinea and Cape Verde and Canary Islands; not known for Nigeria and São Tomé and Príncipe; see SC/62/SM8 and Weir (2007; 2010). It occurs off Gabon with relative abundance of 1.00 individuals/100km (De Boer, 2010a). It also occurs off Angola with relative abundance of 1.46 individuals/100min. It possibly is also occurring in St Helena (Weir, 2007).

The pantropical spotted dolphin was confirmed for Ghana, Togo, Angola and St Helena in SC/62/SM10, SC/62/SM11 and Weir (2010). It is the most abundant small cetacean with wide temporal and spatial distribution along São Tomé Island (no information exists for Príncipe Island, São Tomé and Príncipe), with a SPUE of 0.024 (sightings/60min) and an APUE of 0.389 (individuals/60min) (SC/62/SM8). It occurs off Gabon with a relative abundance of 1.46 individuals/100km (De Boer, 2010a). Not known for Nigeria, but possibly occurring.

6.6.3 Life history and ecology, including habitat

The Atlantic spotted dolphin occurs off Gabon at mean depths of 1,988m and mean SST of 21.5°C (de Boer 2010a). It also occurs off Angola all year round and at mean depths of 1,633m and with mean group sizes of 103.9 individuals (Weir, 2007; 2010).

Pantropical spotted dolphins were encountered in large groups, mostly at depths between 1,000-2,000m and SST of 26°-27°C off São Tomé Island (no information exists for Príncipe Island, São Tomé and Príncipe) (SC/62/SM8). This species also occurs off Gabon, at mean depths of 516m and mean SST of 21.5°C (De Boer, 2010a); off Angola at mean depths of 1,900m and with mean school sizes of 85 individuals (Weir, 2007; 2010).

6.6.4 Directed takes
No information was available on direct takes of these two species.

6.6.5 Incidental takes
Atlantic spotted dolphins are 0.5% of total landings in Ghana (including a mixture of bycatch and direct catch) (SC/62/SM10); possibly in St Helena (Weir, 2010).

Pantropical spotted dolphins are 13.2% of total cetacean landings in Ghana (including a mixture of bycatch and direct catch) (SC/62/SM10). There is also bycatch in Gabon and St Helena (Weir, 2010).

6.6.6 Conclusions and consideration of status
The IUCN Red list status of the Atlantic spotted dolphin is Data Deficient and of the pantropical spotted dolphins is Least Concern. Given the scarcity of information, the sub-committee was not in a position to evaluate status of these species in the region.

6.7 Spinner dolphin (*Stenella longirostris*)
No information was presented at this meeting on taxonomy, population structure, abundance, life history and ecology, including habitat and related issues for this species.

The spinner dolphin is reported to occur in Ghana, Côte d'Ivoire, Angola and St Helena (SC/62/SM10; Weir (2010)) with sightings of groups of 20-200 animals in water depths exceeding 3,500m.

In Ghana, spinner dolphins represent 2.8% of total cetacean landings (including a mixture of bycatch and direct catch) (SC/62/SM10).

The IUCN Red list status of the species is Data Deficient. Given the scarcity of information, the sub-committee was not in a position to evaluate status in the region.

6.8 Clymene dolphin (*Stenella clymene*)
Fertl *et al*. (2003) reviewed the distribution of the Clymene dolphin, (*Stenella clymene*), with emphasis on the South and mid-Atlantic waters, where the range of the species was not well documented. This review also focused on clarifying the literature because confusion surrounding the identifying characteristics of this species has contributed to a general lack of knowledge of this species. Published and unpublished records were compiled and species identification was verified based on: (1) photographs or a detailed description of the animals including diagnostic features; and (2) identifications made by trained observers familiar with Clymene dolphins and examination of voucher material deposited in institutions (e.g. museum collections). A total of 195 records (109 sightings, 67 strandings and 19 captures) were compiled. Relatively small information was available for the eastern Atlantic (only 12 records). In this region, Clymene dolphins were observed in Mauritania (1 stranding), Senegal (5 strandings and 2 captures), Ghana (1 stranding, 1 sighting and 1 capture) and Ascension Island (1 capture). The northernmost record of the species in the eastern Atlantic was in Mauritania (~19°N) and the southernmost record in Ascension Island (St Helena) (3°40'S).

6.8.1 Taxonomy and population structure
No information was provided at this meeting on taxonomy and population structure for this species.

6.8.2 Abundance and distribution
This species has only recently been described to regularly occur in the eastern tropical Atlantic (Weir, 2006). Its occurrence is confirmed for Mauritania, Ghana, Congo, Angola and Gambia in SC/62/SM10 (De Boer, 2010a; Fertl *et al.*, 2003; Murphy *et al.*, 1997; Weir, 2006; 2007; 2010).

6.8.3 Life history and ecology, including habitat
Sightings have occurred over water depths from 466 to >5,000m, indicating a shelf-edge and oceanic occurrence. It is considered to be the most common cetacean off Ghana, based on bycatch records. The species appears to be gregarious, with the four at-sea sightings comprising groups of 12, 50, 250 and 1,000 animals. There is also record of mixed-species school with common dolphins (SC/62/SM10; Weir, 2007; 2010) and with spinner dolphins (Fertl *et al*., 2003).

6.8.4 Directed takes
Fertl *et al*. (2003) reported the evidence of 2 captures in Senegal, 1 in Ghana and 1 in the Ascension Island (St Helena).

6.8.5 Incidental takes
Commonly landed in Ghana as a result of bycatch, with 24.5% of total landings. The species is also caught in tuna purse seine fisheries within the Gulf of Guinea (SC/62/SM10; Weir, 2010).

6.8.6 Conclusions and consideration of status
The IUCN Red list status of the species is Data Deficient. Given the scarcity of information, the sub-committee was not in a position to evaluate status in the region. However, the sub-committee **expressed serious concern** about the ongoing observed bycatch of this species in Ghana.

6.9 Short-beaked common dolphin (*Delphinus delphis*) and long-beaked common dolphin (*Delphinus capensis*)
6.9.1 Taxonomy and population structure
Although both short-beaked and long-beaked common dolphins have been reported to occur in West Africa, the taxonomy of the genus is still uncertain in the area (Weir, 2010). Therefore, it is preferable to refer them only to *Delphinus* sp. whilst describing them as short- or long-beaked according to the classification originally made by the author of the given reports.

Amaral drew attention to her ongoing study of the global systematics of the genus and stressed the importance of obtaining specimens from West Africa. Ofori-Danson indicated that numerous skulls were available from Ghana. Amaral confirmed that both tissues and photographic images would be useful.

6.9.2 Abundance and distribution
Both long-beaked and short-beaked common dolphins occur in Côte d'Ivoire, Ghana, Gabon and Angola (Weir, 2010). In Benin a common dolphin has been recorded and in Congo only long-beaked common dolphins have been recorded (SC/62/SM10) (Weir, 2010). Common dolphins have also been recorded to occur in Togo (SC/62/SM11) and Nigeria (SC/62/SM12). Both forms appear to be sympatric throughout West Africa. In Angola it has been suggested that the long-beaked is more coastal and the short-beaked occurs in more offshore waters, corresponding to the habitat partitioning described to occur in the northeast Pacific (Heyning and Perrin, 1994; Weir, 2010). Off Gabon, common dolphins were seen in deep oceanic waters (>2,400m) (De Boer, 2010a). Reported group sizes vary from one to 500 individuals. Sightings and specimen records indicate a year round occurrence of common dolphins in West Africa.

6.9.3 Life history and ecology, including habitat
The SST in coastal waters of Nigeria where common dolphins have been reported varies between 25 and 34.5°C (SC/62/SM12).

6.9.4 Directed takes
The long-beaked form is one of the regular species caught in Ghana, representing 9.4% of total landings of cetaceans in artisanal fisheries (including a mixture of bycatch and direct catch) (SC/62/SM10).

6.9.5 Incidental takes
Bycatch of common dolphins has been reported for Ghana (SC/62/SM10) and for the Gulf of Guinea (Weir, 2010).

6.9.6 Conclusions and consideration of status
The IUCN Red list status of the long-beaked common dolphin is Data Deficient and of the short-beaked common dolphin is Least Concern. Given the scarcity of information, the sub-committee was not in a position to evaluate status in the region.

6.10 Striped dolphin (*Stenella coeruleoalba*)
No information was presented at this meeting on taxonomy, population structure, directed and incidental takes for this species.

A stranding in Côte d'Ivoire is the only verified record for northern Gulf of Guinea (Weir, 2010). A few sightings were reported off Angola (Weir, 2010) and a stranding was reported in southern Gabon in 2008 (Collins, pers. comm.). Encounter rate of 0.16 animals/100min off northern Angola (Weir, 2007). All sightings were recorded in deep waters of more than 1,500m (mean=1,785m, SD=229.2). Group sizes range from 8-200 animals (mean=59, SD=62.9). It is suspected to inhabit waters off Angola all year round (Weir, 2007; 2010).

The IUCN Red list status of the species is Least Concern. Given the scarcity of information, the sub-committee was not in a position to evaluate status in the region.

6.11 Fraser's dolphin (*Lagenodelphis hosei*)
No information was presented at this meeting on taxonomy, population structure, abundance and directed takes for this species.

This species occurs in Ghana, Angola, Nigeria and in the Gulf of Guinea (SC/62/SM10; Weir, 2010). Weir *et al*. (2008) reviewed the existent records of Fraser's dolphin from the Gulf of Guinea and Angola. There is only one record of this species for the Atlantic side of the African mainland, which is a skull found on the beach of Sangomar Island, Senegal, in 1997 (Van Waerebeek *et al.*, 2000). Within the Gulf of Guinea, records are limited to two bycaught specimens in Ghana. Fraser's dolphins represent <2% of total cetacean landings in Ghana (including a mixture of bycatch and direct catch (SC/62/SM10). For Angola, two at-sea sightings have been recorded (Weir *et al.*, 2008). All new sightings occurred in over 1,000m water depth and comprised 60-150 animals. This species is expected to occur all year round (Weir, 2010; Weir *et al.*, 2008). Off Nigeria a pod of 150 animals was observed and the animals were around 2.5m long. Off Angola sightings occurred in water temperatures of 25°C (Weir *et al.*, 2008).

The IUCN Red list status of the species is Least Concern. Given the scarcity of information, the sub-committee was not in a position to evaluate status in the region.

6.12 Melon-headed whale (*Peponocephala electra*)
No information was presented at this meeting on taxonomy, population structure and incidental takes for this species.

The melon-headed whale has been reported to occur in Ghana, Gabon and Angola (SC/62/SM10; Weir, 2010). Off Angola sightings report groups of 100-300 animals, at water depths of 1,330-2,265m (Weir, 2010). Off Gabon, melon-headed whales have been sighted in deep waters (de Boer, 2010a). This species represents 10.4% of total cetacean landings in Ghana (including a mixture of bycatch and direct catch) (SC/62/SM10).

The current IUCN status for the melon-headed whale is Least Concern. Given the scarcity of information, the sub-committee was not in a position to evaluate status in the region.

6.13 Pygmy killer whale (*Feresa attenuata*)
No information was presented at this meeting on taxonomy, population structure, abundance, life history and directed takes for this species. The only available information is that the species is rarely landed as bycatch in Ghana (representing 0.5% of total cetacean landings; SC/62/SM10).

The IUCN Red list status of the species is Data Deficient. Given the scarcity of information, the sub-committee was not in a position to evaluate status in the region.

6.14 False killer whale (*Pseudorca crassidens*)
No information was presented at this meeting on taxonomy, population structure, abundance, life history and ecology, including habitat and directed takes.

This species has been reported to occur in Côte d'Ivoire, Ghana, Benin, Gabon (Collins mentioned that he has four biopsies from here) and Angola (Weir, 2010). It is considered resident in Angola, with sightings of groups of up to 35 animals and in water depths of over 1,400m with highest relative abundance occurring at depths of 2,000-2,500m (Weir, 2007; 2010). This species is rarely landed in Ghana (SC/62/SM10).

The IUCN Red list status of the species is Data Deficient. Given the scarcity of information, the sub-committee was not in the position of evaluating its status in the region.

6.15 Killer whale (*Orcinus orca*)
6.15.1 Taxonomy and population structure
Collins reported that killer whales observed off Angola, Gabon and São Tomé were similar in external appearance. They lacked a defined dorsal cape, but had a variable pale grey 'saddle' behind the dorsal fin. Their appearance is consistent with the Type A 'nominate' killer whale form described by Pitman and Ensor (2003).

6.15.2 Abundance and distribution
Weir *et al*. (2010) summarised published records from northwest Africa including the Cape Verde Islands and from Namibia and South Africa in the southern hemisphere. They cited reports from Liberia, the Côte d'Ivoire, Ghana, Annobón Island (Equatorial Guinea) and Gabon. Weir *et al*. (2010) provided records of 31 additional confirmed sightings from Angola, Gabon and São Tomé, and a single record from Cameroon. de Boer (2010a) provided an additional record of killer whales in the offshore waters of Gabon. Most sightings have been recorded since 2001 corresponding with the onset of dedicated survey work in the region.

Bamy *et al*. (2010) found no confirmed records from the stretch of coast from southern Senegal (Casamance) to Liberia. Although they considered killer whales to be widespread in coastal and offshore areas of the eastern Atlantic, they also noted that these whales were not common in any particular area. Bamy *et al*. (2010) questioned whether killer whales venture into the shallow waters of Guinea-Bissau, Guinea and Sierra Leone.

6.15.3 Life history and ecology, including habitat
The mean best estimate of killer whale group size off West Africa was 5.56 animals (range=1–17, SD=3.48, *n*=32). The mean group size was similar between regions, comprising 4.9 animals (SD=3.23, *n*=18) in Angola, 6.0 animals (SD=5.16, *n*=7) in Gabon and 6.2 animals (SD=1.33, *n*=6) in São Tomé (Weir *et al.*, 2010).

The month of the sighting was available for 33 of the West African records. The seasonal distribution of sightings indicates a probable year-round occurrence of killer whales within the region. Analysis of the combined dataset reveals that killer whales off West Africa inhabited waters from 10-2,609m, and may therefore be considered as widespread (Weir *et al.*, 2010).

Matches of dorsal fin photos resulted in the identification of 33 individuals in Angola, Gabon and São Tomé. No between-site matches were made and no within-site resightings were recorded in Angolan or Gabonese waters. Between year within site matches were made in Sao Tomé. The absence of definite matches of individual whales between the three study areas is considered inconclusive given the small sample size and poor quality of many images (Weir *et al.*, 2010).

Many of the killer whale groups recorded off West Africa were observed travelling with steady surfacing sequences. However, about one-third (*n*=12) of the records involved observations of killer whale in (direct or indirect) association with other cetacean species. Five encounters were considered antagonistic in nature, involving humpback whales and sperm whales. The latter included an attack observed in Angola and a stranded neonate with tooth rakes on the tail flukes that were consistent with known scarring patterns from killer whales. Two additional observations included aggressive encounters between killer whales and fish prey. These involved a shark and an ocean sunfish (Weir *et al.*, 2010). The 17.3% incidence of presumed killer whale scarring on humpback whale flukes photographed off Gabon is evidence of regular interaction between these species, although some of this scarring likely occurs in the Antarctic feeding areas where agonistic encounters between the species are also reported (Pitman and Ensor, 2003). The absence of killer whale sightings in deep water off Angola during the peak period of sperm whale occurrence between March and May suggests that sperm whales are not the primary targets of killer whales in the area.

6.15.4 Directed takes
No information was presented indicating recent intentional takes.

6.15.5 Incidental takes
One killer whale was identified as bycatch in Ghana between 1998 and 2000 (SC/62/SM8).

6.15.6 Other
Nine dedicated and two anecdotal killer whale sightings reported from seismic vessels off Angola occurred only when the airguns were either off, or were active at very low volume (during either an airgun test or a soft start). It is therefore possible that killer whales avoided the survey vessel during periods of active airgun use (Weir, 2007).

6.15.7 Conclusions and consideration of status
Killer whales may be considered a regular component of the cetacean community off Angola and in the Gulf of Guinea. However, more survey work is required throughout the region to clarify their status and biology off tropical West Africa (Weir *et al.*, 2010).

The IUCN Red list status of the species is Data Deficient.

6.16 Long-finned pilot whale (*Globicephala melas*) and short-finned pilot whale (*Globicephala macrorhynchus*)
6.16.1 Taxonomy and population structure
It is assumed that most records of pilot whales from the Gulf of Guinea to Angola relate to *G. macrorhynchus* and that the species is continuously distributed along the west coast of Africa, although it seems to be replaced off the coast of Namibia and South Africa by *G. melas* (Bamy *et al*., 2010; Weir, 2007).

No data is available on population structure. Information is available from Strait of Gibraltar that could be compared with future sampling from other areas of West Africa.

6.16.2 Abundance and distribution
G. macrorhynchus is present in Ghana (information from bycatch, SC/62/SM10), Côte d'Ivoire, Gabon, Sao Tomé and Príncipe and Angola (information from sightings) (Bamy *et al*., 2010; de Boer, 2010a; Picanço *et al*., 2009; Weir, 2007; 2010). Sightings by fishermen around St Helena remain unconfirmed, and records off Guinea have been considered valid based on photographs (Bamy *et al*., 2010). It is commonly reported in waters of Togo (SC/62/SM11) and Nigeria (SC/62/SM12), and suspected to occur along the entire West African coast (Weir, 2010). It is also present in Cape Verde Islands (Brito, pers. comm.).

There is no data on abundance. Encounter rates are of 0.11 animals/100min off northern Angola (Weir, 2007) and 0.27 animals/100km off Gabon (de Boer, 2010a).

6.16.3 Life history and ecology, including habitat
Pilot whales appear to be present all the year round seaward of the shelf edge (mean depth=2,014m, SD=606.9) in groups of 4-200 (mean=37.2 individuals, SD=56), frequently in association with bottlenose dolphins (Weir, 2007; 2010).

Ritter and Cañadas mentioned that this association with bottlenose dolphins is also commonly observed off the Canaries and southern Spain respectively. On a number of occasions the dolphins have been seen to behave aggressively towards the pilot whales, especially pilot whale calves, something also observed in the Strait of Gibraltar according to Gallego. Ritter noted that this aggressive behaviour has not been reported in the Canaries. He also pointed out that the Canaries has a year-round resident population of pilot whales and that similar resident populations may exist elsewhere along the West African coast and around the offshore islands.

6.16.4 Directed takes
No data available.

6.16.5 Incidental takes
Twenty animals positively identified as *Globicephala macrorhynchus* (through photographs) have been reported bycaught in the artisanal fishing ports of Dixcove, Axim and Apam in Ghana since 1995, representing 9.4% of total identified cetaceans reported bycaught. It seems that most captured cetaceans of all species are used either for human consumption or as bait for shark fisheries (SC/62/SM10).

6.16.6 Conclusions and consideration of status

Pilot whales may be relatively common along most of the West African coast. The IUCN Red list status of these two species is Data Deficient.

6.17 Dwarf sperm whale (*Kogia simus*) and pygmy sperm whale (*Kogia breviceps*)

No information was available on taxonomy, population structure, abundance and directed takes.

The dwarf sperm whale has been reported to occur off Ghana and Angola (Weir, 2010). The pygmy sperm whale has been documented only from temperate areas, i.e. northwest Africa and Namibia. The large number of records suggests the species is fairly common off the Canary Islands but there are fewer records elsewhere: 1 in Madeira, 2 in Mauritania and 2 strandings (4 individuals in total) in Senegal. There is only one record of a pygmy sperm whale in Guinea, an adult landed by artisanal fishermen south of Conakry which was butchered and locally consumed in 2002 (Bamy *et al*., 2010).

Off Angola, the dwarf sperm whale seems to occur year-round in waters over depths of 1,290-2,009m and sightings comprised small groups of one to three animals (Weir, 2007; 2010). The dwarf sperm whale has been reported as caught in Ghana, representing 3.1% of total landings (SC/62/SM10).

The IUCN Red list status of these two species is Data Deficient. Given the scarcity of information, the sub-committee was not in a position to evaluate status in the region.

6.18 Cuvier's beaked whale (*Ziphius cavirostris*) and other ziphiids

Cuvier's beaked whales are present in Mauritania (stranding; Vély, pers. comm.), Ghana (information from bycatch; SC/62/SM10) and Angola (two sightings at sea; Weir, 2007; 2010). Two other ziphiids are likely to occur off Angola, Blainville's (*M. densirostris*) and Gervais' (*M. europaeus*) beaked whales. There was a sighting of three unidentified mesoplodont whales off Angola in 1966 and seven sightings of unidentified ziphiids off Angola between 2003 and 2006, including at least one of *Mesoplodon* sp. and another likely *Z. cavirostris*. A specimen of *M. europaeus* was found stranded on the Angola-Namibia border in 1997 (Weir, 2007; 2010). Most sightings occurred offshore from the Congo River mouth. Two sightings were reported off Gabon (Weir, 2010) and ziphiids are reported to occur in Nigeria (SC/62/SM12). A specimen of *M. europaeus* stranded in Mauritania in 1992 (Robineau and Vely, 1993).

There is no data on abundance. Encounter rates are of 0.006 animals/100min for *Z. cavirostris* and 0.01 animals/100min for unidentified beaked whales off northern Angola (Weir, 2007). Sightings of ziphiids off Angola were composed of 1-3 animals in deep oceanic waters (mean depth = 1,984m, SD = 376.9; Weir, 2007; 2010). One animal (positively identified through photographs) in the port of Axim in Ghana was reported bycaught in artisanal fisheries in 1994, none since (SC/62/SM10).

The IUCN Red list status of the species is Least Concern.

6.19 Recommendations

6.19.1 General recommendations

The sub-committee acknowledged that the failure to manage industrial fisheries sustainably has often caused coastal artisanal and subsistence fisheries to suffer and, in turn, has led local people to seek alternative resources for consumption, including cetaceans.

Given the observed threats and the existing knowledge, the Committee made the following general **recommendations** applicable to all small cetacean species in west and northwestern Africa.

- The tallying of cetacean landings be implemented as standard procedure for fisheries observers at the national level, including the collection of photographic material, recognising that small cetaceans are a *de facto* exploited marine living resource and therefore need to be monitored on a permanent basis.
- The implementation of an intensive biological sampling programme based on fresh carcasses, collecting data on morphological variation, reproduction, growth, feeding, stock identification, genetics, migratory habits, etc. of cetacean species.
- The use of platforms of opportunity to collect data on distribution, relative abundance and behaviour of cetaceans.
- Further assessment of the links between declining fish catches and increasing takes of small cetaceans in West Africa.

The sub-committee recognised that, at least in three of the west African countries, Ghana, Togo and Guinea, from which local experts were able to attend the meeting or send detailed working documents, the ongoing activities represent excellent examples of how the first two of these recommendations could be realised. At the same time, the sub-committee acknowledged the contributions already being made by scientists in Nigeria and Benin and recognised that there is a great need for capacity building and financial support before such programmes can be implemented. The same is true for São Tomé and Príncipe where the status of small cetacean populations has not been fully assessed and for the Cape Verde Islands where no study of small cetaceans has ever been conducted. Thus, the need for capacity building and the implementation of local monitoring programmes in both of these archipelagos was also acknowledged. With regard to the third recommendation, the sub-committee noted and commended the published work by Weir (2007) and de Boer (2010a; 2010b), much of which was based on data from platforms of opportunity (e.g. seismic survey vessels, oceanographic research vessels). Again, these were seen as excellent examples of how this recommendation can be realised in more areas. It is important to recognise that data obtained from operating seismic vessels is likely to be influenced by the evasive behaviour of cetaceans in response to the airgun noise; nevertheless, important information can be gained on species occurrence in otherwise unsurveyed areas as long as observer data are made public and published.

In conclusion, the Committee **recommended** international collaboration for funding and capacity building to support programmes for monitoring, management and conservation of coastal marine living resources in this region.

6.19.2 Atlantic humpback dolphins

Concern was raised by the sub-committee about the vulnerability of Atlantic humpback dolphins throughout their known range, noting their very near-shore distribution, apparently high site fidelity, limited movements and susceptibility to bycatch and hunting which could lead to local extirpation (SC/62/SM6, SC/62/SM9). It is likely that local extirpation has already occurred in some areas. Although much remains unknown about distribution and the extent to which it has changed over time as a result of human activities (e.g. bycatch, habitat degradation), current understanding is that there are regional pockets of relatively high density, such as in Senegal-The Gambia-Guinea-Bissau-Guinea-Sierra Leone, Gabon-Congo or Cameroon-Angola-Namibia.

The sub-committee **recommended** the following items for further conservation and research action for Atlantic humpback dolphins. These include due consideration of recommendations provided by the sub-committee at the 54th meeting of the IWC (IWC, 2002b) and the CMS regional action plan for the conservation of West African small cetaceans[1].

(1) Coordinated data collection should be facilitated in order to improve knowledge of the abundance, distribution and conservation status of *S. teuszii* throughout its known range. Specifically:
  (a) estimates of abundance and distribution are urgently required (including where feasible photo-id);
  (b) tissue samples should be obtained at every opportunity from stranded or bycaught Atlantic humpback dolphins. These need to be appropriately preserved and provided to scientists for genetic analyses investigating population structure;
  (c) critical habitats should be identified, including areas of high density and regular occurrence ('hotspots') and migratory pathways (if such exist), as candidates for focused conservation effort; and
  (d) overviews of existing knowledge, national species lists, specimen collections, research centres and protected areas should be compiled.
(2) Identify and mitigate known and potential threats to *S. teuszii*, particularly entanglement in fishing gear, directed take and anthropogenic noise. Specifically this should include:
  (a) improving the understanding of the causes, levels and impacts of bycatch on *S. teuszii*;
  (b) assessment of the causes, level and intensity of directed small cetacean takes;
  (c) efforts should be made to minimise the ecological impacts of fisheries on, and direct takes of, *S. teuszii* through the implementation of explicit fisheries management measures; and
  (d) ensure that all littoral developments and activities take into account their potential for having negative effects on small cetaceans and the environment.
(3) The designation and management of national and transboundary Marine Protected Areas that include *S. teuszii* habitat based on scientific data and broad stakeholder involvement should be encouraged.

The sub-committee also specifically **recommended** that regional or sub-regional research projects be conducted and management plans developed to conserve the populations of Atlantic humpback dolphins in particular areas. One of these is off Flamingos, Angola (Weir, 2009). Other important areas are along the coasts of Gabon-Congo and Senegal-The Gambia-Guinea-Bissau-Guinea-Sierra Leone where the humpback dolphin population(s) may be transboundary and where bycatch is a serious concern. Another is Mauritania where humpback dolphins were observed regularly in Banc d'Arguin National Park and environs over many years but may have declined recently (Van Waerebeek and Perrin, 2007). The sub-committee **strongly encouraged** scientists in the range states to submit collaborative proposals for funding so that transboundary problems can be addressed in a comprehensive way. In the case of Banc d'Arguin, Vély emphasised the benefits of collaborating with the staff of this National Park who have long-term monitoring data, local support resources and a mandate to monitor and protect the park's living resources. A similar situation exists in Gabon-Congo, where there is interest by national park staff to support conservation of Atlantic humpback dolphins.

In view of the growing concern (e.g. summarised in SC/62/SM6) that the Atlantic humpback dolphin faces some of the same threats that led to the extinction of the baiji and caused the vaquita to become critically endangered, the sub-committee **recommended** that IUCN reassess *S. teuszii* in the light of new information as it may qualify for a more threatened category than Vulnerable.

[1]Plan for Action for the Conservation of Small Cetaceans of Western Africa and Macaronesia, ratified in 2008 by West African member nations of CMS.

7. REPORT ON THE INTERSESSIONAL WORKING GROUP ON CLIMATE CHANGE

Simmonds summarised the ongoing plans for an IWC Workshop on the effects of climate change on small cetaceans. The Workshop plan (10-12 invited participants meeting for three days) was agreed by the Scientific Committee last year and funding was promised by a number of nations and NGOs during the 2009 Commission meeting. However, the Workshop was not held in the last intersessional period as the final funding was only confirmed late in the year. The steering group and convener (Simmonds) are now finalising plans for the Workshop which will probably be held in Vienna in November 2010 (see Appendix 2). Further details can be found in the report of the Scientific Committee from last year. Membership of the steering group remains open. The steering group has identified the following focal topics: restricted habitats, range changes and the Arctic region. During discussion it was suggested that pathogens should also be discussed and skin diseases could be used as a tool. The sub-committee **reconfirmed** its support for the meeting and several suggestions for suitable participants were made. The sub-committee will receive a full report of this meeting at the next Annual Meeting in 2011.

8. PROGRESS ON PREVIOUS RECOMMENDATIONS

IWC Resolution 2001-13 (IWC, 2002a) directs the Scientific Committee to review progress on previous recommendations relating to critically endangered stocks of cetaceans on a regular basis and the sub-committee noted that its previous recommendations stand until new information is received and considered.

8.1 Vaquita

The sub-committee reviewed new information on the critically endangered vaquita (*Phocoena sinus*). SC/62/SM3 reported on a survey in the Upper Gulf of California that was conducted in October-November 2008 in a joint effort between the governments of Mexico and the US. The primary objective was to test alternative acoustic detection technology as a means of monitoring trends in vaquita abundance. The NOAA research vessel *David Starr Jordan* was the main platform and visual effort was conducted under the same sampling protocol applied to estimate vaquita abundance in 1997, and the same areas were covered as in that survey. In 1997 the shallow areas were covered by a shallow-draft boat using visual sampling methods. In 2008 those areas were covered by a sailboat using an acoustic detector (Rainbow Click system with a 2-element oil-filled hydrophone array). Total abundance (based on both acoustic and visual data) was estimated as 250 animals (95% CI 110-564). The estimate for waters inside the vaquita refuge was 123 (95% CI 64-239). The total estimate for 1997 had been 567 (95% CI 177-1,073). Using a Bayesian approach, there was a 90.6% credibility that the population declined over the 11 years from 1997 to 2008. The same analysis using only the visual survey effort (as the stratum was the same in 1997 and 2008) resulted in a 99.9% credibility of decline. This finding is supported by the evidence that the overall distribution of the vaquita population did not change between the two surveys, indicating that the apparent decline was not an artefact of a distributional shift. Approximately half of the population appears to be present inside the vaquita refuge area at any time, with individuals moving freely into and out of the refuge. Hence, they are at risk of interaction with fishing operations when outside of the refuge, and this means that protection from bycatch is only partial.

The sub-committee thanked Jaramillo-Legorreta for bringing these results to the meeting and commended the hard work of the many scientists and others who raised the necessary funds and participated in the surveys and analyses.

There was discussion regarding the adequacy of the current refuge area. Jaramillo-Legorreta stressed that because fishermen consider waters inside the refuge to be a prime shrimping area, fishing activity is very intensive immediately outside its borders. The buy out programme begun by the Mexican government in 2007 has reduced the fishing effort by about 40% but over 600 boats (*pangas*) are still fishing and those fishermen who remain active are strongly committed and unlikely to accept the buy-out offers from the government. This makes it crucial to develop alternative fishing methods that do not involve the risk of vaquita bycatch. However, Jaramillo-Legorreta stated that development of such alternatives has proven extremely difficult and thus far, no method has been found that compares with gillnetting in terms of the ease and efficiency of capturing a certain quantity of shrimp.

The Mexican government made a commitment to reduce the vaquita bycatch to zero within three years starting in 2008. There is no data to confirm that the bycatch rate has been reduced. A reduction can only be inferred from the reduction in fishing effort. Jaramillo-Legorreta noted that a vaquita had been received by officials from the Department of Environment and Natural Resources and turned over to scientists to investigate cause of death, etc., within the last few weeks. He also indicated that because of the regulatory situation, fishermen generally no longer report and deliver bycaught vaquitas to authorities. Perrin noted that because of the small population size, bycatch is a rare event and an individual fisherman may only rarely, or never, even see a vaquita. This makes the implementation of regulations particularly challenging.

SC/62/SM5 reported an assessment of trends in vaquita abundance based on acoustic monitoring. A workshop took place in 2009 with the objective of developing a scheme to detect a decline of 10% per year within three years or 5% within five years, or to detect a 4% increase within five years. Data gathered during the 2008 survey were analysed and the C-POD was selected as the most reliable technology for achieving the objective. The workshop attempted to determine the sample size required to reduce sampling variance to the level of natural variability in the abundance estimates. Using simulation methods, it was established that natural variation is around 3.3% (CV). According to the variance obtained with the data gathered by C-PODs, it was estimated that an effort of 4,900 sampling days would be required. This requirement could be met by deploying 49 C-PODs for 100 days per year or 100 C-PODs for 49 days per year. The final agreed design involved 62 sampling sites inside the vaquita refuge where the probability of losing detectors is considered relatively low because fishing is not allowed there. Currently, implementation is in the phase of designing mooring systems and running a pilot test. It is anticipated that the scheme will be in operation by the end of this year (2010). The project is already funded, but provision must be made to ensure that the necessary resources for maintaining the detector network and for managing and analysing the data are in place for future years as this is by necessity a long-term programme. Jaramillo-Legorreta acknowledged the financial support provided to this work by a number of agencies and organisations in addition to the Mexican government: Cousteau Society, Ocean Foundation, US Marine Mammal Commission and International Fund for Animal Welfare.

Again, the sub-committee thanked Jaramillo-Legorreta for this update on the acoustic monitoring efforts and commended those involved for their hard work and commitment to the cause of saving the vaquita.

During discussion, Jaramillo-Legorreta clarified that although only 50 C-PODS are being considered in the sampling design, 62 C-PODs are going to be deployed so that even if some are lost or damaged, at least 50 will remain in place. Regarding costs of maintenance, these were expected to be low once all of the equipment has been purchased and deployed. Cipriano suggested and the sub-committee **agreed** that it would be useful to document (in working papers or publications) all of the costs of the vaquita conservation and monitoring efforts for future reference.

The Committee **remained gravely concerned** about the fate of the vaquita and it **reiterates** its previous recommendation (IWC, 2010, p.324) that, if extinction is to be avoided, all gillnets should be removed from the upper part of the Gulf of California. The Committee further **recommended** to intensify development and testing of alternative fishing gear (e.g. through a smart-gear competition) that fishermen can use in place of entangle gears. It also strongly **encouraged** Mexico to continue and intensify its efforts to conserve the vaquita.

8.2 Harbour porpoise

No primary papers on harbour porpoises were presented to the sub-committee at this meeting.

Bjørge reported that data from three years of bycatch monitoring in Norwegian waters were available but it had not been possible to prepare the information for presentation in time for the meeting. Bjørge also mentioned that a joint workshop of ASCOBANS/ECS recommended a revision of EU regulation 812/2004 on monitoring and mitigation of bycatch in gillnet fisheries. The present regulation does not include small vessels of less than 15m length, and this has significant implications for bycatch as a large number of small vessels operate without needing to adhere to the EU regulations. The sub-committee **recommended** that the EU regulation should be reviewed.

Ritter summarised available information on numbers of harbour porpoises reported bycaught in German fisheries and numbers found stranded on beaches of the German North Sea and Baltic from 2003 to 2009. Reported bycatch numbers are relatively low but the true levels are likely much higher given that at least 50% of the strandings are of animals that died in fishing gear. An increasing trend in bycatch is suspected. As last year, the sub-committee **expressed concern** about the ongoing evidence of large-scale bycatch in this region and noted, in particular, that the harbour porpoise population in the Baltic proper is red listed as Critically Endangered. Therefore it is important to obtain better information on both the scale of incidental mortality and the stock affinities of the affected porpoises.

Attention was drawn to the vulnerability of the recently identified and isolated Iberian population of harbour porpoises. The Committee **recommended** further study of this population.

8.3 Franciscana

The franciscana (*Pontoporia blainvillei*) is endemic to the eastern coasts of Brazil, Uruguay and Argentina and inhabits coastal waters from *ca* 18°25'S to *ca* 41°10'S. The species is regarded as one of the most threatened small cetaceans in South America due to high bycatch levels as well as increasing habitat degradation throughout its range and it is red-listed as Vulnerable by IUCN (see *http://www.iucn.org*). Four management stocks (known as Franciscana Management Areas or FMAs) have been defined: three in Brazil (FMA I-III), one extending into Uruguay (FMA III) and one in Argentina (FMA IV) (Secchi *et al.*, 2003). The conservation status of the franciscana is of concern due to high levels of incidental mortality in fisheries as well as habitat degradation.

SC/62/SM7 presented information on distribution and provided the first estimate of abundance of franciscanas in FMA II from aerial surveys conducted in December 2008 and January 2009 between the Brazilian states of Santa Catarina (~30°S) and Rio de Janeiro (23°S). A design-based approach was used to sample coastal (coastline to 30m isobath) and offshore (30-50m isobaths) strata along the range of the species and mark-recapture distance sampling methods (MRDS) were used to estimate abundance. Survey sampling also included an area believed to correspond to a hiatus in the distribution between FMA I and FMA II. A total of 60 franciscana groups (157 individuals) were seen in the coastal stratum. No sightings were recorded in the offshore stratum and in the hiatus area, but sampling in the former was limited due to consistently poor weather conditions. Average group size was 2.7 (SE=0.17). Abundance corrected for perception and availability bias was estimated to range between 8,000 and 9,000 individuals (CVs=0.32-0.35). Possible sources of bias in these estimates include underestimation of group size from the aircraft, poor survey coverage in the offshore stratum and the use of franciscana diving parameters estimated from data collected outside of FMA II in the estimation of availability bias. Current estimates of incidental mortality in FMA II correspond to 3.3-6.2% of the estimated population size presented here, suggesting high, likely unsustainable bycatch. Other sources of unaccounted-for mortality are not well known and require monitoring to better assess the chances of long-term survival of franciscanas inhabiting southeastern and southern Brazil.

The sub-committee **noted** that this paper addressed recommendations from previous years (IWC, 2005, p.309). In particular, the aerial surveys were conducted in an area for which no abundance studies had been carried out. In addition, the surveys incorporated a double observer method to produce a correction for perception bias in the estimation of franciscana detection probability. The sub-committee concluded that the estimates of abundance in this study were likely negatively biased because of limited coverage of the offshore stratum and because estimates of group size from aircraft have consistently been smaller than the estimates of group size made from boats and land observation sites in the same region.

With regard to the aerial surveys in FMA II, the sub-committee commended Zerbini and his co-workers for their excellent work and **recommended** that further studies be carried out to:

(1) improve estimates of visibility bias;
(2) evaluate potential biases in the estimation of group sizes; and
(3) estimate franciscana diving parameters in areas where such information is not available.

The sub-committee also **recommended** that franciscana bycatch be estimated in areas for which bycatch estimates are currently unavailable and that assessments be carried out of other possible threat factors such as underwater noise, chemical pollution from coastal development and industrial and human waste discharge, oil and gas exploration activities and vessel traffic.

In introducing Mendez *et al*. (2010), Rosenbaum briefly summarised previous analyses that complement the genetic results on genetic population structure in Brazil (Secchi *et al.*, 1998) and in Brazil, Uruguay and southern Buenos Aires province, Argentina (Lázaro *et al.*, 2004). Mendez *et al.* (2008) analysed mtDNA of specimens from Brazil (*n*=14), Uruguay (*n*=38) and Argentina (*n*=138), by reanalysing previously published data and contributing new samples collected in different localities in Northern, Central and Southern Buenos Aires in Argentina (*n*=135).

Based on mtDNA data, Secchi *et al.* (1998) proposed the existence of at least two Brazilian populations and Lazaro *et al.* (2004) suggested an additional population in Uruguay and a second one in southern Argentina. Mendez *et al.* (2008) suggested that there was substructure in Argentina, with a northern Argentina population in the Samborombon Bay area and a southern population around Claromecó in southern Buenos Aires (the samples previously analysed by Lazaro).

Mendez *et al*. (2010) analysed mtDNA and nuclear data from 12 microsatellite loci from an expanded dataset consisting of 275 franciscana samples from Argentina. Using a combination of frequency-based, likelihood and Bayesian approaches, they found support for the previous suggestion of fine-scaled population structure within Argentina, with at least three population groupings: Northern Buenos Aires, Eastern Buenos Aires and Southern Buenos Aires. Such population structure patterns were concordant with significant environmental heterogeneity. By evaluating ten years of spatially explicit remote sensing oceanographic data covering the entire southern distribution of the franciscana, environmental breaks were detected that were spatially concordant with the observed genetic structure.

Mendez *et al*. (2010) stressed that considering all franciscana genetic analyses to date, there is strong evidence for the existence of at least three populations in Brazil (FMAs I, II and III), one in Uruguay (FMA III) and three in Argentina (FMA IV). Rosenbaum speculated that these populations may be locally adapted to distinct environmental conditions and therefore that the protection of local habitat in its current state, with consideration for potentially changing environmental conditions, is necessary for conservation of the local populations and in turn the species.

The sub-committee welcomed the new information and **encouraged** the continuation of research and conservation efforts for franciscanas in Argentina, particularly in light of the high bycatch rates. The sub-committee **recommended** that the possibility of further population sub-structure within the other FMAs be investigated.

8.4 Narwhal

In its report last year (IWC, 2010, p.325), the sub-committee noted that new estimates of narwhal abundance had recently become available. In the intersessional period the results of aerial surveys in Canada indicating total abundance greater than 60,000 narwhals were published (Richard *et al.*, 2010). Also, the NAMMCO Scientific Committee considered the new estimates from Greenland in its management advice given in April 2009 (IWC/62/4). At its 2009 meeting the NAMMCO Council (NAMMCO, 2010, pp.96-97) considered the new information on narwhal abundance and revised its management advice accordingly. The 2005 NAMMCO assessment had concluded that narwhals in West Greenland were highly depleted and that annual sustainable harvest levels would be as low as 15-75 animals. However, population modelling with the new survey data from 2007 and 2008 indicated that overall abundance was at 51% (95% CI: 27-79%) of carrying capacity, with a 2009 modelled abundance of 12,000 (95% CI: 6,200-26,000), and NAMMCO concluded that its management objectives would be met at 70% probability with annual total removals of 310 (West Greenland) and 85 (East Greenland).

The sub-committee thanked Acquarone for providing this information on behalf of NAMMCO and encouraged the maintenance of closer links between the NAMMCO and IWC Secretariats in regard to the sharing of information, e.g. catch data. The suggestion was also made and discussed that a joint special meeting or workshop on monodontids (involving IWC, NAMMCO, Canada-Greenland Joint Commission on Narwhal and Beluga) should be considered in the near future, assuming that a data availability agreement could be established in advance. Acquarone advised that the next meeting of the NAMMCO Scientific Committee and JCNB scientific working group would probably be in early 2012, leaving adequate time to explore the potential of a joint meeting/workshop. The sub-committee **agreed** that an e-mail working group convened by Bjørge would follow up this possibility during the intersessional period and report back at the next meeting.

Some uncertainty was expressed about whether monodontids are a high priority of the sub-committee at this time particularly in view of the recent narwhal abundance estimates. However, Reeves noted that the Greenland and Canadian High Arctic narwhal stocks are not the only monodontids of concern. There are numerous exploited stocks of belugas in Canada, Alaska and Russia and of narwhals in Hudson Bay/Hudson Strait (Canada) as well as unexploited but small stocks of belugas in Cook Inlet (Alaska) and the St Lawrence River (Canada). Also, the potential for significant changes in sea ice regimes to affect monodontid distribution, ecology and numbers has been widely acknowledged.

8.5 Irrawaddy dolphin

The freshwater population of Irrawaddy dolphins (*Orcaella brevirostris*) in the Mekong River is red-listed by IUCN as Critically Endangered (Smith and Beasley, 2004).

SC/62/WW4 reported on dolphin-watching tourism in the Mekong where photo-identification studies indicate dolphins exhibit high site fidelity to particular deep-water pool areas that are very limited in size (1-2km^2). The population, which according to Bejder has low genetic diversity based on preliminary analyses by M. Kreutzen, has a high mortality rate with 46 carcasses (54% classified as 'newborns') recovered from 2003-05. The cause of the high rate of newborn mortality in particular remains unknown. Dolphin-watching began in two areas in the early 1990s and it has remained unmanaged and unregulated. These two areas contain some of the most important habitat for the dolphin population in the Mekong River, which is now thought to number fewer than 100 individuals. Initially, at both locations, dolphin watching was land-based, with a few rowboats occasionally used to take tourists into the pools to view the animals. This later expanded to involve approximately 15 motorised boats by the early 2000s and more than 20 in recent years.

Bejder noted that there is currently no information on what effects the 20+ tour boats operating at the pools might be having on the behaviour and ecology of the dolphins. SC/62/WW4 recalled that *'[t]here is compelling evidence that the fitness of individual odontocetes repeatedly exposed to whale-watching vessel traffic can be compromised and that this can lead to population level effects*' (IWC, 2006a, p.47) and argued that an adaptive, precautionary approach is essential to managing tourism that targets small, closed, resident communities of cetaceans such as in this case. SC/62/WW4 recommended a range of management interventions, all aimed at decreasing the exposure of dolphins to dolphin-watching vessels. It was argued that for this Critically Endangered population, a 'no vessel-based dolphin tourism' policy is desirable, given that there are high sighting rates within deep pools and that this should facilitate sustainable land-based tourism.

Reeves summarised information received from Gordon Congdon of WWF-Cambodia concerning the current situation in the Mekong as follows.

In 2008 the World Wide Fund for Nature (WWF) Cambodia and the Cambodian Department of Fisheries estimated that the population of Mekong dolphins was about 70 based on a photographic mark-recapture analysis. This estimate did not include a correction for the percentage of unidentifiable individuals, predominantly calves and juveniles. Data from surveys in 2009 and 2010 are still being analysed and an updated population estimate is expected to be available in a few months. The as yet unpublished estimate of 70 is substantially lower than a 2004 estimate of 95 identifiable individuals by Isabel Beasley. Mortality records indicate that at least 92 dolphins, approximately 63% of them classified as calves, have died in the period 2003-2009. In 2010 at least four animals (2 of them calves) had died as of the end of May. The causes of the high mortality are not entirely clear. It is known that some animals have died in gillnets, but there may be other unidentified causes of mortality as well. At a meeting convened by WWF-Cambodia in Phnom Penh in October 2009, an invited group of international experts (R.R. Reeves, R.L. Brownell, Brian Smith, Frances Gulland, Wang Ding, Sam Turvey, Leigh Barrett) concluded that most of the mortality of dolphins in the Mekong was likely due to entanglement in fishing gear and that conservation efforts should focus on the elimination of gillnets in the core habitat for dolphins in the 200km stretch of the Mekong between Kratie town and the Lao border.

Congdon further reported that in Cambodia the conservation of dolphins in the Mekong is primarily the responsibility of the Commission on Dolphin Conservation and Ecotourism Development (Dolphin Commission) which was established in February 2006 by the Cambodian Royal

Government out of concern about the high dolphin mortality rate and interest in the development of 'ecotourism' in Cambodia. Despite substantial efforts by the Dolphin Commission, the mortality rate remains high and the population apparently is continuing to decline. Dolphin conservation efforts in Cambodia have been hindered by inadequate funding for the Dolphin Commission and the lack of regulations that could help to reduce or eliminate the use of gillnets. There is also a need for much better cooperation among the Dolphin Commission, the Fisheries Administration, and WWF. WWF and the Fisheries Administration are currently working to develop protected areas and other regulatory tools to protect dolphins. WWF and local NGOs are also working with local communities to reduce gillnet use and to develop alternative livelihoods in order to reduce fishing pressure in core dolphin habitat. Efforts are also underway to develop transboundary agreements between the governments of Cambodia and Laos to protect dolphins that inhabit the Cheuteal Pool on the Lao-Cambodia border. The population of Irrawaddy dolphins in the Mekong is at a critically low level. It will take a strong and concerted effort on the part of the Cambodian government and all other stakeholders to prevent the extirpation of this population. It is imperative that all responsible parties, especially the Dolphin Commission, the Fisheries Administration, the Lao government and WWF collaborate closely to reduce all causes of mortality so this population can stabilise and recover.

There was some discussion of the heavy scarring on the bodies of Mekong dolphins and the fact that this is not consistent with what is observed in at least some other parts of the species' range (e.g. the Ayeyarwady River in Myanmar). This subject deserves closer study as it is unclear whether such scarring is a 'natural' feature of this population or somehow related to human activities.

The sub-committee **expressed grave concern** about the rapid and unexplained decline of this riverine population. It **commended** the efforts by Cambodian government agencies and WWF-Cambodia to diagnose the cause(s) of this decline, and **strongly recommended** that every effort be made to stop and reverse the decline, e.g. by immediately eliminating or greatly reducing the amount of entangling gear in the pool areas used most intensively by the dolphins and by taking immediate steps to reduce the exposure of the dolphins to tour-boat traffic.

8.6 Other

SC/62/SM2 was an update of Amaral *et al*. (2009), the goal of which is to revise the model of worldwide population structure of common dolphins, genus *Delphinus,* using a multilocus approach. The study presented in SC/62/SM2 included more samples from additional oceanic regions in the mitochondrial DNA dataset and used several nuclear molecular markers. The samples included short-beaked animals from populations in the North Atlantic, northeast (NE) Pacific, southwest Pacific and southeast Indian Ocean; long-beaked animals from populations in the NE Pacific and South Atlantic and animals of the *tropicalis* form from the western Indian Ocean. The main findings were that the long-beaked population in the NE Pacific is highly differentiated from all other populations based on both nuclear and mitochondrial markers. These results reinforce the conclusion from the 2009 meeting of this sub-committee that a taxonomic revision of the long-beaked populations is needed. Regarding the short-beaked populations, the differentiation between populations occurring in different oceans is even higher that suggested in Amaral *et al*. (2009). As would be expected, levels of gene flow were higher within the same ocean. Future analyses will include estimations of migration rates between the different populations and estimations of divergence times. This study also highlighted the difficulty of obtaining informative molecular markers other than mitochondrial DNA and microsatellites, due to the low overall level of polymorphism in the nuclear genome of common dolphins.

When asked if she had been able to determine whether *D. cf. tropicalis* (the long-beaked form in the northern Indian Ocean) was closer to the long-beaked form in the SE Atlantic or to that in the NE Pacific, Amaral stated that she had been able to extract only mtDNA from the *tropicalis* specimens and that analyses of microsatellite markers would be required to resolve this question.

The sub-committee thanked Amaral for this update and **encouraged** the continuation of her global study of the genus. It also **recommended** that efforts should be made to obtain samples from oceanic regions where both short-beaked and long-beaked forms occur, as is the case in West Africa and the SE Pacific.

9. OTHER INFORMATION PRESENTED

SC/62/BC6 was a preliminary global review of operational interactions between odontocetes and the longline fishing industry and potential approaches to mitigation. This is a global problem involving two types of risk, on one hand that the odontocete populations will decline because of bycatch mortality and on the other hand that the longline fisheries will become economically unviable because of catch depredation. Therefore mitigation strategies are needed to ensure the sustainability of both the odontocete populations and the longline fisheries. Bycatch of odontocetes occurs globally in many longline fisheries and involves at least 13 species. Of the few cases reported, bycatch ranged between 0.002 and 0.231 individuals caught per set. The inadequacy of life history and population data makes it difficult to assess sustainability of the bycatch in most cases.

Considerable effort has been devoted to solving the depredation problem and potential solutions have included acoustic and physical tools. Acoustic approaches to mitigation have proven problematic but recent trials using physical depredation mitigation devices (PDMDs) have yielded promising results. The experience of fishermen and their enthusiasm to be involved in developing mitigation tools should not be underestimated. Governments, research institutions, fisheries and funding bodies associated with this problem are encouraged to participate and invest in international collaborations that focus on finding globally applicable solutions.

During discussion Reeves and Bjørge noted that longline fisheries for halibut and Greenland halibut in the northern North Atlantic have increasingly experienced problems with depredation of catches by northern bottlenose whales (*Hyperoodon ampullatus*). When asked if any evidence had been found of odontocetes taking bait from the longlines, Childerhouse stated that although cetaceans are often blamed for bait stealing, fish could also (or instead) be responsible in some cases.

The sub-committee thanked Childerhouse for bringing this widespread and possibly growing problem to its attention.

Panigada presented information regarding the current and ongoing commitment of the Italian government (Ministry of the Environment) to conduct systematic abundance surveys of small cetaceans in Italian waters, including the Pelagos Sanctuary. Such monitoring is among the priority actions mentioned in the Sanctuary Management Plan and by ACCOBAMS and the Specially Protected Areas and Biodiversity Protocol under the Barcelona Convention. Two aerial surveys were conducted within the borders of the Pelagos Sanctuary in winter (the first time the full Sanctuary area has been covered) and summer 2009 and one in the Ionian Sea and Gulf of Taranto in May 2010, providing winter and summer abundance estimates for striped dolphins. The distribution data from the surveys strongly suggest that the Sanctuary does not cover the full population ranges of striped dolphins. Among the preliminary conclusions from the survey data are that:

(1) there is substantial variation in the density and abundance of striped dolphins between the winter and summer seasons, with higher numbers using the Sanctuary area during the summer months, when human activities (and their potential impacts) are at their maximum levels; and
(2) these density and distribution data will serve as a valuable baseline for the proposed ACCOBAMS basin-wide survey and help guide further development of a long-term monitoring programme.

Plans are in place for further surveys in the summer of 2010 covering the northern and central Tyrrhenian Sea, the Pelagos Sanctuary and the Sea of Sardinia.

Fortuna informed the sub-committee that another aerial survey financed by the Italian Government (Ministry of Agriculture, Food and Forestry and Ministry of the Environment) would cover the entire Adriatic Sea. This survey will take place next July and August and results will be presented at the next meeting of this sub-committee. The initiative is also supported by ACCOBAMS and it represents an opportunity to train local scientists from Albania, Italy, Croatia, Montenegro and Slovenia. She also emphasised that all of these efforts were possible owing to the initial technical support of the IWC Scientific Committee.

Štrbenac reported that a basin-wide survey of cetaceans in the Mediterranean and Black Seas remains one of ACCOBAMS's highest priorities. Activities are underway to start such a survey in the next three years (2011-13).

The sub-committee welcomed the new information and supported continuation of such efforts in the Mediterranean Sea and adjacent areas. The sub-committee specifically **endorsed**, as it had in the past, implementation of the ACCOBAMS basin-wide survey as soon as possible.

Flores advised the sub-committee of a workshop on common bottlenose dolphins in the southwestern Atlantic held in April 2010 in Rio Grande, Brazil. He noted that the final report of this workshop will be available later this year and that selected papers and working group reports will be published in the *Latin American Journal of Aquatic Mammals*.

Parsons mentioned two upcoming meetings to be held by the Society for Conservation Biology: the Second International Marine Conservation Congress (14-18 May 2011, Victoria, British Columbia, Canada) and the First International Marine Conservation 'Think Tank' (November/December 2011, Christchurch, New Zealand) which have workshop, symposium and focus group themes that may be of interest to sub-committee members (for example they may focus on small isolated populations)[2].

[2]See *http://www.conbio.org/MARINE* for details.

10. TAKES OF SMALL CETACEANS

At the last meeting, the sub-committee discussed various problems associated with the compilation of data on takes of small cetaceans including both direct catches and bycatch (IWC, 2010, pp.326-8). It recommended a series of changes in how the data should be compiled, reported and interpreted. The process of setting up a system for electronic submission of this data directly by national representatives is still ongoing. The information retrieved by the Secretariat from national progress reports was reviewed (see Annex O). Data on bycatch of small cetaceans is presented in national progress reports.

The sub-committee **reiterated** the importance of having this information submitted and **encouraged** all countries to do so.

The observer from NAMMCO advised that catch data from member countries are routinely published on their website *http://www.nammco.no*. This includes Greenland's catches of narwhals and belugas but does not include the catches of these species in Canada, the US and Russia.

Kasuya pointed out that in ten documents presented at this meeting, there was information from 12 West African countries indicating human consumption of cetaceans, exchange of cetacean meat in markets or direct capture of cetaceans (see Table 1, p.273). Concern was expressed about this situation, mainly because once cetaceans are used as food or are sold in markets, targeted hunting is likely to develop.

Kaufman presented information on a study by C. Castro and P. Rosero on small cetacean interactions with fishing gear in Machalilla National Park, Ecuador. This study analysed information obtained from 185 fishing trips (52 boats using gillnets, 125 purse-seine vessels and 6 with longline hook) off Puerto Lopez, Salango Machalilla from April-September 2009. Scientific observers logged 3,788.65 hours with the fishermen. All bycatches involved gillnets (trammel nets) with 5-inch mesh eye. Four species of cetaceans were caught incidentally in July, two common bottlenose dolphins (28.57%), a dwarf sperm whale (14.28%), two Risso's dolphins (28.57%) and two pantropical spotted dolphins (28.57%). The mortality rate was 0.07 dolphins/day in July and 0.18 dolphins/day in August. Over 400 fishermen participated in training and educational workshops related to reduction of bycatch and conservation of cetaceans.

In discussion, Kaufman explained that Machalilla National Park has a large marine component encompassing Isla de la Plata and much of the fishing occurs within park boundaries. Also, he noted that the apparent increase in bycatch rates at Puerto Lopez (0.07 dolphins/day in this study compared with that reported by Félix and Samaniego (1994special issuepart 1) in 1993) was probably due to both better reporting and increased fishing effort. The sub-committee thanked Kaufman for bringing this information and **expressed concern** about the implications of the documented bycatch. It would be valuable to have clearer information on the scale of the fisheries involved and therefore the implied magnitude of the cetacean bycatch. The sub-committee looked forward to a more detailed report next year.

11. ANY OTHER BUSINESS

11.1 Voluntary fund for small cetacean conservation research

Gales brought to the sub-committee's attention a proposed mechanism and procedure for allocating project support for high priority conservation projects (e.g. improving status of threatened species, capacity building) from the IWC Small Cetacean Research Fund. The IWC Small Cetacean Research Fund is intended to support high priority research that demonstrably links to improving conservation outcomes for small cetaceans globally, particularly those that are threatened or especially vulnerable to human activities. Preference for funding will be based on a determination of need, the quality of the research application and the demonstration of links between research and conservation outcomes. Proposals that demonstrate a capacity building legacy will be viewed favourably.

The IWC Small Cetacean Research Fund, which was substantially increased through an Aus$500,000 voluntary donation from the Government of Australia, will be used to fund approved research. In order to maximise the number of projects supported by the fund, and hence enhance conservation outcomes for small cetaceans, any single proposal will be limited to a maximum of US$50,000. Other IWC member governments will also be encouraged to provide additional voluntary donations to the fund to further support small cetacean research.

A funding application form will be developed and made available via the IWC Secretariat. Applications for funding should be received by the Secretariat at least 60 days prior to the start of the annual meeting of the Scientific Committee. A Small Cetacean Research Fund Review Group will be appointed by the Convenor of this sub-committee and that group will conduct a review of project proposals according to an agreed scoring process that takes account of the objectives of the research fund. The group will rank the proposals and make recommendations for funding to the sub-committee. The group may suggest improvements to proposals where appropriate and can solicit the assistance of other researchers in the review process if necessary.

The Small Cetacean Research Fund Review Group will present the recommended projects and budgets to the sub-committee for its consideration (and potential revision). Approved proposals will be added to the Scientific Committee budget as a specific request to the Small Cetacean Research Fund (i.e. outside the normal Scientific Committee research budget). This final budget request will then form part of the Report of the Scientific Committee. The Secretariat will organise contracts for the successful projects.

The sub-committee emphasised the importance of ensuring that proposal review and project selection are based solely on the criteria and priorities as agreed by the sub-committee and its Small Cetacean Research Fund Review Group. Also, the sub-committee **agreed** on the importance of ensuring that, in addition to a call for proposals via a circular from the IWC Secretariat to all members of the Scientific Committee, a broader announcement mechanism is desirable (the Society for Marine Mammalogy website was suggested as a potentially suitable avenue). In addition, it is important to consider the need for adequate lead time with the call for proposals to allow them to be delivered on time as per the procedures outlined above.

The sub-committee also emphasised the importance of building the Fund by obtaining donations from additional sources. Gales emphasised that the contribution by Australia was not recurrent but rather a one-time donation. Therefore as projects are supported, the size of the Fund will diminish unless more donors come forward. It also noted that good outcomes from the research that is funded should encourage more countries to contribute.

The Committee **expressed** its gratitude to the Government of Australia for its generous contribution to the Voluntary Fund for Small Cetacean Conservation Research, which will make a significant difference to the Fund's ability to pursue its conservation priorities.

Fortuna reminded participants that several countries were already providing funds specifically to support the attendance of invited participants at Scientific Committee meetings (e.g. scientists from West Africa at this year's meeting). This need will continue to exist. In some cases the grants to researchers may include support for them to attend Scientific Committee meetings and present their results. Gales clarified that the Small Cetacean Research Fund is to be managed by this sub-committee and if an application shows that attendance to one or more meetings is likely to lead to conservation action, such attendance would be considered a valid use of the funds.

11.2 Project proposal for the voluntary fund for small cetacean conservation research

Zerbini presented a proposal (see Appendix 3) for funding by the Small Cetacean Conservation Research Fund entitled 'Threatened Franciscanas: Improving Estimates of Abundance to Guide Conservation Actions'. Other researchers directly involved would be Eduardo Secchi, Daniel Danilewicz, Artur Andriolo and Paulo Flores. In addition Zerbini expressed his intention to collaborate closely with other researchers in South America who have been working on this species.

The proposed work is directly linked to previous recommendations of this sub-committee, beginning in 2004 when a review of the status of the franciscana was its priority topic (IWC, 2004, pp.307-12; 2006b, p.314), and the proposal also responds directly to recommendations made at the present meeting based on consideration of SC/62/SM7 (see above). There was strong support in the sub-committee for the proposal, based on the following considerations:

- the franciscana is threatened by a variety of human activities in the region, particularly artisanal fishing;
- the proposal addresses a clear conservation need as expressed in sub-committee recommendations;
- more robust estimates of franciscana abundance (along with improved, more nearly complete estimates of bycatch as well as assessments of other threat factors) are needed to assess the status of populations and develop appropriate mitigation efforts; and
- the proponents have a strong track record (e.g. as reflected in the quality of the work described in SC/62/SM7).

The sub-committee therefore **recommends** that the proposal be funded by the Small Cetacean Conservation Research Fund and also that a full report on the results be provided for consideration at a future meeting.

12. WORK PLAN

The sub-committee reviewed its schedule of priority topics which currently includes:

(1) systematics and population structure of *Tursiops*;
(2) status of ziphiids worldwide; and
(3) fishery depredation by small cetaceans.

After a brief discussion, the sub-committee **agreed** that the priority topic for the next Annual Meeting would be the status of Ziphiidae (beaked and bottlenose whales) worldwide.

The systematics and population structure of *Tursiops* has been on the sub-committee's list of topics to consider for many years. It was noted that there is probably still not much available information from some areas where the genus occurs. This was ascertained in a workshop recently held in October 2009 at the 18th Biennial Conference of the Society for Marine Mammalogy in Quebec, which focused on the creation of a consortium to investigate the taxonomic status of bottlenose dolphins in the Indian Ocean and adjacent waters. A similar scenario probably exists in other oceanic regions (e.g. South Atlantic); therefore the sub-committee decided to further postpone the discussion of this subject as a priority topic.

Although some support was expressed for fishery depredation as a priority topic, it was agreed that further thought should be given to the scope of such a review (e.g. mitigation only, documentation only, or a combination of both) and to how it should be organised (e.g. involvement of specialists in fishing gear and operations). One possibility was that it could be the subject of a pre-meeting Workshop, similar to the Workshop on Bycatch Mitigation just prior to the 2000 meeting of the sub-committee (IWC, 2001). In such a case, it might be decided to include all species and not just small cetaceans (e.g. sperm whales).

Flores drew the sub-committee's attention to the wealth of recent information on the Guiana dolphin (*Sotalia guianensis*) (since 2002, >150 peer-reviewed articles, 42 book chapters, a proceedings volume containing 22 papers, numerous academic theses and dissertations) and noted that the current National Action Plan for the Conservation of Aquatic Mammals of Brazil recognises the Guiana dolphin as a species. He offered a number of reasons for considering a review of the species as a priority topic at a future sub-committee meeting. These included:

- available estimates indicate that most populations are small except for one in southeastern Brazil;
- the 'population' or 'management unit' off southeastern Brazil has no mtDNA genetic diversity;
- there is strong evidence of genetic population structuring, with six to eight 'management units' proposed for the Brazil coast;
- some populations have individuals with high levels of residency, strong site fidelity, small home ranges, restricted daily movements and low genetic diversity;
- contaminant levels appear high in areas of low abundance;
- incidental catches occur throughout the range of Guiana dolphins but catch rates are known for only a few locations;
- direct takes have been recorded in some areas off North Brazil and in other range states; and
- boat traffic has immediate and short-term to medium-term effects on Guiana dolphin behavioural reactions based on five studies conducted.

During discussion, Perrin clarified that the IUCN Red List programme will soon publish separate assessments of the Guiana dolphin and the tucuxi, both of which are considered Data Deficient.

The sub-committee thanked Flores for providing this information on Guiana dolphins and looked forward to reviewing relevant studies at future meetings. However it was noted that the species had been reviewed quite recently as part of the review of small cetaceans in the Caribbean Sea and western tropical Atlantic (IWC, 2007) and suggested that it be considered as a possible secondary topic at a meeting in the near future but not as the priority topic next year.

As mentioned a number of times in this year's sub-committee report, there is increasing evidence of directed takes of small cetaceans for human use within local small-scale fisheries in some areas of Africa, Asia and South America. Some of these takes are related to decreases in fishing incomes, suggesting that cetaceans are serving as some type of substitute for other resources that are becoming scarcer in relation to demands for human consumption (so-called 'marine bushmeat'), bait for fisheries or income generation (including the sale of stranded or bycaught animals). Noting the status of global fisheries, and that this problem may originate at least in part from the effects of industrial fisheries on traditional fisheries, the sub-committee considered that an integrated view was warranted. It is reasonable to suspect a relationship between dwindling fish stocks (whether as a result of overfishing, habitat degradation or climate change) and the increased incidence of directed hunts of cetaceans.

The sub-committee **agreed** to add this issue as a potential future priority topic, depending on the results of an initial global review and assessment by an intersessional e-mail working group. Ritter agreed to convene this group, to collate information and report back at the next Annual Meeting.

13. ADOPTION OF REPORT

The report was adopted at 16:27 on 7 June 2010.

REFERENCES

Amaral, A.R., Beheregaray, L.B., Sequeira, M., Robertson, K.M., Coelho, M.M. and Möller, L.M. 2009. Worldwide phylogeography of the genus *Delphinus* revisited. Paper SC/61/SM11 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 12pp. [Paper available from the Office of this Journal].

Anon. 1953. Limits of Oceans and Seas. *International Hydrographic Organisation Special Publications* 23. International Hydrographic Bureau, Monaco.

Anon. 2008. Draft action plan for the conservation of small cetaceans of western Africa and Macaronesia - Rev.1. UNEP/CMS-WATCH II-Doc.4-Rev.1.

Bamy, I.L., van Waerebeek, K., Bah, S.S., Dia, M., Kaba, B., Keita, N. and Konate, S. 2010. Species occurence of cetaceans in Guinea, including humpback whales with southern hemisphere seasonality. *Marine Biodiversity Records* 3(e48): 10pp. Published online.

Brashares, J.S., Arcese, P., Sam, M.K., Coppolillo, P.B., Sinclair, A.R.E. and Balmford, A. 2004. Bushmeat hunting, wildlife declines, and fish supply in West Africa. *Science* 306: 1180-83.

Cadenat, J. 1956. A propos de cachalot. *Notes Afr.* 71: 82-92. [In French].

Cadenat, J. 1957. Observations de cetaces, sireniens, cheloniens et sauriens en 1955-1956. *Bulletin de l'IFAN* 19A: 1358-75. [In French].

Cadenat, J. 1959. Rapport sur les petits cetaces ouest-africains. Resultats des recherches entreprises sur ses animaux jusqu'au mois de mars 1959. *Bulletin de l'IFAN* 21A: 1367-409. [In French].

Clapham, P. and van Waerebeek, K. 2007. Bushmeat and bycatch: the sum of the parts. *Mol. Ecol. Notes* 16: 2607-09.

De Boer, M.N. 2010a. Cetacean distribution and relative abundance in offshore Gabonese waters. *JMBA*: In press.

De Boer, M.N. 2010b. First record of an anomalously white rough-toothed dolphin (*Steno bredanensis*) off West Africa including notes on rough-toothed dolphin surface behaviour. *Biodiversity Records* In press: 14pp.

Félix, F. and Samaniego, J. 1994. Incidental catches of small cetaceans in the artisanal fisheries of Ecuador. *Rep. int. Whal. Commn (special issue)* 15: 475-80.

Fertl, D., Jefferson, T.A., Moreno, I.B., Zerbini, A.N. and Mullin, K.D. 2003. Distribution of the Clymene dolphin *Stenella clymene*. *Mammal Rev.* 33: 253-271.

Flores, P.A.C. 2008. Occurrence of Franciscana (*Pontoporia blainvillei*) in Bahia Norte, Southern Brazil. *LAJAM* 7(1-2).

Hardman-Mountford, N.J., Richardson, A.J., Agenbag, J.J., Hagen, E., Nykjaer, L., Shillington, F.A. and Villacastin, C. 2003. Ocean climate of the south east Atlantic observed from satellite data and wind models. *Prog. Oceanogr.* 59: 181-221.

Hazevoet, C.J. and Wenzel, F.W. 2000. Whales and dolphins (Mammalia, Cetacea) of the Cape Verde Islands, with special reference to the humpback whale (*Megaptera novaeangliae*) (Borowski, 1781). *Contrib. Zool.* 69(3): 197-211.

Heyning, J.E. and Perrin, W.F. 1994. Two forms of common dolphins (genus *Delphinus*) from the eastern North Pacific: evidence for two species. *Contrib. Sci. Los Angel.* 442: 1-35.

International Whaling Commission. 2001. Report of the Scientific Committee, Annex L. Report of the Workshop on Bycatch Mitigation Measures in Static Fisheries. *J. Cetacean Res. Manage. (Suppl.)* 3:292-96.

International Whaling Commission. 2002a. Chair's Report of the 53rd Annual Meeting. Annex C. Resolutions Adopted During the 53rd Annual Meeting. Resolution 2001-13. Resolution on small cetaceans. *Ann. Rep. Int. Whaling Comm.* 2001:60.

International Whaling Commission. 2002b. Report of the Scientific Committee. Annex K. Report of the Standing Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 4:325-38.

International Whaling Commission. 2003. Report of the Scientific Committee. Annex L. Report of the Sub-Committee on whalewatching. *J. Cetacean Res. Manage. (Suppl.)* 5:382-91.

International Whaling Commission. 2004. Report of the Scientific Committee. Annex L. Report of the Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 6:315-34.

International Whaling Commission. 2005. Report of the Scientific Committee. Annex L. Report of the Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 7:307-17.

International Whaling Commission. 2006a. Report of the Scientific Committee. *J. Cetacean Res. Manage. (Suppl.)* 8:1-65.

International Whaling Commission. 2006b. Report of the Scientific Committee. Annex L. Report of the Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 8:221-40.

International Whaling Commission. 2007. Report of the Scientific Committee. Annex L. Report of the Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 9:297-325.

International Whaling Commission. 2010. Report of the Scientific Committee. Annex L. Report of the Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage (Suppl.)* 11(2):306-31.

Jefferson, T.A., Curry, B.E., Leatherwood, S.E. and Powell, J.A. 1997. Dolphins and porpoises of West Africa: a review of records. *Mammalia* 61(1): 87-108.

Jefferson, T.A. and Van Waerebeek, K. 2004. Geographic variation in skull morphology of humpback dolphins (genus *Sousa*). *Aquat. Mamm.* 30(1): 3-17.

Lázaro, M., Lessa, E.P. and Hamilton, H. 2004. Geographic genetic structure in the franciscana dolphin. *Mar. Mammal Sci.* 20(2): 201-14.

Mendez, M., Rosenbaum, H.C. and Bordino, P. 2008. Conservation genetics of the franciscana dolphin in northern Argentina: population structure, by-catch impacts, and management implications. *Conserv. Genet.* 9(2): 419-35.

Mendez, M., Rosenbaum, H.C., Subramaniam, A., Yackulic, C. and Bordino, P. 2010. Isolation by environmental distance in mobile marine species: molecular ecology of franciscana dolphins at their southern range. *Mol. Ecol.*: 17pp.

Moore, J.E., T.M., C. and R.L., L. 2010. An interview-based approach to assess marine mammal and sea turtle captures in artisanal fisheries. *Biol. Cons.* 143: 795-805.

Murphy, P.F., Van Waerebeek, K. and Jallow, A.O. 1997. Cetaceans in Gambian coastal waters. Paper SC/49/SM11 presented to the IWC Scientific Committee, September 1997, Bournemouth (unpublished). 8pp. [Available from the Office of this Journal].

NAMMCO. 2010. *Annual Report 2009*. North Atlantic Marine Mammal Commission, Tromso, Norway. 529pp.

Nieri, M., Grau, E., Lamarche, B. and Aguilar, A. 1999. Mass mortality of Atlantic spotted dolphins (*Stenella frontalis*) caused by a fishing interaction in Mauritania. *Mar. Mammal Sci.* 15(3): 847-53. [In Notes].

Notarbartolo-di-Sciara, G., Politi, E., Bayed, A., Beaubrun, P.C. and Knowlton, A. 1998. A winter cetacean survey off southern Morocco, with a special emphasis on right whales. *Rep. int. Whal. Commn* 48: 547-50.

Perrin, W.F. 2002. *Stenella frontalis*. *Mamm. Species* 702: 1-6.

Picanço, C., Carvalho, I. and Brito, C. 2009. Occurrence and distribution of cetaceans in São Tomé and Príncipe tropical archipelago and their relation to environmental variables. *J. Mar. Biol. Assoc. UK* 89(5): 1071-76.

Pitman, R.L. and Ensor, P. 2003. Three forms of killer whales (*Orcinus orca*) in Antarctic waters. *J. Cetacean Res. Manage.* 5(2): 131-39.

Reeves, R.R., Smith, B.D., Crespo, E.A. and Notarbartolo di Sciara, G. 2003. *Dolphins, Whales and Porpoises - 2002-2010 Conservation Action Plan for the World's Cetaceans*. IUCN/SSC Cetacean Specialist Group, Gland and Cambridge. xi+139pp.

Reiner, F., Dos Santos, M.E. and Wenzel, F.W. 1996. Cetaceans of the Cape Verde archipelago. *Mar. Mammal Sci.* 12(3): 434-43.

Richard, P.R., Laake, J.L., Hobbs, R.C., Heide-Jørgensen, M.P., Asselin, N.C. and Cleator, H. 2010. Baffin Bay narwhal population distribution and numbers: aerial surveys in the Canadian High Arctic, 2002-04. *Arctic* 63(1): 85-99.

Robineau, D. and Vely, M. 1993. Stranding of a specimen of Gervais' beaked whale (*Mesoplodon europaeus*) on the coast of West Africa (Mauritania). *Mar. Mammal Sci.* 9(4): 438-40.

Robineau, D. and Vely, M. 1997. Donnees preliminaires (faille corporelle, craniometrie) sur le grand dauphin (*Tursiops truncatus*) des cotes d'Afrique du nord-ouest (Mauritanie, Senegal). *Mammalia* 61: 443-48. [In French].

Robineau, D. and Vely, M. 1998. Les cetaces des cotes de Mauritanie (Afrique du nord-ouest). Particularites et variations spatio-temporelles de repartition: role des facteurs oceanographiques. *Rev. Ecol. Terre Vie* 53: 123-52. [In French].

Santos, M.C.O, Oshima, J.E.F. and Da Silva, E. 2009. Sightings of Franciscana dolphins (*Pontoporia blainvillei*): the discovery of a population in the Parangua estuarine complex, southern Brazil. *Brazilian Journal of Oceanography* 57(1): 57-63.

Secchi, E.R., Danilewicz, D. and Ott, P.H. 2003. Applying the phylogeographic concept to identify franciscana dolphin stocks: implications to meet management objectives. *J. Cetacean Res. Manage.* 5(1): 61-68.

Secchi, E.R., Wang, J.Y., Murray, B.W., Rocha-Campos, C.C. and White, B.N. 1998. Population differentiation in the franciscana *Pontoporia blainvillei* from two geographic locations in Brazil as determined from mitochondrial DNA control region sequences. *Can. J. Zool.* 76: 1,622-7.

Smit, V., Ritter, F., Ernert, A. and Strueh, N. 2010. Habitat partitioning by cetaceans in a multi-species ecosystem around the oceanic island of La Gomera (Canary Islands). Poster presented to the ECS Annual Conference, Stralsund, Germany, 22-24 March 2010.

Smith, B.D. and Beasley, I. 2004. *Orcaella brevirostris* (Mekong River sub-population). *In*: IUCN (eds). *IUCN Red List of threatened species version 2009.1*.

Tavares, M., Moreno, I.B., Siciliano, S., Rodriguez, D., De O. Santos, M.C., Lailson-Brito Jr, J. and Fabian, M.E. 2010. Biogeography of common dolphins (genus *Delphinus*) in the southwestern Atlantic Ocean. *Mammal Rev.* 40(1): 40-64.

Tchibozo, S. and van Waerebeek, K. 2007. La baleine a bosse et le lamantin d'Afrique, des potentielles resources de tourisme de la nature au Benin. Abstract, Convention on Migratory Species meeting WATCH, Adeje, Tenerife, Spain, 16-20 Octover 2007. [In French].

Van Waerebeek, K., Bamy, I.L., Jiddou, A.M., Sequeira, M., Diop, M., Ofori-Danson, P.K., Tchibozo, S. and Campredon, P. 2008a. Indeterminate status of West African populations of inshore common bottlenose dolphins *Tursiops truncatus* cautions against opportunistic live-capture schemes. Report to the Fondation Internationale du Banc d'Arguin. [*www.lafiba.com*].

Van Waerebeek, K., Barnett, L., Camara, A., Cham, A., Diallo, M., Djiba, A., Jallow, A.O., Ndiaye, E., Samba Ould Bilal, A.O. and Bamy, I.L. 2004. Distribution, status and biology of the Atlantic humpback dolphin, *Souza teuszii* (Kükenthal, 1892). *Aquat. Mamm.* 30(1): 56-83.

van Waerebeek, K. and De Smet, W.M.A. 1996. A second record of the false killer whale *Pseudorca crassidens* (Owen, 1846) (Cetacea, delphinidae) from West Africa. *Mammalia* 60(2): 319-22.

Van Waerebeek, K., Diallo, M., Djiba, A., Ndiaye, P. and Ndiaye, E. 1997. Cetacean research in Senegal 1995-97; an overview. Paper SC/49/SM10 presented to the IWC Scientific Committee, September 1997, Bournemouth (unpublished). 10pp. [Paper available from the Office of this Journal].

van Waerebeek, K., Hazevoet, C.J., Lopez-Suarez, P., Simao Delgado Rodriguez, M. and Gatt, G. 2008b. Preliminary findings on the mass strandings of melon-headed whales *Peponocephala electra* in Boavista Island in November 2007, with notes on other cetaceans from the Cape Verde Islands. Technical Report to the Fondation Internationale du Banc d'Arguin (FIBA). 9pp. [Unpublished, obtainable from *www.lafiba.com*].

Van Waerebeek, K., Ndiaye, E., Djiba, A., Diallo, M., Murphy, P.F., Jallow, A.O., Camara, A., Ndiaye, P. and Tous, P.T. 2000. *A Survey of the Conservation Status of Cetaceans in Senegal, The Gambia and Guinea-Bissau*. UNEP/CMS Secretariat, Bonn, Germany. 80pp.

Van Waerebeek, K. and Perrin, W.F. 2007. Conservation status of the Atlantic humpback dolphin, a compromised future? CMS Scientific Council Document CMS/ScC14/Doc.6, Bonn, Germany, 14-17 March 2007, 10pp.

Vidal, M., Servidio, A., Tejedor, M., Arbelo, M., Brederlau, B., Neves, S., Perex-Gil, M., Urquiola, E., Perez, G.E. and Fernandez, A. 2009. Cetaceans and conservation in the Canary Islands. Abstracts of the 18th Biennial Conference on the Biology of Marine Mammals, Quebec City, 12-16 October 2009. p.153.

Weir, C.R. 2006. First confirmed records of Clymene dolphin *Stenella clymene* (Gray, 1850) from Angola and Congo, south-east Atlantic Ocean. *African Zoology* 41(2): 297-300.

Weir, C.R. 2007. Occurrence and distribution of cetaceans off northern Angola, 2004/05. *J. Cetacean Res. Manage* 9(3): 225-39.
Weir, C.R. 2009. Distribution, behaviour and photo-identification of Atlantic humpback dolphins *Sousa teuszii* off Flamingos, Angola. *African Journal of Marine Science* 31(3): 319-31.
Weir, C.R. 2010. A review of cetacean occurrence in West African waters from the Gulf of Guinea to Angola. *Mammal Rev.* 40(1): 2-39.
Weir, C.R., Collins, T., Carvalho, I. and Rosenbaum, H. In Press. Killer whales (*Orcinus orca*) in Angolan and Gulf of Guinea waters, tropical West Africa. *J. Mar. Biol. Assoc. UK*.
Weir, C.R., Collins, T., Carvalho, I. and Rosenbaum, H.C. 2010. Killer whales (*Orcinus orca*) in Angolan and Gulf of Guinea waters, tropical West Africa. *J. Mar. Biol. Assoc. UK* 90: 1601-11.
Weir, C.R., Debrah, J., Ofori-Danson, P.K., Pierpoint, C. and van Waerebeek, K. 2008. Records of Fraser's dolphin *Lagenodelphis hosei* (Fraser 1956) from the Gulf of Guinea and Angola. *Afr. J. Mar. Sci.* 30(2): 241-46.

Appendix 1

AGENDA

1. Opening remarks
2. Election of Chair
3. Adoption of Agenda
4. Appointment of rapporteurs
5. Review of available documents
6. Review status of small cetaceans of northeastern Africa and the eastern tropical Atlantic
   - 6.1 Harbour porpoise (*Phocoena phocoena*)
   - 6.2 Rough-toothed dolphin (*Steno bredanensis*)
   - 6.3 Atlantic humpback dolphin (*Sousa teuszii*)
   - 6.4 Risso's dolphin (*Grampus griseus*)
   - 6.5 Common bottlenose dolphin (*Tursiops truncatus*)
   - 6.6 Atlantic spotted dolphin (*Stenella frontalis*) and pantropical spotted dolphin (*Stenella attenuata*)
   - 6.7 Spinner dolphin (*Stenella longirostris*)
   - 6.8 Clymene dolphin (*Stenella clymene*)
   - 6.9 Short-beaked common dolphin (*Delphinus delphis*) and long-beaked common dolphin (*Delphinus capensis*)
   - 6.10 Striped dolphin (*Stenella coeruleoalba*)
   - 6.11 Fraser's dolphin (*Lagenodelphis hosei*)
   - 6.12 Melon-headed whale (*Peponocephala electra*)
   - 6.13 Pygmy killer whale (*Feresa attenuata*)
   - 6.14 False killer whale (*Pseudorca crassidens*)
   - 6.15 Killer whale (*Orcinus orca*)
   - 6.16 Long-finned pilot whale (*Globicephala melas*) and short-finned pilot whale (*Globicephala macrorhynchus*)
   - 6.17 Dwarf sperm whale (*Kogia simus*) and pygmy sperm whale (*Kogia breviceps*)
   - 6.18 Cuvier's beaked whale (*Ziphius cavirostris*) and other Ziphiidae
7. Report on the intersessional working group on climate change
8. Progress on previous recommendations
   - 8.1 Vaquita
   - 8.2 Harbour porpoise
   - 8.3 Franciscana
   - 8.4 Narwhal
   - 8.5 Irrawaddy dolphin
   - 8.6 Other
9. Other presented information
10. Takes of small cetaceans
11. Summary of recommendations
12. Other business
13. Work plan
14. Adoption of Report

Appendix 2

DRAFT AGENDA FOR THE SMALL CETACEANS AND CLIMATE CHANGE WORKSHOP

1. Introductory items
   1.1 Appointment of the Chair
   1.2 Appointment of Rapporteurs
   1.3 Identification of relevant information available to the meeting (considerable collating of information will be done ahead of the meeting)
2. Objectives of Workshop
   2.1 Review and amend as appropriate
3. Overview of existing research and hypotheses
   3.1 Review report of IWC Second Workshop on Climate Change (CC2)
   3.2 Consider hypotheses considered at CC2
   3.3 Consider other relevant information, including recently published reviews
   3.4 Key presentations
      - Arctic
      - Restricted habitats (including sea mounts, atolls, reefs, environmental discontinuities, estuaries and riverine systems)
      - Range changes
   3.5 Other topics
      - Populations at the edge of their range (e.g. Scottish bottlenose dolphins)
      - Implications of sea-level rise
      - Critically endangered small cetaceans – the vaquita and the river dolphins
4. Identification of key aspects
   4.1 Key studies
   4.2 Key species, populations and areas
   4.3 Opportunities for future research
5. Recommendations
   5.1 Further research
   5.2 Conservation implications and responses
   5.3 Other

Appendix 3

PROJECT PROPOSAL FOR THE VOLUNTARY FUND FOR SMALL CEATCEAN CONSERVATION RESEARCH

TITLE

Threatened Franciscanas: Improving Estimates of Abundance to Guide Conservation Actions

BRIEF DESCRIPTION OF PROJECT

The franciscana (*Pontoporia blainvillei*) is endemic of the eastern coast of South America between Brazil (18°25'S) and Argentina (41°10'S). The species is regarded as the most threatened small cetacean in South America due to high, possibly unsustainable, bycatch levels as well as increasing habitat degradation throughout its range (Secchi *et al.*, 2003) and is listed as Vulnerable by the IUCN Red List of Threatened Species (see *http://www.cmsdata.iucn.org/downloads/cetacean_table_for_website.pdf*).

Aerial surveys have been conducted through most of the species range as they are considered the most reliable method for estimating abundance of franciscanas; see SC/62/SM7 (Crespo *et al.*, 2010; Danilewicz, In press; Secchi *et al.*, 2001). However, such estimates can be biased due to difficulties in group size estimation and lack of appropriate correction factors for availability bias. Previous studies have shown that franciscana groups seen from planes are 2-4 times smaller than those seen from still or slow moving platforms; see SC/62/SM7 (Bordino *et al.*, 1999; Crespo *et al.*, 2010; Secchi *et al.*, 2001), suggesting that biases in estimates of abundance from underestimation of group size can be substantial. In addition, estimates of diving parameters used in franciscana aerial surveys are available only for a small, possibly isolated (Mendez *et al.*, 2008), population in Anegada Bay, Argentina. If diving parameters of franciscanas in this bay differ from other areas, additional bias may occur for estimates computed for other parts of the franciscana range.

The objective of this proposal is to compute correction factors to improve abundance estimates of franciscana dolphins. Boat and aerial surveys will be carried out in Babitonga Bay, southern Brazil. There are a number of advantages in conducting this study there. First, this is a place where franciscanas predictably occur in relatively large densities throughout the year (Cremer and Simoes-Lopes, 2008). Second, group sizes seen in Babitonga Bay - mean=7, range=1-22 individuals (Cremer and Simoes-Lopes, 2005) - are believed to be representative of those seen through most of the range of the species (e.g. Crespo *et al.*, 1998; Flores, 2008). Finally, the bay is relatively protected and therefore provides good weather conditions (e.g. relatively calm waters) for sighting surveys from both types of platforms.

Independent estimates of mean group sizes and their associated uncertainty will be obtained from the boat and the airplane and a correction factor will be calculated. In addition, diving parameters of franciscanas (notably, average times submerged and at the surface) will be computed to obtain an estimate of availability bias different from that computed with diving data from franciscanas in Argentina. Finally, experiments will be conducted to estimate the time an object is available for the observer in the airplane, a quantity needed for estimating availability bias. These parameters will then be used in the estimation of this correction factor as proposed by Barlow *et al.* (1988).

In discussion of document SC/62/SM7 during the 2010 Scientific Committee meeting, the Small Cetaceans Sub-Committee made the following recommendations to improve estimates of abundance: (1) improve estimates of visibility bias; (2) evaluate potential biases in the estimation of group sizes; and (3) estimate franciscana diving parameters in areas where such information is not available. The objectives of this proposal directly address these recommendations.

The proposed research will lead to improved estimates of abundance of franciscanas and will provide a basis to evaluate the long-term viability of various franciscana populations. Such efforts can be used by local governments and international organizations to establish or prioritise management strategies for the species (e.g. mitigation of bycatch and other human impacts). Assessing the status of the franciscana has been a long-term recommendation of various bodies, including the governments of the franciscana range states, the IUCN (Reeves *et al.*, 2003) and the IWC Scientific Committee (IWC, 2005). Results of this study can be also used to increase awareness of the franciscana issues within educational and conservation contexts.

This study will also provide the opportunity for new scientists to participate in field work and therefore will contribute to local capacity building. Finally, the proponents will seek advice from scientists from other countries with experience in aerial surveys and therefore will enhance international collaboration.

TIMETABLE

Surveys will be conducted in the austral summer 2010/11 and results will be reported at the next IWC Scientific Committee.

RESEARCHERS' NAMES AND AFFILIATIONS

- Alexandre Zerbini (National Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA, USA and Instituto Aqualie, Rio de Janeiro, RJ, Brazil).
- Eduardo Secchi (Universidade Federal do Rio Grande, Rio Grande, RS, Brazil).
- Daniel Danilewicz (Instituto Aqualie, Rio de Janeiro, RJ, Brazil; Grupo de Estudos de Mamíferos Aquáticos do Rio Grande do Sul – GEMARS, Porto Alegre, RS, Brazil).
- Artur Andriolo (Universidade Federal de Juiz de Fora, Juiz de Fora, MG, Brazil and Instituto Aqualie, Rio de Janeiro, RJ, Brazil).
- Paulo André Flores (Instituto Chico Mendes para a Conservacao da Biodiversidade, Florianopolis, SC, Brazil).

ESTIMATED TOTAL COST WITH BREAKDOWN AS NEEDED

Aircraft charter: 14hs @ £1,040 = £14,560

Fuel for skiff 300 litres @ £1.05 = £315

Room and board: 4 scientists for 5 days @ £42/day = £840

Supplies = £1,380

Total = £17,095

REFERENCES

Barlow, J., Oliver, C.W., Jackson, T.D. and Taylor, B.L. 1988. Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon, and Washington: II. Aerial surveys. *Fish. Bull.* 86(3): 433-44.

Bordino, P., Thompson, G. and Iñíguez, M. 1999. Ecology and behaviour of the franciscana (*Pontoporia blainvillei*) in Bahía Anegada, Argentina. *J. Cetacean Res. Manage.* 1(2): 213-22.

Cremer, M.J. and Simoes-Lopes, P. 2005. The occurrence of *Pontoporia blainvillei* (Gervais and d'Orbigny) (Cetacea, Pontoporiidae) in an estuarine area in southern Brazil. *Rev. Bras. Zool.* 22(3): 717-23.

Cremer, M.J. and Simoes-Lopes, P. 2008. Distribution, abundance and density estimates of franciscanas, *Pontoporia blainvillei* (Cetacea, Pontoporiidae) in Babitonga Bay, southern Brazil. *Rev. Bras. Zool.* 25: 397-402.

Crespo, E.A., Harris, G. and González, R. 1998. Group size and distributional range of the franciscana, *Pontoporia blainvillei*. *Mar. Mammal Sci.* 14(4): 845-49.

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. Mammal Sci.* 26: 17-35.

Danilewicz, D. In press. Abundance estimation for a threatened population of franciscana dolphins in southern Brazil: uncertainties and conservation considerations. *J. Mar. Biol. Assoc. UK*.

Flores, P.A.C. 2008. Occurrence of Franciscana (*Pontoporia blainvillei*) in Bahia Norte, Southern Brazil. *LAJAM* 7(1-2).

International Whaling Commission. 2005. Report of the Scientific Committee. Annex L. Report of the Sub-Committee on Small Cetaceans. *J. Cetacean Res. Manage. (Suppl.)* 7:307-17.

Mendez, M., Rosenbaum, H.C. and Bordino, P. 2008. Conservation genetics of the franciscana dolphin in northern Argentina: population structure, by-catch impacts, and management implications. *Conserv. Genet.* 9(2): 419-35.

Reeves, R.R., Smith, B.D., Crespo, E.A. and Notarbartolo di Sciara, G. 2003. *Dolphins, Whales and Porpoises - 2002-2010 Conservation Action Plan for the World's Cetaceans*. IUCN/SSC Cetacean Specialist Group, Gland and Cambridge. xi+139pp.

Secchi, E.R., Danilewicz, D. and Ott, P.H. 2003. Applying the phylogeographic concept to identify franciscana dolphin stocks: implications to meet management objectives. *J. Cetacean Res. Manage.* 5(1): 61-68.

Secchi, E.R., Ott, P.H., Crespo, E.A., Kinas, P.G., Pedraza, S.N. and Bordino, P. 2001. A first estimate of franciscana (*Pontoporia blainvillei*) abundance off southern Brazil. *J. Cetacean Res. Manage.* 3(1): 95-100.

Annex M

Report of the Sub-Committee on Whalewatching

Members: Kato (Chair), Bejder (co-Chair), Amaral, Bami, Brito, Carlson, Choi, de Stephanis, Edwards, Flores, Fortuna, Funahashi, Gallego, Groch, Holm, Iñíguez, Jaramillo-Legoretta, Kasuya, Kaufman, Luna, Lusseau, Marcondes, Mattila, Nelson, Palka, Parsons, Reeves, Ridoux, Ritter, Robbins, Rose, Simmonds, Sironi, Stachowitsch, Štrbenac, Tchibozo, Urbán, Vély, Weinrich, Williams, Wright.

1. CONVENOR'S OPENING REMARKS AND TERMS OF REFERENCE

Kato welcomed the members of the sub-committee and noted the priority items identified by the Scientific Committee:

(1) proposal for a large-scale whalewatching experiment (LaWE; including reports from the intersessional steering group and the advisory group);
(2) review whalewatching off North Africa;
(3) assess the impacts of whalewatching on cetaceans.

In addition, the following items were recommended:

(1) review reports from intersessional working groups:
    (i) online database for worldwide tracking of commercial whalewatching and associated data collection; and
    (ii) swim-with-whale operations;
(2) identify platforms of opportunity and assess data of potential value to the Scientific Committee;
(3) review of whalewatching guidelines and regulations; and
(4) review of risks to cetaceans from whalewatching vessel collisions.

In closing he announced that he would be stepping down as Chair after 15 years and would consult with members of the sub-committee on its future.

2. ELECTION OF CHAIR AND APPOINTMENT OF RAPPORTEURS

Kato was elected Chair with Bejder as co-Chair. Carlson was appointed rapporteur with assistance from Rose.

3. ADOPTION OF AGENDA

The adopted Agenda is given as Appendix 1.

4. REVIEW OF AVAILABLE DOCUMENTS

The documents available to the sub-committee were identified as: SC/62/WW1-6 and SC/62/WW8; SC/62/SM8; Eisfeld *et al.* (2010); Parrott *et al*. (2010); Ritter (2010); Smit *et al*. (2010); Weir (2009) and IWC/62/CC8.

5. PROPOSAL FOR A LARGE-SCALE WHALE-WATCHING EXPERIMENT

5.1 Report from intersessional steering group on LaWE

Lusseau presented a proposal from the large-scale whalewatching experiment (LaWE) intersessional steering group (Appendix 2) which elaborated on the objectives, aims, methodology, design, management and funding considerations for this initiative.

Three options were presented for procedural mechanisms to manage the different components of the LaWE project, ranging from top-down (in which the IWC would have a steering group role) to decentralised (in which the IWC would have a coordinating role; see fig. 1 of Appendix 2). After discussion, it was agreed (see Fig. 1) that a transitional process was preferable, with a top down approach (hierarchical structure) at the initial stage of the project progressing into a mechanism where the IWC would have more of a coordinating role (network structure). It was recognised that the key constraint was budgetary needs and financial stability and that the options should be posed in terms of structure and budget.

During discussion it was noted that effects of whalewatching and other vessel traffic would be distinguished between in the nested study design of the LaWE. The sub-committee noted that it had developed a glossary of terms for whalewatching that would be useful for site categorisation (IWC, 2006, pp.249-51).

The draft email request for marine mammal listserves, such as MARMAM, regarding a call for participation in the LaWE was revised at the request of the sub-committee and sent to the Secretariat for comment. A final version was approved and scheduled for posting soon after this year's meeting.

It was suggested that IWC member nations would be able to use the results of the project as the basis for appropriate scientific management of whalewatching. The information collected during LaWE will also provide data on general biology and life history parameters of cetaceans that are relevant to the work of the IWC Scientific Committee. The sub-committee then discussed a variety of potential funding sources for the LaWE effort including:

(1) IWC membership: funding derived from fees/contributions from member nations;
(2) national/regional initiatives: funding derived from national or regional governments involved in the support/promotion of whalewatching;
(3) NGOs: funding derived from national/international NGOs involved in the conservation of cetaceans;
(4) whalewatching operators: funding derived from whale/dolphin-watching operators; and
(5) hybrid model: targets key operators in high profile whalewatching areas with additional funding sought from host countries, IWC, NGOs and other sources.

The sub-committee considered that the whalewatching industry represents an important possible funding source for LaWE. Particular emphasis was placed on the opportunity provided by large, mature companies in key ports that have the potential both to understand the importance of the effort and to provide the means of generating meaningful funds. This might aid the initial LaWE study site selection; however, it was noted that the identification of funding sources will ultimately be the responsibility of individual IWC member nations. The sub-committee noted that the feasibility of achieving successful funding could be aided by the formation of a fund similar to that of the Small Cetacean Fund where NGOs and the private sector, in addition to funds raised by

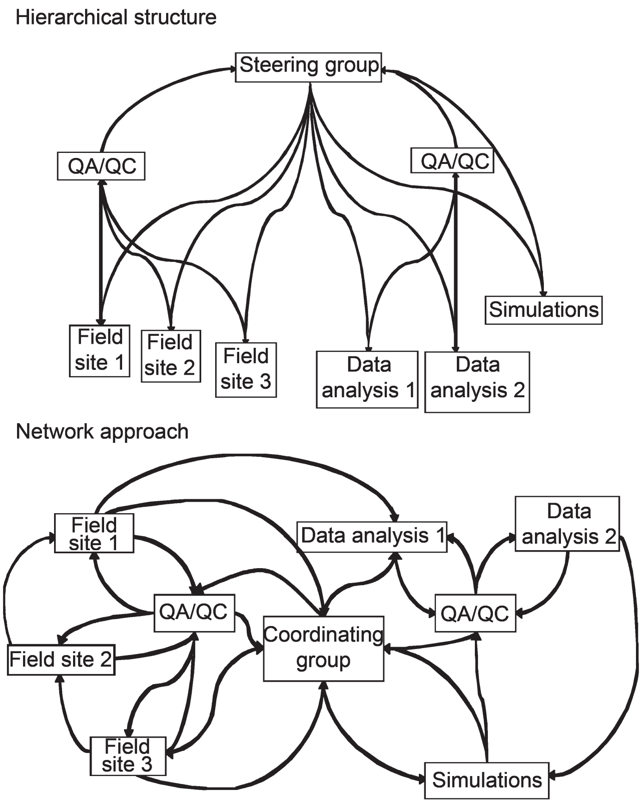

Fig. 1. Potential procedural linkages between the different components of the project (QA: quality assurance, QC: quality control). In a hierarchical structure, the LaWE group would have a steering group role, while in a network approach it would have a communication coordination role.

IWC member nations, could contribute to IWC-endorsed research efforts. The sub-committee **recommended** that an e-mail correspondence group be formed to further develop the budget for the LaWE, although it noted that until power analyses are completed and species and sites are chosen only approximate budgets can be created.

Lusseau reported that there had been no intersessional interaction between the steering and advisory groups due to time constraints. It was suggested that the site selection template developed by Carlson should be finalised and forwarded to the advisory group to commence the selection process. After discussion, it was **agreed** that the two intersessional groups would be combined into one 'steering group' to maximise collaborative discussions (see Annex Q).

There will be a budget request to assist the LaWE intersessional work of £3,919 to hire a research assistant to develop procedural mechanisms to centralise data received from research groups relevant to LaWE with the Secretariat and commence power analysis for key parameters depending on data received. In addition, funds are requested to organise a pre-meeting for the LaWE steering committee to review and advance intersessional progress on all aspects, including reviewing data received, advancements in power analysis, and the selection of appropriate study species and sites.

5.2 Report from LaWE advisory group
Rose reported that there was no formal report from the advisory group as the LaWE is not yet at the point of selecting research sites.

5.3 Discussion of the proposal
This Item is discussed under Item 5.1.

5.4 Other
Lusseau presented SC/62/WW5, a summary of progress from a project tasked to develop a formal mathematical structure from the US National Academy of Sciences Population Consequences of Acoustic Disturbance (PCAD) conceptual framework. This PCAD working group has been convened by the University of California Santa Barbara with support from the Office of Naval Research, meeting every six months over a three-year period. During these meetings modellers and field researchers meet to develop approaches and discuss the feasibility of fitting them to a wide range of existing data to try parameterising the agreed models. This PCAD working group has made significant progress over the first two meetings. It decided to develop three statistical models to provide the linkages from disturbance to population dynamics. Work has focussed on the first models (disturbance to physiological conditions). It developed a state space modelling approach (SSM) based on McFarland and Sibly's (1975) concepts (the hydraulic model and its subsequent extensions) that behaviour emerges from the interactions between the motivational states of individuals and the environment. Motivational states and physiological conditions (here initially body condition) are hidden processes that are linked to observed behaviour. The parameters of these processes are then inferred (exploring both maximum likelihood and Bayesian estimation methods) by fitting these SSMs to behavioural time series. First implementations with simple systems (southern elephant seals' at-sea movement) proved extremely successful and body condition time series could be estimated and validated against body weight when the seals returned to the colony. A similar, albeit more complex, model was developed for coastal dolphin population case studies and will be implemented over the next year. The working group is happy to continue reporting to the sub-committee on progress and looks forward to exploring possibilities to interact with the LaWE project.

During discussions, one member noted that the motivational state-space approach to the PCAD model was creative; however, the PCAD working group needs to acknowledge the limitations of the original US National Research Council model. For example, it has been shown that behavioural responses cannot reliably be used to infer disturbance impact in animals without extensive contextual information, which has not been fully incorporated into the model. While energetic condition and related concepts such as hunger are included in the working model, almost no consideration has been given to psychological condition. Anxiety, cognitive bias and other stress-related conditions will greatly affect motivation, behavioural responses to disturbance, and the ultimate impact on vital rates. Furthermore, overall psychological condition may be influenced by non-behavioural consequences of acoustic exposure, including masking, which are also missing from the model. Lusseau replied that the stress hormone pathway study was an exploration initiative because the technique is at an early stage. Another member noted that while faecal sampling for hormones was discussed at the Bunbury workshop, the strategy was to use the best available technique to measure stress responses in a rapidly developing field. EKG monitors to measure heart rate in tagged whales may soon be available and could present another opportunity to gather equivalent information.

A concern was expressed about the restrictions on the remit of the PCAD project. In response, Lusseau noted that the modelling approach was flexible enough to incorporate the type of alternative pathways mentioned and that the group was currently focussing on energetic pathways because it meant that parameters could be estimated by fitting the state space models to existing behavioural and demographic data. However, this did not preclude extending models in the future when more information becomes available. Importantly, this approach will allow construction of contrasting models and cross-validation of them against observations. It was noted that this was a significant step in developing quantitative methods to address non-lethal effects of disturbances. However, it was also noted that, while this is just a model and simplicity is valuable, the current omissions may have implications for any subsequent wide-spread application of the PCAD model and these limitations should be explicitly recognised to avoid any misapplication, especially in management settings. When asked what should be the 'take home' message for LaWE from this exercise, it was noted that the progress made in this working group validated the feasibility of the approach proposed for LaWE and that the variables selected in LaWE were appropriate (Appendix 2).

6. REVIEW WHALEWATCHING OFF NORTH AFRICA

Brito presented SC/62/SM8 on cetacean sightings, local human activities and conservation off São Tomé (São Tomé and Príncipe, Gulf of Guinea, West Africa). São Tomé and Príncipe is an equatorial archipelago situated in the Gulf of Guinea composed of two main islands and several small islands and islets. This region seems to be an important area for cetaceans probably due to prey abundance and the existence of shallow and protected bays. However, the status of species or populations of cetaceans has not been assessed due, in part, to lack of information and effort. Whalewatching is a fairly recent activity now growing due to an increase in tourism in São Tomé and Príncipe. Encounters with humpback whales and other small cetaceans are frequent and could represent a significant income for the local economy. These activities are restricted to the city of São Tomé (north) and Ilhéu das Rolas (south) where main resorts are located and also occur on the Island of Príncipe, at Ilhéu Bom Bom. At the latter site, no research on cetacean distribution, interactions with human activities or whalewatching occurrence has been conducted. Whalewatching is directed mainly to humpback whales during the breeding season and during the rest of the year to small cetaceans, including bottlenose and pantropical spotted dolphins (the most sighted species in the region).

A similar situation may exist in the Cape Verde Islands where there are resorts and a significant number of tourists. Here, most whalewatching occurs in association with other maritime activities such as scuba diving and is focused primarily on humpback whales; observations of other species are opportunistic. Brito noted that several measures regarding the conservation of natural populations of cetaceans are needed for São Tomé, Príncipe and Cape Verde Islands (including international standards of operation, educational programmes and research) to reinforce a change to a more conservation-oriented perspective with direct involvement of local communities.

One member noted that an overview of whalewatching activities in the Mediterranean will be prepared under ACCOBAMS. More information is available on the ACCOBAMS official website (*http://www.accobams.org*).

The sub-committee welcomed Brito's report and noted the lack of information on whalewatching activities in western and northern Africa. Furthermore, it expressed concern at the potential for expansion of whalewatching activities in the region without sufficient scientific information on cetaceans and called for an assessment of the scope of activities to be made by relevant authorities as soon as possible.

7. ASSESS THE IMPACTS OF WHALEWATCHING ON CETACEANS

Bejder presented SC/62/WW4 on the Critically Endangered Irrawaddy dolphin (*Orcaella brevirostris*) population inhabiting the Mekong River. Here, photo-identification studies indicate dolphins exhibit high site fidelity during the dry season to particular deep water pool areas that are limited in size (1-2km^2). Preliminary genetic analyses indicate very low genetic diversity within the population and a high mortality rate with 46 carcasses recovered from 2003-05. Fifty-four percent of recovered carcasses were newborns. The cause of the high rate of newborn mortality remains unknown. Dolphin-watching tourism began in two areas along the dolphin's habitat in the early 1990s, which remains unmanaged and unregulated. The locations of these dolphin-watching areas are two of the most important habitats for the remaining population in the river, numbering less than 100 individuals. Initially, at both locations, the dolphin-watching industry was land-based, with a few row-boats occasionally taking tourists into the pool to view dolphins. This later expanded to larger motorised boats that offered dolphin tours in the pools, expanding to approximately 15 motorised boats by the early 2000s and now numbering more than 20.

Bejder noted that there is currently no information on what effects these 20+ tourist boats operating at the pools are having on the behavioural ecology of the resident dolphins. The paper argued that an adaptive, precautionary approach is essential to managing tourism that targets small, closed, resident communities of cetaceans. It was argued that for this Critically Endangered population, a 'no vessel-based dolphin tourism' policy is desirable, given that there are high sighting rates within deep pools that facilitate sustainable land-based tourism. Specifically, it was noted that the issues associated with Cambodian cetacean-watching tourism may be generic to developing countries. The dolphin-watching industry is typically unregulated and by the time it comes to the attention of officials, it is impossible to stop or modify, both on economic grounds and because of lack of capacity and political will. For example, at Lovina in north Bali, up to 160 artisanal fishing boats, and 140 tourist boats, operate dolphin-watching focused on spinner dolphins. A single school of dolphins may be surrounded by >60 boats. At Chilika Lagoon in India, up to 250 fishing vessels participate in an industry based on a small (<150 animals), isolated and declining population of Irrawaddy dolphins, which is also subjected to gillnetting impacts.

The sub-committee noted its concern over the Critically Endangered Mekong River Irrawaddy dolphin population. In 2006, the IWC Scientific Committee noted that there was compelling evidence that the fitness of individual odontocetes repeatedly exposed to tour vessel traffic can be compromised and that this can lead to population level effects. It also stated that, in the absence of data, it should be assumed that such effects are possible until indicated otherwise – particularly for small, isolated and resident populations. Accordingly, the sub-committee **strongly recommends** that the Cambodian government and relevant agencies make every effort to reduce the exposure of dolphins to vessel-based tourism in deep-water pools in the Mekong River.

SC/62/WW1 reports on behavioural responses of southern right whales (SRW) to human approaches in Bahia San Antonio, Rio Negro, Argentina. The study was conducted to obtain information to evaluate recent authorised whale-based tourism and the implementation of accurate regulations and conservation measures. A total of 50 SRW groups were approached with a small zodiac during the seasons of 2008 and 2009, accounting for a total of 39h of behavioural observations. The approaches occurred in a slow and controlled way up to a minimum distance of 100m. A focal animal observation (instantaneous point sample) was used to record three mutually exclusive behavioural states: rest, travel and socialising and/or aerial activity. Groups (chosen at random) consisted of solitary animals (0.52), Surface Active Groups (SAG; 0.32) and non-SAGs (0.13). Due to the paucity of data in the past, all behavioural responses were analysed regardless of group composition. Results indicated that whales continued travelling during an approach, but doubled their resting time after the approach (22% → 40%) and significantly decreased their time socialising or being aerially active (21% → 2%). Although the probability that a whale remained in a social/aerially active behaviour when exposed to anthropogenic approaches decreased notably (-22%), no significant effect was found (Z-test for 2 proportions, $p>0.05$), probably due to the relatively small dataset. Nevertheless, the authors conclude that the apparent change in SRW social behaviour urgently requires more detailed information to implement conservation strategies to adequately regulate the commercial whale-based tourism in the area. The sub-committee noted the small sample size but commended the before-during-after experimental design.

Parsons introduced SC/62/WW2, summarising recent advances in whalewatching research as follows: Noren *et al.* (2009) investigated the prevalence of 'surface active behaviours' (e.g. spy hops, breaches, tail slaps, pectoral fin slaps) in the vicinity of boats in 'southern resident' killer whales, a population that was listed as depleted under the US Marine Mammal Protection Act in 2001, and is classified as 'endangered' in the United States and Canada. Results indicate that surface active behaviours generally increased when boats were closer. The most common behaviour reported was a 'tail slap', a behaviour that the researchers suggested 'may be performed by killer whales when disturbed'. As the highest tail slap frequency was recorded when boats were within 150m of the specific whale, the authors concluded that minimum approach distance of 100m in whalewatching guidelines may be insufficient in preventing behavioural responses from whales.

Arcangeli and Crosti (2009) conducted a study on an Australian common bottlenose dolphin (*Tursiops truncatus*) population in the coastal waters of Bunbury. Dolphins were observed for a total of 64 hours and the proportion of time engaged in 'diving', 'milling' and 'travelling' behaviour increased when boats were present within 350m. The proportion of time spent 'resting' decreased from 31% of the time to 20% and the proportion of time 'foraging' decreased from 20% of the time to 7.6% (a 62% decrease). This result is one of the greatest decreases noted to date. Due to calm sea conditions, the research vessel was able to observe the dolphins with engines off; therefore, the effect of the vessel was not a confounding factor.

Christiansen *et al.* (2010) used a Markov chain analysis to investigate changes in Zanzibar Indo-Pacific bottlenose dolphin (*T. aduncus*) behavioural states in relation to boat traffic. Overall, biologically important behaviours such as 'resting', 'foraging' and 'socialising' tended to decrease in the presence of boats.

Scarpaci *et al.* (In press) reported on the impact of swim-with-cetacean tourism on bottlenose dolphins within a 'sanctuary zone' in Port Phillip Bay, Australia, a protected area implemented to provide a refuge for the dolphins from vessel activity. A land-based observer found that vessel presence resulted in larger school size regardless of school composition and a significant decrease in foraging behaviour. Feeding behaviour was observed for a high proportion of the time when vessels were absent and the authors suggested that this site may be an important feeding area, and the reduction in feeding behaviour could be biologically important.

Sousa-Lima and Clark (2009) used automated acoustic recordings to monitor and track the singing behaviour of male humpback whales in Abrolhos Marine National Park, Brazil, a major humpback whale breeding ground. The behaviour of 11 tracked whales in response to approaches by tour boats showed that, of the 11 whales approached by boats, nine moved away, and of these, five ceased singing for at least 20 minutes. Of the animals that moved away, two-thirds did so when the boat was more than 4km away, with a mean response distance of 7.5km.

This is in contrast to previous studies that showed humpback whales moving away from tour vessels at distances of less than 0.3km (e.g. Corkeron, 1995; Sousa-Lima *et al.*, 2002).

Stamation *et al.* (2010) monitored the behaviour of groups of humpback whales off Queensland Australia from both whalewatching vessels and land-based platforms. Nearly half (46%) of the groups observed from whalewatching vessels exhibited no detectable response, 23% approached whalewatching vessels and 17% moved away. There appeared to be no relationship between the behaviour of the group (e.g. 'foraging', 'travelling' or 'surface active') and their response. Certain behaviours such as 'spy hop', 'trumpet blows' and 'tail swishes' were more frequent in whales approaching vessels, and it was suggested that these latter two behaviours might be aggressive and directed to the whalewatching vessels that were being approached. Avoidance behaviour was significantly more likely to be observed when boats approached closer than 100m and for mother-calf groups was more likely at 200m.

Filla and Monteiro (2009) investigated various types of whalewatching on estuarine or 'guianensis' dolphins (*Sotalia guianensis*) in Cananéia, southeast Brazil. The study indicated that dolphins' response was influenced by interaction time, with longer periods producing less negative responses, but this is related to the longer interactions generally occurring during boat-based, undergraduate course trips where boats tended to operate at a slow speed, viewed dolphins at a distance and waited for dolphins to voluntarily approach the vessel, i.e. type of whalewatching tour may affect impacts. This study further indicates that direct approaches are inappropriate and produce negative responses.

Jensen *et al.* (2009) found that common bottlenose dolphin and pilot whale (*Globicephala macrorhynchus*) communication calls could be masked substantially by small outboard engine noise, with higher speeds resulting in more masking, as well as frequent gear changes that produce relatively high levels of broadband sound.

The sub-committee welcomed Parsons' review and encouraged him to prepare a review for the next meeting. They clarified that these reviews are not intended as critiques of methodologies or results but rather are to inform the sub-committee of new research results of interest.

Bejder presented SC/62/WW3 on the US National Oceanic and Atmospheric Administration's (NOAA) efforts on developing management plans to reduce the exposure of resting spinner dolphins (*Stenella longirostris*) to human activity in Hawaiian waters. One potential management approach under consideration by the NOAA focuses on time-area closures to reduce the number and intensity of interactions between humans and dolphins during critical rest periods in particular bays. Research will combine boat-based and land-based visual observations with passive acoustic monitoring and is an international collaboration between researchers from American, Australian and Scottish universities. The conceptual framework is a Before-After-Control-Impact (BACI) design where the local abundance, distribution and behaviour of spinner dolphins in five resting bays will be assessed before and after the implementation of time-area closures. The study will implement Pollock's robust capture-recapture sampling design (Pollock *et al.*, 1990) to reduce population parameter bias when estimating the abundance of spinner dolphins in the five resting bays. Closures will be introduced in four bays (each with varying levels of human activity) while the fifth bay (control) will remain open. Time area closures will not be implemented until a full year of pre-closure data collection has been completed. The data will be collected during field seasons lasting six months per year over three-four years, beginning in July 2010. The authors highlighted this study as a possible candidate project for inclusion in the Large-scale Whalewatching Experiment (LaWE) initiative, as it incorporates many facets that the LaWE initiative strives to achieve.

The sub-committee **commended** the NOAA funded and instigated study and deemed it relevant to the LaWE initiative.

SC/62/WW8 presented a precaution on interpreting the results of impact study data analysis. Weinrich and Corbelli (2009) published an analysis of the effects of whalewatching on female humpback whale (*Megaptera novaeangliae*) calving frequency and calf survival on their feeding grounds in the southern Gulf of Maine. One of their findings suggested the possibility of confounding variables. In a breakpoint regression analysis of cumulative whalewatching exposure to the lifetime calving rate of individual females, there was a significant positive correlation between variables. Further, in multivariate analyses of individual calving events (e.g. logistic regressions), several positive relationships were found between exposure and reproductive parameters. The 'whalewatching exposure' variable in a case such as this is therefore really a proxy for the amount of time that a whale is spending in a key and important habitat. In effect, instead of saying that there was a positive correlation between boat exposure and fitness parameters, a more correct statement would relate to the effect of the whale's habitat use patterns on its fitness parameters. If this is correct, then it is possible that a deleterious whalewatching effect is hidden in what appears to be a positive relationship between exposure and a life history parameter. In this case, the relationship between exposure and the parameters examined may be, in fact, showing a weaker positive trend then would exist in the absence of whalewatching exposure. However, because there is a positive relationship at all, the tendency would be to dismiss the effects as either absent or inconsequential.

The sub-committee welcomed this paper as an important consideration in some impact analyses. It was noted that this contribution clarifies that whalewatching is essentially another habitat variable, and should be treated as such in multivariate models. In some populations (e.g. killer whales) there might also be a confounding variable between sightability and life history parameters; for instance, the ability to detect a calf may be related to the frequency with which a whale is sighted, further confounding related variables. In relation to the study on which the original analysis was based, it was noted that both the specific (Gulf of Maine) and the oceanic (North Atlantic) population overall is not growing at the rate reported for many southern hemisphere populations, but the rate of known entanglement mortality reported to the Scientific Committee last year (3.7%, see Robbins *et al.*, 2009) may play a notable role in this lower growth rate.

Lusseau presented work carried out by a team of Canadian researchers (Parrott *et al.*, 2010), which developed an agent-based simulation platform to assess the characteristics of interactions between whales and vessels under different scenarios. The simulation is composed of a spatial environment in which a whale individual-based model and a boat (including various categories of boat with different behaviour) agent-based model can evolve. It simulates the spatio-temporal movement of marine mammals and vessel traffic in the St Lawrence Estuary (Canada). It estimates movement parameters from long-term data collected using onboard GPS and vessel monitoring systems for vessels and a combination of land-based theodolite tracking and boat-based sightings of marine mammals from whalewatching boats and research vessels. The model was written in Java using the Repast platform. The whale movement model was validated using a pattern-oriented approach. This platform can be used to inform decision-making by simulating different vessel and whalewatching traffic scenarios.

This project is highly relevant to the LaWE objectives and offers an avenue to simulate boat interaction consequences for cetaceans using behavioural statistical models of disturbance effects. This effort was welcomed by the sub-committee and it was noted that it was a positive development of the preliminary work first presented to the sub-committee in 2006 (IWC, 2006).

It was noted that the work of the sub-committee has been influential with other research initiatives in the understanding of the effects of disturbances on cetacean populations.

At last year's meeting there was discussion on the impacts of aerial whalewatching. Groch reported that she was not able to analyse behavioural data collected in previous years during southern right whale photo-identification surveys from a helicopter in Brazil due to survey design. Sironi reported that a trial was conducted to record behavioural observations during the 2009 southern right whale photo-identification aerial survey in Argentina from a fixed-winged aircraft. Due to staff and space restrictions in the aircraft, it was not possible to collect reliable data. Dedicated flights should be done in order to obtain more accurate behavioural data.

8. REVIEW REPORTS OF INTERSESSIONAL WORKING GROUPS

8.1 Online database for worldwide tracking of commercial whalewatching/associated data collection

Robbins summarised the status of an on-line database for tracking whalewatching operations and associated data collection programmes. This database was originally described in Robbins and Frost (2009) and is intended to facilitate studies of whalewatching impact as well as to allow better assessments of the scientific value of data collection programmes. Database development has made considerable progress intersessionally and will likely go online prior to next year's Annual Meeting. The sub-committee **recommended** that the intersessional working group continue and report back to the sub-committee next year (see Annex Q).

8.2 Swim-with-whale operations

Rose reported that due to time constraints no progress was made intersessionally on field-testing a questionnaire to further assess the extent of swim-with-whale operations. However, a draft questionnaire is ready to be distributed and plans are in place to do so in the Dominican Republic and possibly Australia before next year's meeting. The sub-committee welcomed the commitment of funding for this effort by the Pacific Whale Foundation. The sub-committee **recommended** that the intersessional working group continue and report back to the sub-committee next year (see Annex Q).

9. OTHER ISSUES

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

One member stated that the progress continues in efforts to stimulate submission of opportunistic data from ecotourism cruise ships in the Southern Ocean to the Antarctic Humpback Whale Catalogue (AHWC). Opportunistic data represent a significant portion of the AHWC. For the period 1981-2010, 684 individuals have been identified from ecotourism and other opportunistic sources. In the Antarctic Peninsula region, 60% of the photographs from catalogued individuals were contributed by opportunistic sources, primarily from ecotourism. The availability of these data has broadened our understanding of the exchange between areas and in some cases provided information that was previously not available. For example, a photograph collected from a whalewatching vessel contributed to the first re-sighting between breeding group A and breeding group C (SC/62/SH27).

Ritter (2010) reported on a near-miss event involving a large vessel and humpback whales (*Megaptera novaeangliae*) off Antarctica. Observations were made from the bridge of a cruise ship, during a regular cruise along the Antarctic Peninsula. In February 2009, two humpback whales were encountered. The ship travelled at a speed of less than 10 knots closing in on the whales without purposefully approaching them. The animals only reacted at a distance of about 10m from the vessel, when they showed a startle reaction and sharply as well as vigorously turned away from the vessel. Observations from cruise ships thus can be informative on cetacean behaviour.

Smit *et al.* (2010) reports on opportunistic research off the coast of La Gomera (Canary Islands). From 1995 to 2007, the presence and distribution, as well as the combined occurrence, of different species were monitored year round from whalewatching vessels. Sightings of 5,739 cetacean groups comprising 21 species were made. Five species – bottlenose dolphins (*Tursiops truncatus*), short-finned pilot whales (*Globicephala macrorhynchus*), Atlantic spotted dolphins (*Stenella frontalis*), common dolphins (*Delphinus delphis*) and rough-toothed dolphins (*Steno bredanensis*) – accounted for 87% of all sightings. The physical characteristics of sighting locations (distance to coast, depth and sea bottom slope) of these five species were analysed using GIS. All three parameters showed significant inter-species differences. It appears that a species' habitat selection can be driven by a combination of physical characteristics as well as the presence/absence of other cetacean species. The study highlights the importance and the potential of mutual long-term cooperation between whalewatching operators and scientists.

The sub-committee welcomed the reports and reiterated the value of collaboration between researchers and whalewatching operations and other platforms of opportunity.

9.2 Review of whalewatching guidelines and regulations

Carlson noted that the compendium of whalewatching guidelines and regulations around the world is in the process of being updated and will be available on the IWC's website in August.

SC/62/WW2 described several papers relating to guidelines and compliance. Noren *et al.* (2009) noted that during the first year of their study 91% of boats observed were within 100m of the whales (dropping to 65% in the second year), demonstrating the high degree of non-compliance with local voluntary guidelines for whalewatching (a minimum approach distance of 100m). Williams *et al.* (2009) noted that changes in killer whale movement were affected by the number of vessels in the vicinity of whales. Guidelines in this region currently dictate that vessels not approach closer than 100m but do not proscribe a maximum number of vessels around a killer whale group.

Stamation *et al.* (2010) noted in their study that although 78% of the whalewatching vessels observed were 100m or further from whales (the distance required by local whalewatching guidelines), the remaining 22% approached closer than 100m or intersected the whales' route. Moreover they found that avoidance behaviour was significantly more likely to be observed when boats approached closer than 100m. Local regulations require whalewatching vessels to be no closer than 300m to whales with calves but only 14% of interactions between these groups and vessels adhered to this guideline and avoidance behaviour was more likely to be observed from these groups when vessels came within 200m.

Sousa-Lima and Clark (2009) suggested that managers of a marine protected area (MPA) for humpback whales should try to reduce noise levels within the MPA, and suggested regulations to that effect, requiring, for example, quieter engines as well as speed limits and restrictions of numbers of boats. Jensen *et al*. (2009) suggested that small outboard vessels should be restricted to speeds below 2.5 knots (as masking was negligible at 50m at this speed) and gear shifts should be minimised. The researchers' findings support whalewatching guidelines that recommend boats travel at low speeds at a distance of 50m or more.

9.3 Review of risk to cetaceans from collisions with whalewatching vessels

No new information was brought to the sub-committee this year. Some members indicated that papers on this item would be submitted to next year's meeting. The sub-committee noted that this issue will be discussed at a joint workshop with ACCOBAMS in Monaco from 21-24 September 2010.

9.4 Future of the Sub-committee on Whalewatching

The sub-committee took note of IWC/62/CC8 and discussed the possible interface between the Conservation Committee's (CC) work and its own work on whalewatching. The CC has established a Standing Working Group on Whalewatching and intends to develop a draft strategic plan for five years (2010-15). IWC/62/CC8 made reference to the work of the sub-committee and various scientific issues and the sub-committee noted in the section on Capacity Building and Development that actions 'may include… provision of expert assistance through the Scientific Committee's sub-committee on whalewatching'.

The sub-committee is seeking clarification on the mechanism by which this expert assistance will inform the work of the Standing Working Group. It generally welcomed the opportunity to liaise with the CC and Commission, but noted its own terms of reference, and that the advice it offers should be within that framework. One possible mechanism, for example, would be to designate a representative from the sub-committee to work directly with the CC on this issue, thereby providing a formal interface.

The sub-committee is also seeking clarification on the envisioned management objectives for whalewatching, as IWC/62/CC8 states both 'growth' and 'sustainability' objectives. Clarification on this issue will guide the scientific work of the sub-committee for Objective 7 of the LaWE project ('Develop an integrated and adaptive management framework for whalewatching that accounts for uncertainties, and includes monitoring and feedback mechanisms').

The sub-committee draws the attention of the CC to the definitions of whale ecotourism developed by the sub-committee (IWC, 2006) and considered it important that the CC take a strategic view of what it might achieve in the five years. It also stressed the importance of a good scientific basis for the work that it is recommending to the Commission.

One member suggested that it would be valuable to increase communication and explore possibilities to collaborate with the UN World Tourism Organisation, as its remit complements the work of the sub-committee in a number of aspects. Lusseau volunteered to liaise for this purpose.

9.5 Other

Simmonds presented a paper by Eisfield *et al.* (2010) on the behaviour of a female solitary sociable dolphin studied on the southeast coast of England in 2007 and previously discussed by the sub-committee. This was the first time that the behaviour of such an animal was systematically recorded. By the time this study was conducted, the young female was highly interactive with people in the water. People accompanied the dolphin for 18.4% of the 100hr of observation, and their presence changed her behaviour. The study recorded 39 different behaviours; feeding and resting behaviours declined in frequency in the presence of people. In addition, the dolphin exhibited behaviour possibly hazardous to people in the water, which included preventing swimmers from leaving the water. The dolphin received several wounds, at least one of which was life-threatening, and may have eventually died as a result of her habituation to human company. The vulnerability of solitary sociable dolphins created by a high level of human interactions was again emphasised by this study.

The sub-committee **reiterated its recommendation** of 2008: habituation of solitary dolphins can make them vulnerable to harm, including being killed, and should be avoided.

10. WORK PLAN

The work plan prioritised major items as listed below.

(1) Assess the impacts of whalewatching on cetaceans (methods and results of changes in behaviour and movement patterns; methods and results of physiological changes to individuals; and methods and results of demographic and distributional changes).

In addition, the following items were **recommended** for the next meeting.

(2) Review reports from Intersessional Working Groups: (i) large-scale whalewatching experiment (LaWE) Steering Group; (ii) LaWE Budget Development Group; (iii) online database for worldwide tracking of commercial whalewatching and associated data collection; and (iv) swim-with-whale operations.
(3) Consider information from platforms of opportunity of potential value to the Scientific Committee.
(4) Review of whalewatching guidelines and regulations.
(5) Review of collision risks to cetaceans from whalewatching vessels.

The sub-committee discussed the work plan and set priorities for next year as listed. Terms of reference and members of the Intersessional Working Groups as **agreed** by the sub-committee are listed in Table 1.

Table 1

Intersessional working groups and related information.

Group	Terms of Reference	Membership
LaWE Steering Group	Initiate collaboration request and report on responses; develop procedural mechanisms to centralize data received from identified collaborators relevant to LaWE with the Secretariat; utilise received data to commence power analysis for key parameters; develop matrix to categorise populations for site selection; initiate contact with field researchers to inform options for site matrix; continue to facilitate communication on LaWE progress with members of the sub-committee.	Lusseau (Convenor), Bejder, Bjørge, Carlson, Robbins, Rose, Sironi, Weinrich, Williams
LaWE Budget Development Group	Advance development of a draft budget and funding mechanisms for the LaWE.	Weinrich (Convenor), Kaufman, Lusseau
Online database for worldwide tracking of commercial whalewatching and associated data collection	Advise on the design of a database of whalewatching activities and associated data.	Robbins (Convenor) Bejder, Carlson, Kaufman, Lusseau, Simmonds, Weinrich, Williams
Swim-with-whale operations	Field-test a questionnaire intended to assess the extent and potential impact of swim-with-whale operations and refine as needed.	Rose (Convenor) Parsons, Ritter, Sironi, Weinrich

11. ADOPTION OF THE REPORT

The report was adopted at 16:53 on 6 June 2010. The sub-committee thanked Kato for his 15 years of leadership and expressed its deep appreciation for his admirable and wise guidance.

REFERENCES

Arcangeli, A. and Crosti, R. 2009. The short-term impact of dolphin-watching on the behaviour of bottlenose dolphins (*Tursiops truncatus*) in western Australia. *Journal of Marine Mammals and their Ecology* 2(1): 3-9.

Christiansen, F., Lusseau, D., Stensland, E. and Berggren, P. 2010. Effects of tourist boats on the behaviour of Indo-Pacific bottlenose dolphins off the south coast of Zanzibar. *Endangered Species Research* 11(1): 91-99.

Corkeron, P.J. 1995. Humpback whales (*Megaptera novaeangliae*) in Hervey Bay, Queensland: Behaviour and responses to whale-watching vessels. *Can. J. Zool.* 73(7): 1290-99.

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.

Filla, G. and Monteiro, E. 2009. Monitoring tourism schooners observing estuarine dolphins (*Sotalia guianensis*) in the estuarine complex of Cananeia, south-east Brazil. *Aquat. Conserv.* 19(7): 772-78.

International Whaling Commission. 2006. Report of the Scientific Committee. Annex M. Report of the Sub-Committee on Whalewatching. *J. Cetacean Res. Manage. (Suppl.)* 8:241-51.

Jensen, F.H., Bejder, L., Wahlberg, M., Aguilar Soto, N., Johnson, M. and Madsen, P.T. 2009. Vessel noise effects on delphinid communication. *Mar. Ecol. Prog. Ser.* 395: 161-75.

McFarland, D.J. and Sibly, R.M. 1975. The behavioural final common path. *Phil. Trans. Roy. Soc. Lond. B* 270: 265-93.

Noren, D.P., Johnson, A.H., Rehder, D. and Larsen, A. 2009. Close approaches by vessels elicit surface active behaviours by southern resident killer whales. *Endangered Species Research* 8(3): 179-92.

Parrott, L., Chion, C., Martins, C.C.A., Lamontangne, P., Turgeon, S., Landry, S., Zhens, B., Marceau, D.R.M., Cantin, G., Menard, N. and Dionne, S. 2010. 3MTSim: An agent-based model of marine mammals and maritime traffic to assist managment of human activities in the Saint Lawrence Estuary, Canada. *Environmental Modelling and Software*: 22pp. [Submitted].

Pollock, K.P., Nichols, J.D., Brownie, C. and Hines, J.E. 1990. Statistical inference for capture-recapture experiments. *Wildl. Monogr.* 107: 1-97.

Ritter, F. 2010. Short description of a near-miss event involving a large vessel and humpack whales (*Megaptera novaengliae*) off Antarctica. Poster presented to the ECS Annual Conference, Stralsund, Germany, 22-24 March 2010. [Available from: *http://www.europeancetaceansociety.eu*].

Robbins, J. and Frost, M. 2009. An on-line database for world-wide tracking of commercial whalewatching and associated data collection programs. Paper SC/61/WW7 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 2pp. [Paper available from the Office of this Journal].

Robbins, J., Landry, S. and Mattila, D.K. 2009. Estimating entanglement mortality from scar-based studies. Paper SC/61/BC3 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 4pp. [Paper available from the Office of this Journal].

Scarpaci, C., Nugegoda, D. and Corkeron, P. In press. Nature-based tourism and the behaviour of bottlenose dolphins, *Tursiops* sp., in Port Phillip Bay, Victoria, Australia. *Victorian Field-Naturalist*.

Smit, V., Ritter, F., Ernert, A. and Strueh, N. 2010. Habitat partitioning by cetaceans in a multi-species ecosystem around the oceanic island of La Gomera (Canary Islands). Poster presented to the ECS Annual Conference, Stralsund, Germany, 22-24 March 2010. [Available from *http://www.europeancetaceansociety.eu*].

Sousa-Lima, R.S. and Clark, C.W. 2009. Whale sound recording technology as a tool for assessing the effects of boat noise in a Brazilian marine park. *Park Science* 26(1): 59-63.

Sousa-Lima, R.S., Morete, M.E., Fortes, R.C., Freitas, A.C. and Engel, M.H. 2002. Impact of boats on the vocal behaviour of humpback whales off Brazil. *J. Acoust. Soc. Am.* 112(5): 2430-31.

Stamation, K.A., Croft, D.B., Shaughnessy, P.D., Waples, K.A. and Briggs, S.V. 2010. Behavioural responses of humpback whales (*Megaptera novaeangliae*) to whale-watching vessels on the southeastern coast of Australia. *Mar. Mammal Sci.* 26(1): 98-122.

Weinrich, M. and Corbelli, C. 2009. Does whale watching in Southern New England impact humpback whale (*Megaptera novaeangliae*) calf production or calf survival? *Biol. Conserv.* 142: 2931-40.

Weir, C.R. 2009. Distribution, behaviour and photo-identification of Atlantic humpback dolphins *Sousa teuszii* off Flamingos, Angola. *African Journal of Marine Science* 31(3): 319-31.

Williams, R., Bain, D., Smith, J.C. and Lusseau, D. 2009. Effects of vessels on behaviour patterns of individual southern resident killer whales *Orcinus orca*. *Endangered Species Research* 6(3): 199-209.

Appendix 1

AGENDA

1. Opening remarks
2. Election of Chair and rapporteurs
3. Adoption of Agenda
4. Review of available documents and information
5. Discuss the proposal for a Large-scale Whalewatching Experiment (LaWE; including reports from the Intersessional steering group and advisory group)
    - 5.1 Report from intersessional working group
    - 5.2 Report from LaWE advisory group
    - 5.3 Discussion of the proposal
    - 5.4 Other
6. Review whalewatching off North Africa
7. Assess the impact of whalewatching on cetaceans
8. Review of intersessional working groups
    - 8.1 Online database for worldwide tracking of commercial whalewatching operations and associated data collection (Convenor: Robbins)
    - 8.2 Swim-with-whale operations (Convenor: Rose)
9. Other issues
    - 9.1 Consider information from platforms of opportunity of potential value to the Scientific Committee
    - 9.2 Review of whalewatching guidelines and regulations
    - 9.3 Review risks to cetaceans from collisions with whalewatching vessels
10. Work plan
11. Other matters
12. Adoption of the Report

Appendix 2

REPORT FROM THE INTERSESSIONAL LaWE STEERING GROUP

LaWE Steering Group[1]
Contact: *d.lusseau@abdn.ac.uk*

ABSTRACT

The LaWE (Large-scale Whalewatching Experiment) steering group and the LaWE advisory group were developed during SC/60 in response to IWC (2008), the Bunbury report that proposed the development of an IWC research initiative to define the principles that determine how whalewatching interacts with other pressures on cetaceans to lead to impacts on their life history parameters in some instances. The steering group is to develop proposals for methodology, design and management of this initiative, including receiving advice from the LaWE advisory group regarding candidate study sites and taxa. Following on the initial Bunbury workshop report, the steering group, including a representative of the advisory group, further developed a proposal for LaWE including the precise definition of aims and hypotheses (IWC, 2010). Here, we provide a brief overview of this proposal and proposed options to manage this project.

THE LaWE PROPOSAL

The initiative aims to understand possible effects of whalewatching on the demographic parameters of cetacean populations. The first aim is to explore causal relationships between whalewatching exposure and survival and vital rates of exposed cetacean individuals. The second aim is to understand the mechanisms involved in causal effects, if they exist, in order to define a framework for proper management. Taking heed of the precautionary principle, we chose to meet the aims concurrently; if taken sequentially, the second objective would be sufficiently time-consuming to effectively delay implementation of proper management on decadal scales.

Objectives

(1) Determine whether the vital rate effects described in recent studies can be observed in other situations (IWC/58/Rep1).
(2) Determine how exposure to whalewatching affects the ecology, behaviour and/or physiology of cetaceans.
(3) Conduct short-term studies to inform the likelihood of long-term population impacts.
(4) Assess temporal variation of individual responses to disturbance (e.g. habituation, tolerance and sensitisation).
(5) Develop a modelling framework to explore potential population consequences of changes in life history parameters given observed effects and effect sizes and use additional datasets to test model predictions.
(6) Determine the effectiveness of mitigation measures employed to reduce the effects of whalewatching.
(7) Develop a management framework for whalewatching that accounts for uncertainties, and includes monitoring and feedback mechanisms.

Research design

Aim 1

Demonstrate a causal relationship between whalewatching exposure and the survival and vital rates of exposed cetacean individuals.

We propose to use **a nested block study design** to account for environmental and biological variability, with multiple control and whalewatching site replicates within species, between ecological conditions and between species with different life history strategies. A nested block design will allow accounting for inherent variability by using replicate control and exposure sites.

In principal, four categories of cetacean populations are targeted by whalewatching:

- resident populations where breeding, nursing and feeding occur in the same area;
- cetaceans on their breeding grounds;
- cetaceans on their feeding grounds; and
- cetaceans on their migratory corridors.

Aim 2

Understand the mechanisms involved in causal effects.

We will use short-term controlled exposure experiments. The interpretation of the results of these experiments will be context-specific, e.g. depending on habitat quality or physiological status. It is not feasible to measure all covariates that can influence these results. Therefore within- and between- species site replications and **nested block design** will also be essential.

Variables

Aim 1

Compare levels of exposure to whalewatching and measures of a variety of demographic parameters.

(1) Vital rate and survival information, e.g. age at maturity, reproductive and survival parameters, obtained through rigorously designed mark-recapture studies using photo-id and other non-invasive techniques.
(2) Range and spatial use information using a range of non-lethal techniques such as photo-id and passive acoustic techniques.
(3) The quantity and rate of exposure of individuals to the number and type of whalewatching boats.
(4) To the fullest extent possible, environmental covariates from each site (however those are not essential thanks to the study design).

Aim 2

Determine short-term responses.

(1) Activity budgets, movement patterns, and habitat use by sampling the movement of individuals.
(2) Data on social patterns.
(3) The physiological status of individuals using metabolic indices, body condition indices and (where possible) stress hormone levels.
(4) Characteristics of whalewatching interactions including characteristics of boats and their behaviour.

[1]Lars Bejder, Murdoch University; Arne Bjørge, Institute of Marine Research; David Lusseau, University of Aberdeen; Mason Weinrich, Whale Center of New England; Rob Williams, University of British Columbia. LaWE Advisory Group representative: Naomi Rose, Humane Society International.

Hypotheses and work plan

Objective 1

Determine whether the vital rate effects described in existing studies can be observed in other situations.

HYPOTHESIS 1.1

There is a relationship between cumulative exposure to whalewatching interactions and the vital rates of individual cetaceans.

HYPOTHESIS 1.2

For species that segregate their life history into different geographic locations, exposure in one of the locations can be sufficient to cause an effect in vital rates.

Objective 2

Determine how exposure to whalewatching affects the ecology, behaviour and/or physiology of cetaceans.

HYPOTHESIS 2.1

Interactions with whalewatching boats elicit behavioural responses that are analogous to responses to predation risk.

HYPOTHESIS 2.2

Whalewatching boats impact cetaceans through trait-mediated indirect effects where the animals are forced to modify their behaviour because of environmental disturbance (e.g. by the boat influencing prey behaviour).

HYPOTHESIS 2.3

Whalewatching boats affect cetaceans by obstructing their behaviour (e.g. the boat acting as a physical barrier or acoustic masking).

HYPOTHESIS 2.4

The levels of stress hormones (e.g. corticosteroids) of individuals are related to their exposure to whalewatching interactions

Objective 3

Conduct short-term studies to inform the likelihood of long-term population impacts.

This objective represents a work plan that follows on the hypotheses framed under Objective 2. These studies will involve a series of controlled exposure experiments within and beyond the LaWE experimental sites using the list of pre-determined variables.

Objective 4

Assess temporal variation of individual responses to disturbance (habituation and sensitisation).

HYPOTHESIS 4.1

The magnitude of an individual's response is temporally dependent on exposure to a controlled stimulus.

HYPOTHESIS 4.2

If 4.1 is true, the rate of habituation or sensitisation will be dependent upon the exposure history in relation to the onset of the impact assessment.

Objective 5

Develop a modelling framework to explore potential population consequences of changes in life history parameters given observed effects and effect sizes and use additional datasets to test model predictions.

Individual-based models will be used to inform the mechanistic relationships between whalewatching exposure and individual vital rates and survival probability. There will be several aims to these simulations.

- Identify possible pathways that can lead exposed individuals to have significantly altered vital rates or survival probability.
- Inform study design by highlighting the minimum set of variables required to achieve project Aim 2.
- Inform study design in two ways. First, by defining the sensitivity of demographic parameters to uncertainty in parameter estimates. Second, by estimating variance of parameters and hence informing sample size.
- These models will offer a mechanism through which we will then be able to run simulations to inform on the potential outcomes of different management actions (Objective 7).

Objective 6

Determine the effectiveness of mitigation measures employed to reduce the effects of whalewatching:

(a) understand the precise stimulus that elicit responses from the animal.

HYPOTHESIS 6.1

The effect size of a response is the same regardless of the characteristics of the whalewatching interaction.

HYPOTHESIS 6.2

If hypothesis 6.1 is refuted, the effect size of the response is dependent upon one or more specific properties of the interaction:

(b) the effectiveness of mitigation measures that reduce exposure to those areas identified in (a).

HYPOTHESIS 6.3

A reduction of the exposure to significant characteristics of the whalewatching interactions will significantly reduce effect size.

Objective 7

Develop an integrated and adaptive management framework for whalewatching that accounts for uncertainties, and includes monitoring and feedback mechanisms.

- Once the models developed in Objective 5 are informed by results from the empirical studies (including those from Objective 3), we can use simulation to inform the potential outcome of different management actions in various situations.

INTERSESSIONAL TERMS OF REFERENCE

During last year's meeting, the steering group was charged with a number of intersessional tasks:

Task 1. LaWE steering group to develop procedural mechanisms for the LaWE project.

Task 2. Initiate power analyses to further develop and refine methodology.

Task 3. Receive advice from the LaWE advisory group on appropriate sites and species.

Task 4. Develop an IWC-centralised data collection and QA/QC procedure for pre-existing and new data to inform Objective 3 and power analyses.

Due to both financial and time constraints the LaWE steering group did not meet intersessionally this year. However, the following progress has been made on Tasks 1-4 and further progress is anticipated prior to the completion of this year's meeting.

Task 1. Procedural mechanisms for the LaWE project

Procedural linkages

Given the number of field sites envisioned necessary for the LaWE initiative, and therefore the number of research teams needed, there are two key procedural aspects that require special planning and forethought. Firstly, we need to define mechanisms for communication and coordination of data (both collection and storage) and analytical efforts across all teams. Secondly, we need to ensure consistency between teams and within teams over the research period, in data collection and analyses. Furthermore, not all research teams will have the required skills to carry out all components of the projects and therefore, when possible, we need to ensure the provision of a homogeneous training programme. For tasks for which this is not feasible (e.g. specialised analytical skills), we will need to develop separate teams.

We have identified four primary, *non-mutually exclusive*, groups of individuals who will interact during this project: (1) data management and QA/QC; (2) field data collection; (3) data analyses and simulations; and (4) project management. These interactions could take place in a number of ways, which are presented in Fig. 1. Data collection would be undertaken in a consistent manner at numerous field sites, data management would be completed by a team responsible for assuring and controlling data quality, data analyses would be conducted by dedicated specialised teams, and a group would coordinate and manage the project.

From the experiences drawn from other large project initiatives (e.g. the Census of Marine Life and to some extent the Revised Management Procedure), we know that neither a top-down approach (Option 1), nor a bottom-up approach (Option 2) will help us achieve the goal of this project. Instead, the procedures we put in place will need to ensure two primary goals:

(1) ensure that data is collected in the same manner at all field sites with the same quality standard; and
(2) ensure that communication between all four groups is maximised so that if problems arise (e.g. sampling hindrances, QA/QC issues, etc.) they can be quickly dealt with, given the ability to learn from past experiences in other sections of the project, and if unanticipated difficulties arise they can be discussed and resolved in an open and timely manner.

It will be important for this procedure to:

(1) not hinder innovation emerging from field sites and allow for useful emerging procedures/ideas to be propagated at other sites if need be;
(2) foster a sense of community to allow free exchange between all members; and
(3) foster feedback loops along the information exchange paths.

Under these conditions we propose that the network approach (Fig. 1, Option 3) would be most efficient for this project. Here, a coordinating group would act as a 'hub' of information exchange rather than an information sink or source.

Financial considerations

Finally, to ensure the success of this project it is essential that data collection can be maintained at all selected sites. It was recognised in the Bunbury report that external financial contributions will be necessary to sustain the project. Different countries and/or regions will have different abilities to cover, and sustain at the appropriate time scale, the cost of the workload required at their field sites. Therefore, it will be important to define a procedure to ensure that the LaWE project is not jeopardised by financial instability at selected field sites. The IWC, as an international body who has dealt with such matters in the past, has pre-existing mechanisms for nations to contribute to specific research efforts with minimal geographic restrictions, and represents a promising vehicle to achieve this important goal.

This project is essentially a Research and Development component of the global whalewatching industry. As such, it is important for the industry to realise the value of this work for its sustainability and its viability.

Many countries are already funding research on whalewatching impact from levies on whalewatching passengers. Such funding schemes should be encouraged in all locations to adequately fund components of the LaWE project.

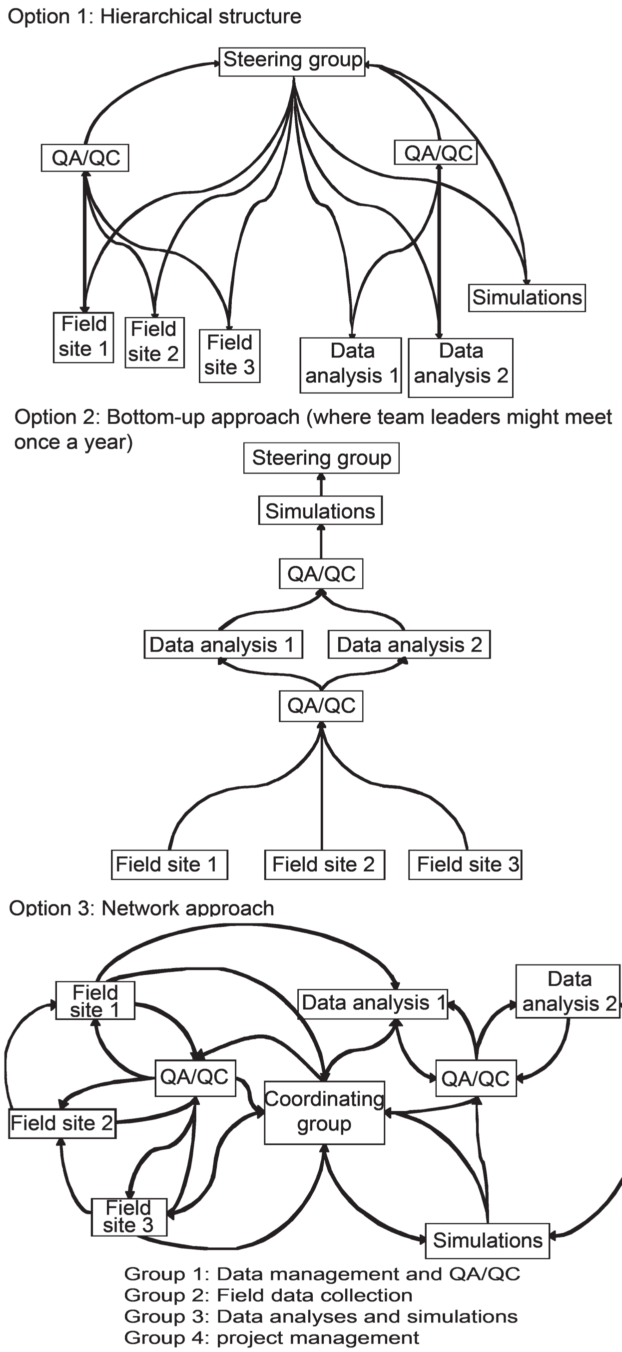

Fig. 1. Potential procedural linkages between the different components of the project (QA: quality assurance, QC: quality control).

It is necessary to recognise that data collection is only one component of the project and, at times, the easiest to fund. However, financial stability is also required for the other components (QA/QC, analysis and simulations). In time, we can envisage the procedure to be fully incorporated to the workload of the IWC in the same manner as the current whaling RMP is.

Task 2. Initiate power analyses to further develop and refine methodology
Preliminary work on this task (as reported in IWC, 2008) showed that a meta-analysis cannot be completed using currently published information, largely due to a disparity in information reported. This task will therefore require Task 4 to be completed before analyses can proceed. Development of a budget for such efforts, as well as potential funding sources, will also be required.

Task 3. Receive advice from the LaWE advisory group on appropriate sites and species
We have not engaged with the LaWE advisory group intersessionally because we have not yet reached the point where specific field sites and dialogues on other issues would have been helpful. We look forward to initiating and streamlining this process starting at this year's meeting.

Task 4. Develop an IWC-centralised data collection and QA/QC procedure for pre-existing and new data to inform Objective 3 and power analyses

(a) We plan to engage in discussion with the IWC Secretariat to assess the feasibility, and associated costs, for housing data with the Secretariat to both ensure transparency and to take advantage of data-sharing mechanisms already in place at the Secretariat.
(b) We have drafted the following email to be distributed through the MARMAM listserve subsequent to discussions at this year's meeting.

Text of e-mail for consideration by the whalewatching sub-committee

'International Whaling Commission – Large-scale Whalewatching Experiment (LaWE): scoping call for participation

We are seeking collaborations with researchers working on the behavioural ecology of cetaceans around the world. The long-term goal of the collaborations is to develop research to determine sustainable levels of whalewatching.

For the past 25 years, a large number of studies have investigated the effects of whalewatching on cetaceans and their potential impacts. From this body of work there is a consensus emerging that 'the fitness of individual odontocetes repeatedly exposed to whalewatching vessel traffic can be compromised and that this can lead to population level effects' (IWC, 2006). There is currently no consensus on mysticetes. The IWC Scientific Committee has strongly encouraged the development of research, particularly on large whales, to determine sustainable levels of whalewatching.

To this end we are developing a large-scale research programme (Large-scale Whalewatching Experiment – LaWE) with the goal of providing scientific advice to determine sustainable levels of whalewatching. This IWC initiative has been developed to assess how whalewatching exposure can interact with the life history strategies of the targeted individuals and the ecological conditions of their habitat to lead to population-level consequences. We have developed a research programme proposal with seven clear objectives. The text of the proposal is available at *http://www.iwcoffice.org/conservation/whalewatching.htm*. We are hoping to be able to initiate the project in the year to come, starting with a power analysis to define the number of sites that will be required for hypotheses-testing.

To this end, we are opening a call to researchers who have conducted behavioural studies (not necessarily whalewatch impact research) on cetaceans (odontocete and mysticete) in the past or are currently doing so. We have carried out previous attempts to meta-analyse data from pre-existing whalewatching impact assessment studies to compare effect size across different sites. However, this analysis came to an impasse due to disparities in methodology and the statistics reported. Such meta-analyses will help focus sampling strategies and work towards several of the objectives of LaWE. We are therefore interested in collating raw data on key parameters identified for the LaWE project to carry out such meta-analyses (as well as power analyses) for one of the aims of the LaWE ('Understand the mechanism involved in the causal relationship between whalewatching exposure and the survival and vital rates of exposed individuals'). We have identified interest in the following variables:

Activity budgets (based on focal follow sampling).

Movement patterns (based both from land-based sampling techniques and animal instrumentation).

Habitat use (both from photo-identification and the sampling of the movement of individuals).

This is an initial call to gauge interest in entering in such coordinated collaborative effort. If you possess such data, that could be used for the power analyses described in the research proposal, with information on quality control and quality assurance during sampling (e.g. formalised sampling protocols, consistent and regular calibration of sampling procedures), and are interested in participating to this collaborative effort, please contact us by emailing David Lusseau (*d.lusseau@abdn.ac.uk*). We will then discuss the possible mechanisms to develop this collaboration, ensuring the respect of data ownership, which will be coordinated from within the IWC.'

OTHER MATTERS

The Conservation Committee has now focused its work on whalewatching through the creation the Standing Working Group on Whalewatching (IWC/61/Rep5). This working group is developing a strategic plan to foster the development of whalewatching in a sustainable manner. We feel it is primordial that a close working relationship exists between LaWE and the Standing Working Group on Whalewatching to ensure that any development advice is based on robust scientific advice and to ensure that LaWE receives advice from the Standing Working Group on Whalewatching for Objective 7.

The IWC Scientific Committee sub-committee has recognised the relevance of the Population Consequence of Acoustic Disturbance (PCAD) model and framework to whalewatching effect studies on the scale of the LaWE (IWC/58/Rep1). LaWE steering group members have become aware of other current endeavours to implement the PCAD framework. This effort is providing a formalisation of PCAD and testing it on a wide variety of marine mammal case studies (see SC/62/WW6). This effort has made considerable progress in developing a modelling approach to PCAD which will be extremely valuable for LaWE. Indeed, this approach echoes LaWE's Objectives 2-4 and provides a statistical modelling framework to use data collected under the proposed study design to achieve Aim 2. It would be profitable for LaWE to engage more closely with this initiative.

REFERENCES

International Whaling Commission. 2006. Report of the Scientific Committee. Annex M. Report of the Sub-Committee on Whalewatching. *J. Cetacean Res. Manage. (Suppl.)* 8:241-51.

International Whaling Commission. 2008. Report of the Intersessional Workshop to Plan a Large-Scale Whalewatching Experiment; LaWE, 30 March-4 April 2008, Murdoch University, Bunbury, Australia. *J. Cetacean Res. Manage. (Suppl.)* 11:483-500.

International Whaling Commission. 2010. Report of the Scientific Committee. Annex M. Report of the Sub-Committee on Whalewatching. Appendix 2. Addendum to the Bunbury report re: intersessional LaWE steering group and LaWE advisory group. *J. Cetacean Res. Manage (Suppl.)* 11(2):341-45.

Annex N

Report of the Working Group on DNA

Members: Pastene (Chair), An, Baker, Bravington, Cipriano, Donovan, Donoghue, Gaggiotti, Hoelzel, Kanda, Leaper, Lyrholm, Pampoulie, Perrin, Uoya, Víkingsson, Waples, Yoshida.

1. ELECTION OF CHAIR

Pastene convened and chaired the Group.

2. APPOINTMENT OF RAPPORTEURS

Cipriano and Pastene acted as rapporteurs.

3. ADOPTION OF AGENDA

The adopted Agenda is given as Appendix 1. Items 5, 6, 7 and 8 of the Agenda are in response to requirements placed on the Scientific Committee by IWC Resolution 1999-8 (IWC, 2000), which called for annual reports on progress in the following areas:

(1) genetic methods for species, stocks and individual identification;
(2) collection and archiving of tissue samples from catches and bycatch; and
(3) status of and conditions for access to reference databases of DNA sequences or microsatellite profiles derived from directed catches, bycatch, frozen stockpiles and products impounded or seized because of suspected infractions.

Agenda Item 9 is in response to requirements placed on the Scientific Committee by the Commission to review Annex {DNA} in document IWC/62/7rev.

4. REVIEW OF DOCUMENTS

Relevant information was contained in IWC/62/6rev, IWC/62/7rev (Annex {DNA}), SC/62/O19 and Baker *et al.* (2010).

5. PROGRESS ON GENETIC METHODS FOR SPECIES, STOCK AND INDIVIDUAL IDENTIFICATION

No document was available for discussion under this Agenda Item. The Chair noted that at last year's meeting the Group reviewed Cipriano and Pastene (2009), which made a comprehensive review of current knowledge of techniques to extract DNA from 'difficult' samples.

6. REVIEW RESULTS OF THE 'AMENDMENTS' OF SEQUENCES DEPOSITED IN GENBANK

During the first round of sequence assessment (IWC, 2009b, p.437) some inconsistencies were found but these appear to be due to a lag in the taxonomy recognised by *GenBank* or uncertainty in taxonomic distinctions currently under investigation (e.g. the number of species and appropriate names for recently described species of 'Bryde's whales'). As agreed by the Committee in previous years, any anomaly detected in the species identity assessment will be shared with members of the Committee. The original submitter would be notified of the inconsistency and a suggestion made that an amendment be made to the entry. A summary of amendments as derived from the results of the first round of sequence assessments (IWC, 2009b, p.437) is shown below:

- 23 labelled as *Balaenoptera acutorostrata* in *GenBank* were identified as *B. bonaerensis;*
- 9 labelled as *B. edeni* in *GenBank*; and
- 10 labelled as *Eubalaena glacialis* in *GenBank* were identified as *E. australis* and *E. japonica.*

The Committee noted last year that it has not yet decided on the names for the different species of Bryde's whales and that *B. edeni* is the only name accepted by the Committee to date (IWC, 2010, p.73). The Committee suggested that with regard to the nine sequences labelled as *B. edeni* no amendments should be made at this stage but that some notification should be made in *GenBank* that their taxonomic status is currently under consideration.

Following up on a task assigned by the Committee last year, the Chair informed that he had contacted *GenBank* officers to make the above indicated amendments. He was informed that only the original submitters of the sequences can make amendments to their submissions. In view of this he contacted the relevant submitter scientists encouraging them to make the relevant amendments. As a result the notification regarding Bryde's whale taxonomy was made. Amendment work by the original submitters of right and minke whale sequences is ongoing and this work will be completed during the next intersessional period.

7. PROGRESS ON COLLECTION AND ARCHIVING OF SAMPLES FROM CATCHES AND BYCATCHES

An update of the status of the Norwegian register was available to the Group (see Appendix 2). The collection of samples includes commercial catches of common minke whales from 1997 to 2009. The number of samples missing from the register by year ranged from 0-11. Some of the missing samples reflect unsampled whales, while others resulted from inadvertent duplicates.

Kanda reported on the status of the Japanese register (see Appendix 3). The collection of samples is from scientific whaling in the Antarctic (JARPA and JARPA II) and North Pacific (JARPN II), bycatches and strandings. It includes complete coverage for 2009 and the 2009/10 Antarctic season.

Pampoulie reported on the status of the Icelandic register (see Appendix 4). Samples are presently in hand for all whales taken in 2003-09. Pampoulie also noted that only whales intended for export from Iceland were currently being genotyped for inclusion in that country's registry, although tissue samples from all whales were being archived, and will be genotyped as soon as possible.

8. REFERENCE DATABASES AND STANDARDS FOR A DIAGNOSTIC REGISTER OF DNA PROFILES

Genetic analyses have been completed and data on mtDNA, microsatellites and sex entered in the Norwegian register for years up to 2007 (see Appendix 2). For 2008 samples, laboratory work has been completed but the results have not been analysed yet. Laboratory work is ongoing for the 2009 samples.

For the Japanese register (see Appendix 3), the genetic analyses based on mtDNA have been completed for North Pacific common minke, Bryde's, sei and sperm whales taken by scientific whaling through to 2009. Laboratory work on microsatellites for these samples is being conducted. The genetic samples of Antarctic minke whales sampled by JARPA II have not been analysed yet, except for sex and for microsatellites of 190 samples taken in 2006/07 (six loci) and 551 taken in 2007/08 (six loci). For bycatch samples, genetic analyses based on mtDNA have been completed for all samples through to 2009. Laboratory work on macrosatellites for these samples is being conducted. Laboratory work is ongoing for stranded animals in 2009 for both mtDNA and STR.

For the Icelandic register (see Appendix 4) genetic analyses (mtDNA and microsatellites) were completed for common minke whales taken by scientific whaling in 2003-07. Laboratory work of samples taken under commercial whaling in 2006 and 2009 is under way. Genetic analyses were completed for fin whale commercial samples collected in 2006 and 2009.

The Group **recommended** the adoption of a standard format for the updates of national DNA registers to assist with the review of such updates in the future. The format used by the Norwegian registry update report should be used as a model for the standard format. The Chair will work intersessionally with colleagues from Norway, Japan and Iceland to agree on the standard format. Also, the Group noted the addition of a 'per cent completed' column for genetic analysis of tissue samples would be useful to assist in the annual review. Víkingsson, while agreeing with these recommendations, reminded the Group that Norway, Japan and Iceland are providing update of their registries to the Group on a voluntarily basis.

The Group also noted that full technical specifications for the Japanese and Icelandic DNA registries had never been received or reviewed, and that although such information is provided voluntarily, such a review would be helpful for the Group's annual review of the status of DNA registries under its standing Agenda Items. The Chair again reminded the Group that reports of updates of registers should include a list of references including the relevant documents on protocols used.

9. CONSIDERATION OF REQUEST FOR ADVICE FROM THE COMMISSION

The Working Group on DNA Testing held a joint meeting with the Working Group on Bycatch to review Annex {DNA} of document IWC/62/7rev, according to the Terms of Reference provided in Annex G of IWC/62/6rev (Appendix 5). Pastene and Perrin co-chaired the sessions, which was attended by most of the members of the two Working Groups. The draft technical specifications for establishment/maintenance of diagnostic DNA registers and general approaches for design of market sampling schemes in Annex {DNA} of IWC/62/7rev were derived from the report of a workshop held from 7-9 March 2005 (IWC/M05/RMSWG5) following Terms of Reference given in Annex B of that report. Participants at the 2005 workshop included the Specialist Group established by the RMS (Revised Management Scheme) Working Group at its meeting in Sweden in December 2004.

In the sections below, excerpts from parts of Annex {DNA} of IWC/62/7rev are indicated by:

indented type in alternate font size.

Comments and suggestions for improvements made during the discussion and additional text and footnotes **recommended** by the Working Groups (hereafter 'Group') to improve clarity and completeness of the specifications for the DNA registry and market sampling scheme are indicated below by:

[italic text in square brackets].

A complete and uninterrupted version of a modified Annex {DNA} is included in Appendix 6.

1. SPECIFICATIONS FOR THE ESTABLISHMENT/ MAINTENANCE OF A DIAGNOSTIC[17] DNA REGISTER/ TISSUE ARCHIVE

1.1 Laboratories
1.1.1 Minimum laboratory requirements

(1) Laboratories performing DNA analysis shall be recognised by the Contracting Government under whose jurisdiction whales are harvested.
(2) Quality control and quality assurance features shall ensure that:
 (a) analysts have acceptable education, training and experience for the task;
 (b) reagents and equipment are properly maintained and monitored;
 (c) procedures used are generally accepted in the field and have been approved by the IWC Scientific Committee (see Items 1.2-1.5);
 (d) appropriate controls are used.
(3) Thorough laboratory records (protocols, notes, worksheets, etc.) shall be maintained and archived for possible inspection (see Item 1.7).
(4) Changes in equipment and approved methods shall be recorded and reported annually to the IWC to allow ongoing standardisation among registers (see Item 1.7).
(5) A suitable inventory management system shall be in place so that the whereabouts and use of each sample/aliquot over time during storage and analysis can be traced.
(6) Portions of the tissue samples and DNA extracts should be retained and stored in an appropriate manner (see Item 1.2.3).

The Group noted that the length of time that archived samples were to be stored was not specified in item 6, but it was clear that the intent was for long-term storage. The modified text **recommended** by the Group was:

[(6) Portions of the tissue samples and DNA extracts should be retained and stored indefinitely or until advised by the SC, using an appropriate preservation method (see Item 1.2.2).]

(7) The probability of errors occurring should be estimated and minimised, using standard procedures. DNA data quality/acceptability should be decided in accordance with generally accepted rules and reported annually where possible (e.g. PHRED scores for sequences, SDs of fragment length measurements for microsatellite alleles, means and SDs of peak heights for microsatellites, some evaluation of stutter for each microsatellite locus). This information should be reported annually to the IWC (see Items 1.5 and 1.7).

[17]A diagnostic DNA register is one that contains DNA profiles of any animals from which products *might* legally appear on the market (e.g. from legal direct catches, bycatches, ship strikes etc.). On this basis, any products found on the market that were from whales not included in the register will be from illegal whales.

The Group agreed that a variety of error-checking procedures should be followed, including *inter alia* genotyping errors, mis-labelling, identification of duplicate samples, etc.

The Group also suggested that sample quality should be checked routinely prior to genetic analysis because some samples (e.g. those derived from bycaught animals) may be degraded and thus would require increased replication to ensure accuracy. References useful for outlining such considerations and providing methods for quality control and reporting include the Guidelines agreed by the IWC Scientific Committee (IWC, 2009a) and also Morin *et al.* (2010). Modified text to clarify both requirements was **recommended** by the Group:

[(7) The probability of genotyping errors occurring should be estimated and minimised, using standard procedures and also including provisions for detection of mis-labelling, duplicate samples, data entry errors, etc. DNA sample quality should be checked routinely prior to genetic analysis to ensure adequate accuracy in the genotyping of degraded samples (as recommended in IWC (2009a), and subsequent updates to the genetic analysis guidelines). DNA data quality/acceptability should be addressed in accordance with generally accepted rules and reported annually where possible (e.g. PHRED scores for sequences, SDs of fragment length measurements for microsatellite alleles, means and SDs of peak heights for microsatellites, some evaluation of stutter for each microsatellite locus). This information should be reported annually to the IWC (see Items 1.5 and 1.7).]

(8) A reference set of samples should be designated for allelic standards and an equimolar allelic ladder should be constructed by cloning and sequencing a range of alleles for each microsatellite locus.

The Group discussed whether cloning and sequencing of a range of microsatellite alleles was strictly necessary, and agreed that because many microsatellite markers had been originally derived from different cetacean species this could be an important factor in the use of data derived from such markers in other species. The Group also noted that the intent for use of allelic standards was not stated explicitly, but included inter-laboratory calibration (see section 1.1.2 below), which is one of the greatest challenges needed for ensuring accuracy in the development and maintenance of DNA registries.

(9) The laboratory shall participate in calibration exercises with other laboratories if requested to do so by the IWC (see Item 1.1.2).

The Group noted that several different factors are important in calibration exercises and **recommended** revised wording to clarify this requirement:

[(9) The laboratory shall participate in calibration exercises with other laboratories if requested to do so by the IWC (see Item 1.1.2), and taking into account both the analysts involved, the methods and/or software used for binning alleles, and the type of equipment used for genotyping.]

(10) The laboratory should be available for external evaluation and participate regularly in proficiency tests such as double-blind comparisons (e.g. see Item 1.7).

The Group noted that footnote 17 (see p.309) did not adequately describe provisions for ensuring that a DNA register could be used to distinguish whales derived from legally sanctioned trade, and **recommended** alternate wording to satisfy this requirement:

[[17]A diagnostic DNA register is one that contains DNA profiles of all animals from which products might legally appear on the market (e.g. from legal direct catches, legal imports, bycatches, ship strikes etc.). DNA profiles from legally imported whales should thus be included in the importing country's registry as one of the conditions for importation. On this basis, any products found on the market that were from whales not included in the register will be from illegally taken or illegally imported whales.]

1.1.2 Calibration of laboratories if more than one is used

Where more than one laboratory is used to generate a single register or a group of registers, or for the comparison of samples (e.g. under Item 1.8 or Item 2), appropriate calibration of microsatellite genotype scoring (e.g., absolute size or binning) must be undertaken and the results reported to the IWC. The details of the calibration exercise shall be determined by the international expert group (see Item 1.7). The calibration exercise will primarily comprise a double blind experiment with known individuals. Cloned alleles should be used to construct an allelic ladder for calibration purposes. The results of calibration exercises must be reported to the IWC. In designing calibration exercises and reviewing the results, it must be remembered that the primary function of diagnostic DNA registers is to determine whether illegal activity is taking place and that the default position is no match = illegal activity. In this regard it is important to estimate the likelihood of:

- erroneously failing to match products to an animal in the register when it is actually there – i.e. falsely implying an infraction;
- erroneously matching products to an individual in the register when it is not actually there – i.e. missing an infraction when one has occurred.

1.2 Sample collection

Samples for DNA registry should be collected by trained personnel before products from them can enter the market.

The Group noted that Annex {SI} of IWC/62/7rev applies only to commercial, scientific and indigenous catches, but there was no specification for training of and information to be collected by others who may be involved in the collection of genetic samples for DNA registries including those involved in collection of samples from bycaught or stranded whales. A representative from Japan noted that written instructions and probably some initial briefing/training sessions were provided to fishermen who may be involved in collection of samples from bycaught whales. The Group **recommended** an additional footnote to specify such a requirement:

*[**1.2 Sample collection***

Samples for DNA registry should be collected by trained personnel[18] before products from them can enter the market.

[18]Contracting Governments under whose jurisdiction bycaught/stranded whales and their products may be legally marketed are responsible to develop a technical manual for collecting samples and ancillary data for inclusion in DNA registries, and for disseminating such materials and training to others who may be involved in the collection of genetic samples for such use.]

1.2.1 Size of samples

At least two samples of skin/muscle of at least 5x5x5mm must be collected from each animal for each register/archive. In addition, where possible, at least four muscle samples of 20x20x20mm should be taken and frozen as quickly as possible for each register/archive. Samples must also be obtained from any foetuses present.

1.2.2 Preservation
Samples should initially be preserved in 95% ethanol (in at least five times the volume of the sample, due to potential problems of dilution and evaporation) and if practical refrigerated or frozen immediately. If not able to be frozen immediately, the samples should be shipped as soon as possible (preferably within 7 days) to the analysing laboratory. This temporary storage and shipping should be in temperatures <25°C to minimise the possibility of degradation of the sample.

Long-term storage of skin/muscle samples should be in 95% ethanol at or below -20°C. The additional muscle samples should be frozen in liquid nitrogen; transport should be with dry ice. Long-term storage of frozen tissue samples should be at or below -80°C.

The Group **recommended** additional clarification of the sample preservation requirements in sections 1.2.1 and 1.2.2:

[1.2.1 Size of samples

At least two samples of skin/muscle of at least 5x5x5mm must be collected from each animal for each register/archive. In addition, where possible, at least four muscle samples of 20x20x20mm should be taken. Where possible, a sample of tissue from any foetuses detected should be collected. All samples should be taken as quickly as possible and immediately placed in an appropriate preservative, and then frozen as quickly as possible at or below -20°C.

1.2.2 Preservation

Samples should initially be preserved in 95% ethanol (in at least five times the volume of the sample, due to potential problems of dilution and evaporation) or in five times the volume of NaCl-saturated DMSO (dimethyl-sulfoxide). If not able to be frozen immediately, the samples should be shipped as soon as possible (preferably within 7 days) to the analysing laboratory. This temporary storage and shipping should be in temperatures <25°C to minimise the possibility of degradation of the sample.

Long-term storage of skin/muscle samples should be in 95% ethanol or NaCl-DMSO at or below -20°C. The additional muscle samples should be frozen in liquid nitrogen; transport should be with dry ice. For best preservation long-term storage of frozen tissue samples should be at or below -80°C or if that is not possible at or below -20°C.]

1.2.3 Labelling
Reliable labelling of the sample is essential. The container should be labelled on both the inside and the outside with a unique identifying code that can be related directly to the biological and other information collected for the individual (see Item 1.2.4). The label on the inside must be indelible and insoluble in alcohol to ensure that the number remains legible after storage in ethanol. The label on the outside must also be robust and remain legible if exposed to ethanol or water.

1.2.4 Information to be collected
In addition to the information noted in {SI} Annex dated *day/month/year* to be collected for each whale (including date, locality, species, sex, and body length), the unique identifier (see Item 1.2.3) and the name (plus address if non-nominated person, e.g. in the case of bycatch) of sampling person must be recorded.

1.3 Tissue analysis
1.3.1 Extraction of DNA
Extraction of DNA should be carried out using standard methods which have been reviewed and approved by the IWC Scientific Committee. Extracted DNA aliquots should be stored in freezers at or below -80°C.

1.4 Markers and methods of analysis
Analysis of samples should be undertaken without knowledge of the biological and other information available for the whale from which the sample was taken.

Samples should be analysed for (at least):

(1) mitochondrial DNA - primarily for identification to species and population but also contributes to profiling;
(2) microsatellites (or Short Tandem Repeats, STRs) – for DNA profiling;
(3) Y chromosomes - sex identification which also contributes to profiling.

1.4.1 Mitochondrial DNA
Analytical methods must be approved by the international expert group (see Item 1.7). Species identification should be accomplished with an approximately 500bp fragment of the 5'-end of the control region and sequencing should occur in both directions.

1.4.2 Microsatellites
Analytical methods must be approved and reviewed annually by the international expert group (see Item 1.7). Fluorescent techniques that allow electronic records to be kept should be used.
This group will ensure that the number and degree of variability of loci used in DNA registers will be sufficient to allow for an acceptable level of average probability of correctly identifying an individual.

1.4.3 Sex identification
Analytical methods must be approved by the international expert group (see Item 1.7). Sex is an additional genotype that may prove useful to identify market samples and may also serve as a check on field data. Error rates (obtained by comparison with reliable field identification of sex) should be estimated and reported to the international expert group (see Item 1.7).

The Group noted that data quality standards recently adopted by the Committee were not mentioned in the text for items 1.4.1, 1.4.2, and 1.4.3 and **recommended** the following amendments:

[1.4.1 Mitochondrial DNA
Analytical methods adhering to the quality standards as specified in the IWC genetic data quality guidelines (IWC, 2009a or subsequent updates) must be approved by the international expert group (see Item 1.7). Species identification should be accomplished with an approximately 500bp fragment of the 5'-end of the control region and sequencing should occur in both directions.

1.4.2 Microsatellites
Analytical methods adhering to the quality standards as specified in the IWC genetic data quality guidelines (IWC, 2009a or subsequent updates) *must be approved and reviewed annually by the international expert group (see Item 1.7). Fluorescent techniques that allow electronic records to be kept should be used. This group will ensure that the number and degree of variability of loci used in DNA registers will be sufficient to allow for an acceptable level of average probability of correctly identifying an individual.*

1.4.3 Sex identification
Analytical methods adhering to the quality standards as specified in the IWC genetic data quality guidelines (IWC, 2009a or subsequent updates) must be approved by the international expert group (see Item 1.7). Sex is an additional genotype that may prove useful to identify market samples and may also serve as a check on field data. Error rates (obtained by comparison with reliable field identification of sex) should be estimated and reported to the international expert group (see Item 1.7).]

1.5 Format of individual records
Each whale is given a unique identifier that can be cross-referenced back to the biological and associated data for that animal. Records must contain:

(a) A microsatellites and sex profile, in which each whale profile is given one row, with one column for each allele (two columns for each microsatellite marker and the sex locus).
(b) A mtDNA sequence file, in which each profile has one row, and one column for each site where the sequence deviates from the reference sequence.

In addition, the following must be archived:

General information for each sample
- genotyping system
- software system

'Raw' data
- electropherograms
- quality scores
- raw allele sizes
- peak heights
- gel image (depending on platform used)
- number of times the genotype replicated

Summary data on each locus
- error rate and how determined
- allele frequencies in a given population
- deviations from Hardy-Weinberg equilibrium
- evidence of null-alleles, short-allele dominance (or short-allele bias due to preferential amplification) or other artefacts

1.6 Matching
The international expert group (see Item 1.7) will agree on software packages to be used for matching purposes.

1.7 External audit of DNA registers
An international expert group established pursuant to paragraph 42 shall:
- review and approve the initial technical specifications for the register(s) and any changes to those protocols;
- where necessary, decide on appropriate laboratories;
- where necessary, design calibration exercises for laboratories and review the results of those exercises;
- review annually specific information and statistics formally reported by the register(s) under Items 1.4 - 1.6;
- design and undertake periodic technical audits including the provision for trials using 'blind' control samples;
- design and arrange for periodic site visits to examine whether the agreed protocols (under Items 1.2-1.5) are being followed.

The international expert group shall submit an annual report to the IWC and its Contracting Governments for consideration two months before each Annual Meeting of the IWC.

The Group noted that whether the report of the international expert group should be submitted to the IWC Scientific Committee, the Commission, or the Secretariat was unclear and that there was also a potential change in the scheduling of IWC meetings, and **recommended** clarification in the wording of the provision for submission of the report mentioned in the last provision of section 1.7:

[The international expert group shall submit an annual report to the Secretariat of the IWC for distribution to contracting governments and the Commission (and, if necessary subsidiary bodies of the Commission) at least two months before it must be considered.]

1.8 Submission procedure for samples for comparison with registers
Submission of tissue samples to the IWC for comparison with registers:

(1) may be made by Contracting Governments; and
(2) shall be accompanied by officially-attested documentation of chain of custody from time of collection to submission that contains the following information:

- name and address of 'collector';
- location obtained;
- type of vendor;
- date and time of collection;
- label, if present (or verbal description of nature and origin of product offered by vendor);
- where possible, photographs; and
- comments by the Contracting Government where the market sample was collected.

Analysis of the samples shall be carried out following the procedures documented in Items 1.3–1.4 by an IWC-approved laboratory, in accordance with any necessary calibration procedures. Officially-attested documentation of chain of custody must be established for the period between submission to a Contracting Government (or appropriate intergovernmental body) and provision of analytical results.

The comparison of the resultant profile shall be made using agreed software (see Item 1.6) against the appropriate register(s).

When the matching has been completed, the IWC Secretariat shall make public the results within one week.

The Group considered all of section 1.8 in light of the stated objective of Annex {DNA}: 'to ensure a…robust, independent and transparent system'. Item 1.8 makes a crucial contribution to these objectives, by providing a mechanism for sample verification that is not reliant on national market sampling schemes, and is also not reliant on the international expert panel, whose role is to audit the system rather than to focus on individual samples. By providing an opportunity for third parties to have samples verified against an IWC-held electronic register, Item 1.8 could greatly contribute to the independence, transparency and robustness of the entire 'DNA system'. However, the current wording of Item 1.8 does not fully make clear the intent nor the mechanism.

With respect to the mechanism itself, the Group noted the following points:[2]

1. The physical submission of tissue samples to the IWC Secretariat (as in the current wording of the first sentence of 1.8) may be difficult because of the CITES permit issues, and is in any case normally unnecessary. Instead, it would be adequate to submit the documentation to the IWC, and the tissue itself could be sent to and analysed by a qualified laboratory* in the country of origin. That laboratory would then genotype the sample and transmit the complete sample profile (see item 1.5 above) electronically to the Secretariat, who would then conduct the matching analysis against DNA profiles held in the central DNA database.
2. The intent of specifying how and by whom samples may be submitted (subitems 1 and 2 of section 1.8) is a safeguard against fraudulent or mischievous claims. It is, however, crucial to avoid unintended side-effects of these provisions, since item 1.8 will fail as a transparent, independent and robust safeguard unless the rules for submission can be met in practice. Since it is beyond the remit of the Scientific Committee to comment on details of chain-of-custody documentation, the Group noted that these details might warrant further consideration in a different Committee of the IWC.
3. The IWC's electronic register is to be updated annually (paragraph 42 of Annex A – draft Amendments to the Schedule, IWC/62/7rev), although this provision is not stated in Annex {DNA}. Additionally, according to the current wording of item 1.8, the results of matching

*A qualified laboratory is one recognised by a Contracting Government that meets the standards of items 1.1.1 and 1.1.2 as specified by the international expert group.

are supposed to be made public within one week. This could lead to a sample failing to match profiles in the IWC's central register simply because the latter had not been updated at the time of sample submission. The possibility of a match cannot be excluded until after that update. This might also have implications for the timing of updates to the IWC's central register, relative to timings of IWC meetings.

In order to take account of all these difficulties with the current wording of section 1.8, the Group **recommended** the following revision of the entire section, including the requirement for submission of electronic profiles from paragraph 42 of Annex A (new item 1.9), and an additional footnote 19:

[1.8 Mechanism for comparing samples to the IWC's central register, further to domestic market survey systems
A Contracting Government may request the IWC to compare any appropriately-documented tissue sample against the IWC's electronic register, regardless where the sample was collected. The tissue sample should be sent to a qualified laboratory[19], not necessarily associated with the national registry. The associated documentation, which is specified below, should be sent to the Secretariat. The laboratory should send the DNA profiles (see item 1.5) to the Secretariat as soon as possible, and the sample should be kept in long-term storage (see item 1.1.1, 1.2.3).

The associated documentation shall describe chain of custody from time of collection to submission, including the following information:

- *name and address of 'collector';*
- *location obtained;*
- *type of vendor;*
- *date and time of collection;*
- *label, if present (or verbal description of nature and origin of product offered by vendor);*
- *where possible, photographs; and*
- *comments by the Contracting Government where the market sample was collected.*

Analysis of the samples shall be carried out following the same quality control, sample handling and calibration procedures specified above in Items 1.1 – 1.4 by a qualified laboratory[19]. Officially-attested documentation of chain of custody must be established for the period between submission and provision of analytical results.

The comparison of the DNA profile against the IWC's central register shall be made using agreed software (see Item 1.6) [Option 1: after the annual update from the relevant national register.] [Option 2: Profiles that do not match would be held in a database that would be checked against the annually-updated registry each year.] The Secretariat shall make public the results within one week.

1.9 Submission of DNA Profiles to the IWC's Central Registry
Contracting Governments under whose jurisdiction whales and whale products may be legally marketed shall maintain a diagnostic DNA register and tissue bank. Before any products from a whale enter the market, samples for the DNA registry shall be collected from that whale, and submitted for inclusion in the domestic registry. DNA profiles shall be transmitted annually to a centralised archive maintained by the Secretariat.]

[[19]A qualified laboratory is one recognised by a contracting government that meets the standards of items 1.1.1 and 1.1.2 as specified by the international expert group.]

2. SPECIFICATIONS FOR THE ESTABLISHMENT/ MAINTENANCE OF MARKET SAMPLING SCHEMES

The purpose of market sampling is twofold: to act as a deterrent to illegal activity and to detect whether such activity is occurring. Market sampling in its initial stage is not intended to determine the precise number of animals that may be involved. Rather, if illegal products are discovered, a targeted method of detecting the origin of the products and the extent of the illegal operation specific to the case should be developed.

2.1 Design principles

(1) Market sampling schemes shall be case-specific. Their design shall be based on the best available information on the temporal and geographical nature of the particular market(s) and product pathways. Power to detect/deter will increase with the geographical and temporal scope of the surveys.
(2) The design of market sampling schemes will be iterative and schemes should be reviewed periodically. Experimental testing of their potential to detect illegal products should be undertaken and reported. This should include estimation of the possibility of falsely suggesting illegal activity and missing illegal activity when it occurs.
(3) Appropriate (e.g. not highly processed products from which it is difficult to obtain reliable microsatellite profiles) products should be chosen.
(4) A balance between deterrence (sampling carried out openly and with publicity) and detection (undercover sampling) shall be maintained and reported.
(5) The full range of cetacean products shall be sampled in case mislabelling occurs.
(6) An officially-attested documentation of chain of custody from time of collection to results of matching must be collected and archived, including the information given in Item 2.3.
(7) Analysis and matching must be carried out in an IWC-approved laboratory (with appropriate calibration if necessary) following the procedures given in Item 1 above.

2.2 Development of appropriate market sampling schemes including audit

The international expert group (see Item 1.7) under the auspices of the IWC shall:

(1) co-operate in the design of and approve any market sampling scheme before it is implemented and review the associated results;
(2) co-operate in the design of and approve experimental work and review results referring to Item 2.1 (2) above.
(3) design and arrange for periodic site visits to ensure that the approved scheme is being implemented.

The Group noted that some 'degraded' and/or 'processed' samples from market surveys could not be analysed using exactly the same procedures as those currently used for 'fresh' and 'unprocessed' samples, but that methods could be developed to allow accurate comparison of such samples with profiles in DNA registries. The Group **recommended** one additional development goal to take into account the potential inclusion of such samples from market surveys:

[(4) Experimental procedures should reflect the need for a standardised set of markers suited to the generation of accurate data from degraded source materials.]

2.3 Data to be collected

- Product or sample of product of sufficient size to obtain DNA sample (see Item 1.2.2);
- Location obtained;
- Date and time;
- Label (or verbal description of nature and origin of product offered by vendor);

- Source (e.g. wholesale market, shop, dockside etc.);
- photograph of product before sub-sampling; and
- name and contact information of person collecting.

This information should be archived in an appropriate electronic manner.

2.4 Reporting
The authorities responsible for undertaking the market sampling schemes in accordance with Paragraph 42 of the Schedule shall submit an annual report of their market sampling activities to the international expert group via the IWC Secretariat at the end of February of each year. That report shall include: details of the methods used; a summary of the number and nature of the products sampled, and the geographical and temporal spread of sampling; the results of the matching exercise. The international expert group shall submit an annual report to the IWC and its Contracting Governments for consideration two month before each regular Meeting of the IWC.

The group **recommended** a slight revision of the text concerning reporting to the IWC to take into account potential changes in the meeting schedule(s) and to match the revised wording in section 1.7 above:

[The international expert group shall submit an annual report to the Secretariat of the IWC for distribution to contracting governments and the Commission (and, if necessary subsidiary bodies of the Commission) at least two months before it must be considered.]

10. OTHERS

SC/62/O19 from Baker and Brownell describes a proposal to the IWC DAG under Procedure B, requesting access to the Japanese DNA register for the purposes of evaluating the technical aspects of traceability/trackability of sei, fin and Antarctic minke whale products purchased at commercial outlets in Santa Monica, USA and Seoul, South Korea. SC/62/O19 requested that the proposal be considered for endorsement by the Group.

Kanda stated that he was not prepared to endorse the proposal in SC/62/O19 given the current policy of Japan, Norway and Iceland regarding DNA registers access and market surveys. The Group could not reach an agreement on whether or not to endorse the proposal in SC/62/O19 although recognising that the matching exercise proposed would, in principle, be valuable for testing functionality of DNA registers for identifying and tracking whale products.

11. WORK PLAN

The terms of reference for the Working Group will remain the same for the next year, unless the Commission requests other information in the interim. Members of the Working Group were encouraged to submit papers relating to these terms of reference and to propose additional agenda items. Results of the 'amendment' work on sequences deposited in *GenBank* will be reported next year.

12. ADOPTION OF THE REPORT

The report was adopted by consensus.

REFERENCES

Baker, C.S., Steel, D., Choi, Y.-C., Lee, H., Kim, S.K., Choi, S.K., Ma, Y.-U., Hambleton, C., Psihoyo, L., Brownell Jr, R.L. and Funahashi, N. 2010. Genetic evidence of illegal trade in protected whales links Japan with the US and Korea. *Biology Letters*: 5pp.

Cipriano, F. and Pastene, L. 2009. A review of current knowledge of techniques to extract and amplify DNA from 'difficult' whale samples. Paper SC/61/SD2 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 5pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2000. Chairman's Report of the Fifty-First Annual Meeting. Appendix 9. IWC Resolution 1999-8. Resolution on DNA testing. *Ann. Rep. Int. Whaling Comm.* 1999:55.

International Whaling Commission. 2009a. Report of the Scientific Committee. Annex I. Report of the working group on stock definition. Appendix 2. Guidelines for DNA data quality control for genetic studies relevant to IWC management advice. *J. Cetacean Res. Manage. (Suppl.)* 11:252-56.

International Whaling Commission. 2009b. Report of the Scientific Committee. Annex N. Report of the working group on DNA. *J. Cetacean Res. Manage. (Suppl.)* 11:344-49.

International Whaling Commission. 2010. Report of the Scientific Committee. *J. Cetacean Res. Manage (Suppl.)* 11(2):1-98.

Morin, P.A., Martien, K.K., Archer, F.I., Cipriano, F., Steel, D., Jackson, J. and Taylor, B.L. 2010. Applied conservation genetics and the need for quality control and reporting of genetic data used in fisheries and wildlife management. *J. Heredity* 101(1): 1-10.

Appendix 1

AGENDA

1. Election of Chair
2. Appointment of rapporteurs
3. Adoption of the Agenda
4. Review of documents
5. Progress on genetic methods for species, stock and individual identification
6. Review of results of the 'amendments' of sequences deposited in *GenBank*
7. Progress on collection and archiving of tissue samples from catches and bycatches
8. Reference databases and standards for diagnostic DNA registries
9. Consideration of request for advice from the Commission
10. Other
11. Work plan
12. Adoption of the Report

Appendix 2

STATUS OF THE NORWEGIAN MINKE WHALE DNA REGISTER BY MAY 2010

Hans Julius Skaug

Table 1

Status of the Norwegian minke whale DNA register.

Year	DNA register[1]	IWC catch statistics[2]	Not landed[3]	Landed[4]	Duplicates[5]	Missing samples[6]	Lab. problem[7]	Total missing[8]
1997	488	503	7	496	3	5	0	8
1998	609	625	11	614	1	4	0	5
1999	571	591	17	574	2	1	0	3
2000	470	487	6	481	3	8	0	11
2001	538	552	11	541	2	1	0	3
2002	625	634	9	625	0	0	0	0
2003	637	647	9	638	1	0	0	1
2004	530	544	7	537	7	0	0	7
2005	626	639	6	633	3	4	0	7
2006	531	545	7	538	4	2	1	7
2007	575	597	5	592	6	11	0	17
2008[9]	-	536	4	532	-	-	-	-
2009[10]	-	485	1	484	-	-	-	-

[1]Number of unique individuals contained in the DNA-register (not containing duplicates). [2]Number of individuals caught by Norway, including individuals not landed. [3]Number of individuals killed, but not taken onboard the vessel. [4]Number of individuals taken onboard the vessel. [5]Number of occurrences of (tissue) sample switching onboard the vessel as detected by comparison of genetic profiles; i.e. two samples have been returned from an individual, and no sample has been returned for an individual. [6]Number of individuals for which tissue samples are missing for other reasons than sample switching. [7]Genetic laboratory not able to obtain microsatellite profile from tissue sample. [8]The difference between the columns 'Landed' and 'DNA register'. [9]Laboratory completed, but results not analysed. [10]Laboratory analyses not completed.

This table shows the number of individuals contained in the DNA-register, and the number of individuals missing. For 2008 the genetic analyses are not completed, as indicated by the '-' in the table.

Appendix 3

AN UPDATE OF THE JAPANESE DNA REGISTER FOR LARGE WHALES

Naohisa Kanda and Mutsuo Goto, The Institute of Cetacean Research

Table 1

Status of the Japanese DNA register for large whales.

Source/species	Period	Genetic samples	mtDNA	STRs	Sex
Scientific whaling					
NP minke whale	09	162	162	*	162
NP Bryde's whale	09	50	50	*	50
NP sei whale	09	100	100	*	100
NP sperm whale	09	1	1	*	1
Antarctic minke whale	05/06	853	0	0	853
	06/07	505	0	190	505
	07/08	551	0	551	551
	08/09	679	0	0	679
	09/10	506	0	0	506
Antarctic fin whale	08/09	1	0	0	1
	09/10	1	0	0	1
Bycatches					
NP minke whale	09	119	119	*	*
NP humpback whale	09	3	3	*	*
Strandings					
NP minke whale	09	3	*	*	*
NP humpback whale	09	1	*	*	*
NP sperm whale	09	1	*	*	*

STR=microsatellites; NP=North Pacific. **Note 1:** as explained in IWC (2006), sex of the whales taken by scientific whaling was determined by scientists onboard the research vessels. **Note 2:** 0=not yet analysed at the time this table was prepared. *Under analysis.

The status of the Japanese DNA register for large whales was presented and discussed during the 2005 Scientific Committee meeting (IWC, 2006). The number of genetic samples and the number of individuals analysed and registered were reported.

The status report included information of the scientific whaling in the North Pacific (JARPNII) up to 2004, of the scientific whaling in the Antarctic (JARPA) from the austral summer season 1987/88 to 2004/05, and of the bycatches and strandings up to 2005.

Genetic profiles of the following individuals have been added to the dataset since the last scientific meeting.

REFERENCE

International Whaling Commission. 2006. Report of the Working Group on DNA testing. *J. Cetacean Res. Manage. (Suppl.)* 8: 252-258.

Appendix 4

STATUS OF THE ICELANDIC WHALE DNA REGISTER

Christophe Pampoulie and Gisli A. Víkingsson

Practical arrangements regarding the establishment of the Icelandic DNA register were concluded in 2007.

The Marine Research Institute, Reykjavik, is responsible for the establishment and maintenance of the registry that is of the same format as the Norwegian DNA registry.

Table 1 gives the present status of the registry. Samples from all the common minke whales landed as a part of the Icelandic research programme (2003-07) as well as from commercial catches of one minke whale and seven fin whales have been archived.

Genetic analyses of fin whales taken for commercial purposes in 2009 have been completed.

Table 1

Icelandic whale DNA register.

Year	Type[1]	No. genetic samples	Microsatellites	MtDNA	Sex
Common minke whale					
2003	SP	36	36	36	36
2004	SP	25	25	25	25
2005	SP	34	34	34	34
2006	SP	58	58	58	58
2006	C	1	0	0	0
2007	SP	36	36	36	36
2007	C	6	0	0	0
2008	C	38	0	0	0
2009	C	81	11	11	11
Fin whale					
2006	C	7	7	7	7
2009	C	125	125	125	125

[1]SP=Special Permit catch; C=commercial catch.

Appendix 5

TERMS OF REFERENCE AND GUIDANCE FOR THE SCIENTIFIC COMMITTEE'S WORK WITH RESPECT TO THE 'FUTURE OF THE IWC' DISCUSSIONS (FROM ANNEX G OF IWC/62/6REV)

The Scientific Committee shall review, for clarity and completeness:

(1) Annex {DNA} – DNA registry and market sampling scheme (this is based on the work of an earlier specialist group (IWC/55/COMMS3) and the objective is to ensure that it remains up-to-date and complete, representing a cost-effective, robust, independent and transparent system in conjunction with the other monitoring and control measures).

In particular the review of the proposed mechanism (for national schemes with international audit) will ensure that the technical specifications:

- under Section 1 (specifications for the establishment/maintenance of a diagnostic DNA register/tissue archive) remain adequate, suggesting improvements if necessary, including the clarification of details, including appropriate auditing mechanisms, such that appropriate auditing can begin during the first season of an interim arrangement; and
- under Section 2 (specifications for the establishment/maintenance of market sampling schemes) remain adequate, and in particular that a process to allow effective market sampling to occur at the start of the interim period is established, recognising, as stated under Item 2.1 that this will be an iterative process.

Appendix 6

REVISED ANNEX {DNA} DATED *DAY/MONTH/YEAR* (FROM DOCUMENT IWC/62/7REV)

Specifications and Requirements for Diagnostic[17] DNA Registers and Market Sampling Schemes

1. SPECIFICATIONS FOR THE ESTABLISHMENT/ MAINTENANCE OF A DIAGNOSTIC DNA REGISTER/TISSUE ARCHIVE

1.1 Laboratories

1.1.1 Minimum laboratory requirements

(1) Laboratories performing DNA analysis shall be recognised by the Contracting Government under whose jurisdiction whales are harvested.

(2) Quality control and quality assurance features shall ensure that:

  (a) analysts have acceptable education, training and experience for the task;
  (b) reagents and equipment are properly maintained and monitored;
  (c) procedures used are generally accepted in the field and have been approved by the IWC Scientific Committee (see Items 1.2 - 1.5); and
  (d) appropriate controls are used.

(3) Thorough laboratory records (protocols, notes, worksheets, etc.) shall be maintained and archived for possible inspection (see Item 1.7).

(4) Changes in equipment and approved methods shall be recorded and reported annually to the IWC to allow ongoing standardisation among registers (see Item 1.7).

(5) A suitable inventory management system shall be in place so that the whereabouts and use of each sample/ aliquot over time during storage and analysis can be traced.

(6) Portions of the tissue samples and DNA extracts should be retained and stored indefinitely or until advised by the SC, using an appropriate preservation method (see Item 1.2.2).

(7) The probability of genotyping errors occurring should be estimated and minimised, using standard procedures and also including provisions for detection of mis-labelling, duplicate samples, data entry errors, etc. DNA sample quality should be checked routinely prior to genetic analysis to ensure adequate accuracy in the genotyping of degraded samples (as recommended in IWC (2009), and subsequent updates to the genetic analysis guidelines). DNA data quality/acceptability should be addressed in accordance with generally accepted rules and reported annually where possible (e.g. PHRED scores for sequences, SDs of fragment length measurements for microsatellite alleles, means and SDs of peak heights for microsatellites, some evaluation of stutter for each microsatellite locus). This information should be reported annually to the IWC (see Items 1.5 and 1.7).

(8) A reference set of samples should be designated for allelic standards and an equimolar allelic ladder should be constructed by cloning and sequencing a range of alleles for each microsatellite locus.

(9) The laboratory shall participate in calibration exercises with other laboratories if requested to do so by the IWC (see Item 1.1.2), and taking into account both the analysts involved, the methods and/or software used for binning alleles, and the type of equipment used for genotyping.

(10) The laboratory should be available for external evaluation and participate regularly in proficiency tests such as double-blind comparisons (e.g. see Item 1.7).

1.1.2 Calibration of laboratories if more than one is used

Where more than one laboratory is used to generate a single register or a group of registers, or for the comparison of samples (e.g. under Item 1.8 or Item 2), appropriate calibration of microsatellite genotype scoring (e.g. absolute size or binning) must be undertaken and the results reported to the IWC. The details of the calibration exercise shall be determined by the international expert group (see Item 1.7). The calibration exercise will primarily comprise a double blind experiment with known individuals. Cloned alleles should be used to construct an allelic ladder for calibration purposes. The results of calibration exercises must be reported to the IWC. In designing calibration exercises and reviewing the results, it must be remembered that the primary function of diagnostic DNA registers is to determine whether illegal activity is taking place and that the default position is no match = illegal activity. In this regard it is important to estimate the likelihood of:

- erroneously failing to match products to an animal in the register when it is actually there – i.e. falsely implying an infraction;
- erroneously matching products to an individual in the register when it is not actually there – i.e. missing an infraction when one has occurred.

1.2 Sample collection

Samples for DNA registry should be collected by trained personnel[18] before products from them can enter the market.

1.2.1 Size of samples

At least two samples of skin/muscle of at least 5x5x5mm must be collected from each animal for each register/ archive. In addition, where possible, at least four muscle samples of 20x20x20mm should be taken. Where possible, a sample of tissue from any foetuses detected should be collected. All samples should be taken as quickly as possible and immediately placed in an appropriate preservative, and then frozen as quickly as possible at or below -20°C.

[17]A diagnostic DNA register is one that contains DNA profiles of all animals from which products might legally appear on the market (e.g. from legal direct catches, legal imports, bycatches, ship strikes etc.). DNA profiles from legally imported whales should thus be included in the importing country's registry as one of the conditions for importation. On this basis, any products found on the market that were from whales not included in the register will be from illegally taken or illegally imported whales.

[18]Contracting Governments under whose jurisdiction bycaught/stranded whales and their products may be legally marketed are responsible to develop a technical manual for collecting samples and ancillary data for inclusion in DNA registries, and for disseminating such materials and training to others who may be involved in the collection of genetic samples for such use.

1.2.2 Preservation

Samples should initially be preserved in 95% ethanol (in at least five times the volume of the sample, due to potential problems of dilution and evaporation) or in five times the volume of NaCl-saturated DMSO (dimethyl-sulfoxide). If not able to be frozen immediately, the samples should be shipped as soon as possible (preferably within 7 days) to the analysing laboratory. This temporary storage and shipping should be in temperatures <25°C to minimise the possibility of degradation of the sample.

Long-term storage of skin/muscle samples should be in 95% ethanol or NaCl-DMSO at or below -20°C. The additional muscle samples should be frozen in liquid nitrogen; transport should be with dry ice. For best preservation long-term storage of frozen tissue samples should be at or below -80°C or if that is not possible at or below -20^{o}C.

1.2.3 Labelling

Reliable labelling of the sample is essential. The container should be labelled on both the inside and the outside with a unique identifying code that can be related directly to the biological and other information collected for the individual (see Item 1.2.4). The label on the inside must be indelible and insoluble in alcohol to ensure that the number remains legible after storage in ethanol. The label on the outside must also be robust and remain legible if exposed to ethanol or water.

1.2.4 Information to be collected

In addition to the information noted in Annex {SI} dated *day/month/year* to be collected for each whale (including date, locality, species, sex, and body length), the unique identifier (see Item 1.2.3) and the name (plus address if non-nominated person, e.g. in the case of bycatch) of sampling person must be recorded.

1.3 Tissue analysis

1.3.1 Extraction of DNA

Extraction of DNA should be carried out using standard methods which have been reviewed and approved by the IWC Scientific Committee. Extracted DNA aliquots should be stored in freezers at or below -80°C.

1.4 Markers and methods of analysis

Analysis of samples should be undertaken without knowledge of the biological and other information available for the whale from which the sample was taken.

Samples should be analysed for (at least):

(1) mitochondrial DNA - primarily for identification to species and population but also contributes to profiling;
(2) microsatellites (or Short Tandem Repeats, STRs) – for DNA profiling; and
(3) Y chromosomes - sex identification which also contributes to profiling.

1.4.1 Mitochondrial DNA

Analytical methods adhering to the quality standards as specified in the IWC genetic data quality guidelines (IWC, 2009, or subsequent updates) must be approved by the international expert group (see Item 1.7). Species identification should be accomplished with an approximately 500bp fragment of the 5'-end of the control region and sequencing should occur in both directions.

1.4.2 Microsatellites

Analytical methods adhering to the quality standards as specified in the IWC genetic data quality guidelines (IWC, 2009, or subsequent updates) must be approved and reviewed annually by the international expert group (see Item 1.7). Fluorescent techniques that allow electronic records to be kept should be used. This group will ensure that the number and degree of variability of loci used in DNA registers will be sufficient to allow for an acceptable level of average probability of correctly identifying an individual.

1.4.3 Sex identification

Analytical methods adhering to the quality standards as specified in the IWC genetic data quality guidelines (IWC, 2009, or subsequent updates) must be approved by the international expert group (see Item 1.7). Sex is an additional genotype that may prove useful to identify market samples and may also serve as a check on field data. Error rates (obtained by comparison with reliable field identification of sex) should be estimated and reported to the international expert group (see Item 1.7).

1.5 Format of individual records

Each whale is given a unique identifier that can be cross-referenced back to the biological and associated data for that animal. Records must contain:

(a) a microsatellites and sex profile, in which each whale profile is given one row, with one column for each allele (two columns for each microsatellite marker and the sex locus); and
(b) a mtDNA sequence file, in which each profile has one row, and one column for each site where the sequence deviates from the reference sequence.

In addition, the following must be archived:

General information for each sample

- genotyping system
- software system

'Raw' data

- electropherograms
- quality scores
- raw allele sizes
- peak heights
- gel image (depending on platform used)
- number of times the genotype replicated

Summary data on each locus

- error rate and how determined
- allele frequencies in a given population
- deviations from Hardy-Weinberg equilibrium
- evidence of null-alleles, short-allele dominance (or short-allele bias due to preferential amplification) or other artefacts

1.6 Matching

The international expert group (see Item 1.7) will agree on software packages to be used for matching purposes.

1.7 External audit of DNA registers

An international expert group established pursuant to paragraph 42 shall:

- review and approve the initial technical specifications for the register(s) and any changes to those protocols;
- where necessary, decide on appropriate laboratories;

- where necessary, design calibration exercises for laboratories and review the results of those exercises;
- review annually specific information and statistics formally reported by the register(s) under Items 1.4 - 1.6;
- design and undertake periodic technical audits including the provision for trials using 'blind' control samples; and
- design and arrange for periodic site visits to examine whether the agreed protocols (under Items 1.2-1.5) are being followed.

The international expert group shall submit an annual report to the Secretariat of the IWC for distribution to contracting governments and the Commission (and, if necessary subsidiary bodies of the Commission) at least two months before it must be considered.

1.8 Mechanism for comparing samples to the IWC's central register, further to domestic market survey systems

A Contracting Government may request the IWC to compare any appropriately-documented tissue sample against the IWC's electronic register, regardless of where the sample was collected. The tissue sample should be sent to a qualified laboratory[19], not necessarily associated with the national registry. The associated documentation, which is specified below, should be sent to the Secretariat. The laboratory should send the DNA profiles (see item 1.5) to the Secretariat as soon as possible, and the sample should be kept in long-term storage (see item 1.1.1, 1.2.3).

The associated documentation shall describe chain of custody from time of collection to submission, including the following information:

- name and address of 'collector';
- location obtained;
- type of vendor;
- date and time of collection;
- label, if present (or verbal description of nature and origin of product offered by vendor);
- where possible, photographs; and
- comments by the Contracting Government where the market sample was collected.

Analysis of the samples shall be carried out following the same quality control, sample handling and calibration procedures specified above in Items 1.1 – 1.4 by a qualified laboratory[19]. Officially-attested documentation of chain of custody must be established for the period between submission and provision of analytical results.

The comparison of the DNA profile against the IWC's central register shall be made using agreed software (see Item 1.6) [Option 1: after the annual update from the relevant national register.] [Option 2: Profiles that do not match would be held in a database that would be checked against the annually-updated registry each year.] The Secretariat shall make public the results within one week.

1.9 Submission of DNA Profiles to the IWC's Central Registry

Contracting Governments under whose jurisdiction whales and whale products may be legally marketed shall maintain a diagnostic DNA register and tissue bank. Before any products from a whale enter the market, samples for the DNA registry shall be collected from that whale, and submitted for inclusion in the domestic registry. DNA profiles shall be transmitted annually to a centralised archive maintained by the Secretariat.

[19]A qualified laboratory is one recognised by a contracting government that meets the standards of items 1.1.1 and 1.1.2 as specified by the international expert group.

2. SPECIFICATIONS FOR THE ESTABLISHMENT/ MAINTENANCE OF MARKET SAMPLING SCHEMES

The purpose of market sampling is twofold: to act as a deterrent to illegal activity and to detect whether such activity is occurring. Market sampling in its initial stage is not intended to determine the precise number of animals that may be involved. Rather, if illegal products are discovered, a targeted method of detecting the origin of the products and the extent of the illegal operation specific to the case should be developed.

2.1 Design principles

(1) Market sampling schemes shall be case-specific. Their design shall be based on the best available information on the temporal and geographical nature of the particular market(s) and product pathways. Power to detect/deter will increase with the geographical and temporal scope of the surveys.
(2) The design of market sampling schemes will be iterative and schemes should be reviewed periodically. Experimental testing of their potential to detect illegal products should be undertaken and reported. This should include estimation of the possibility of falsely suggesting illegal activity and missing illegal activity when it occurs.
(3) Appropriate (e.g. not highly processed products from which it is difficult to obtain reliable microsatellite profiles) products should be chosen.
(4) A balance between deterrence (sampling carried out openly and with publicity) and detection (undercover sampling) shall be maintained and reported.
(5) The full range of cetacean products shall be sampled in case mislabelling occurs.
(6) An officially-attested documentation of chain of custody from time of collection to results of matching must be collected and archived, including the information given in Item 2.3.
(7) Analysis and matching must be carried out in an IWC-approved laboratory (with appropriate calibration if necessary) following the procedures given in Item 1 above.

2.2 Development of appropriate market sampling schemes including audit

The international expert group (see Item 1.7) under the auspices of the IWC shall:

(1) co-operate in the design of and approve any market sampling scheme before it is implemented and review the associated results;
(2) co-operate in the design of and approve experimental work and review results referring to Item 2.1 (2) above;
(3) design and arrange for periodic site visits to ensure that the approved scheme is being implemented; and
(4) experimental procedures should reflect the need for a standardised set of markers suited to the generation of accurate data from degraded source materials.

2.3 Data to be collected

- Product or sample of product of sufficient size to obtain DNA sample (see Item 1.2.2);
- location obtained;
- date and time;
- label (or verbal description of nature and origin of product offered by vendor);
- source (e.g. wholesale market, shop, dockside etc.);
- photograph of product before sub-sampling; and
- name and contact information of person collecting.

This information should be archived in an appropriate electronic manner.

2.4 Reporting

The authorities responsible for undertaking the market sampling schemes in accordance with Paragraph 42 of the Schedule shall submit an annual report of their market sampling activities to the international expert group via the IWC Secretariat at the end of February of each year. That report shall include: details of the methods used; a summary of the number and nature of the products sampled, and the geographical and temporal spread of sampling; the results of the matching exercise.

The international expert group shall submit an annual report to the Secretariat of the IWC for distribution to contracting governments and the Commission (and, if necessary subsidiary bodies of the Commission) at least two months before it must be considered.

REFERENCE

International Whaling Commission. 2009. Report of the Scientific Committee. Annex I. Report of the working group on stock definition. Appendix 2. Guidelines for DNA data quality control for genetic studies relevant to IWC management advice. *J. Cetacean Res. Manage. (Suppl.)* 11:252-56.

Annex O

Progress Reports

This Annex summarises information presented in the National Progress Reports

Tables on following pages

FAO Fishing Description and Codes

Surrounding nets		**Dredges**		**Hooks and lines**	
With purse lines	PS	Boat dredges	DRB	Handlines and pole-lines (hand operated)	LHP
One-boat operated purse seines	PS1	Hand dredges	DRH	Handlines and pole-lines (mechanised)	LHM
Two-boat operated purse seines	PS2	**Lift nets**		Set longlines	LLS
Without purse lines (lampara)	LA	Portable lift nets	LPN	Drifting longlines	LLD
Seine nets		Boat-operated lift nets	LNB	Longlines (not specified)	LL
Beach seines	SB	Shore-operated stationary lift nets	LNS	Trolling lines	LTL
Boat seines	SV	Lift nets (not specified)	LN	Hooks and lines (not specified)	LX
Danish seines	SDN	**Falling gear**		**Grappling and wounding**	
Scottish seines	SSC	Cast nets	FCN	Harpoons	HAR
Pair seines	SPR	Falling gear (not specified)	FG	**Harvesting machines**	
Seine nets (not specified)	SX	**Gillnets and entangling gear**		Pumps	HMP
Trawls		Set gillnets (anchored)	GNS	Mechanised dredges	HMD
Bottom trawls	TBB	Driftnets	GND	Harvesting machines (not specified)	HMX
Beam trawl	OTB	Encircling gillnets	GNC	**Miscellaneous gear**	MIS
Otter trawls (side or stern)	PTB	Fixed gillnets (on stakes)	GNF	**Recreational fishing gear**	RG
Pair trawls	TBN	Trammel nets	GTR	**Gear not known or specified**	NK
Nephrops trawls	TBS	Combined gillnet-trammel nets	GTN	**Shark control nets**	NSC
Shrimp trawls (not specified)	TM	Gillnets and entangling gillnets (not specified)	GEN		
Midwater trawls		Gillnets (not specified)	GN		
Otter trawls (side or stern)	OTM	**Traps**			
Pair trawls	PTM	Stationary uncovered pounds nets	FPN		
Shrimp trawls	TMS	Pots	FPO		
Midwater trawls (not specified)	TM	Fyke nets	FYK		
Otter twin trawls	OTT	Stow nets	FSN		
Otter trawls (not specified)	OT	Barriers, fences, weirs, etc	FWR		
Pair trawls (not specified)	PT	Aerial traps	FAR		
Other trawls (not specified)	TX	Traps (not specified)	FIX		

NATURAL MARKING DATA

Species	Feature	Area/stock	No. photo-id'd	Catalogue (Y/N)	Catalogue total	Contact person/institute; refs
Argentina						
Southern right whale	Callosity pattern	SW Atlantic, N Patagonia	530 (Spring 09)	Y	~2,700 individuals	V. Rowntree/ICB-WCI/OA *rowntree@biology.utah.edu*
Southern right whale	Head callosity pattern	S Patagonia	2	Y	9	Fundacíon Cethus/ *cethus@cethus.org*
Commerson's dolphin	Colouration pattern, scars	Bahía San Julián	5	Y	64	″
Commerson's dolphin	Dorsal fin, flippers, fluke/body scars	Tierra del Fuego, Argentina	3	Y	5	L. Cappozzo; I.C. Sáez/MACN
Franciscana	Dorsal fin, flippers, fluke/body scars	S Buenos Aires coast, Argentina	7	Y	59	L. Cappozzo; M.F. Negri; M.V. Panebianco; M.N. Paso Viola/MACN
Franciscana	Dorsal fin	Samborombon, San Blas	8	Y	19	P. Bordino/AquaMarina-CECIM
Killer whale	Dorsal fin	San Blas	1	Y	4	″
Australia						
Australian snubfin dolphin	Photo-ID	Western NT	-	-	-	C. Palmer/NRETAS
Indo-Pacific humpback dolphin	Photo-ID	Western NT	-	-	-	″
Bottlenose dolphin	Photo-ID	Western NT	-	-	-	″
Australian snubfin dolphin	Photo-ID	Gulf of Carpentaria, Sir Edward Pellew Islands, NT	-	-	-	H. Marsh/JCU; G. Parra/SARDI
Indo-Pacific humpback dolphin	Photo-ID	Gulf of Carpentaria, Sir Edward Pellew Islands, NT	-	-	-	″
Bottlenose dolphin	Photo-ID	Gulf of Carpentaria, Sir Edward Pellew Islands, NT	-	-	-	″
Blue whale	Lateral markings/ dorsal fin	S Australia	25	Y	~70	M. Morrice/BWS
Blue whale	Lateral	Geographe Bay, WA land and small vessel surveys	13	N	170	C. Burton/WWR
Bottlenose dolphin	Dorsal fin	Bunbury, Peppermint Beach-Binningup	196	Y	196	H. Smith/MUCRU
Bottlenose dolphin	Dorsal fin	Bunbury, Preston-Binningup	-	-	-	V. Buchanan/MUCRU
Bottlenose dolphin	Dorsal fin	Port Phillip	In prog.	Y	110	S. Mason/DRI
Bottlenose dolphin	Dorsal fin	Gippsland Lakes	In prog.	Y	30	K. Charlton-Robb/Monash; DRI; S. Mason/DRI
Indo-Pacific bottlenose dolphin	Dorsal fin	SA	-	-	-	M. Bossley/WDCS
Common dolphin	Dorsal fin	Port Phillip	In prog.	Y	12	S. Mason/DRI
Humpback whale	Fluke	Port Phillip	-	-	-	DRI/Monash
Humpback whale	Flukes	Port Douglas/Cairns, QLD (Group V/BSE)	24	Y	4,854	G. Kaufman/PWF
Humpback whale	Flukes	Whitsunday Islands, QLD (Group V/BSE)	21	Y	4,854	″
Humpback whale	Flukes	Hervey Bay, QLD (Group V/BSE)	100	Y	4,854	″
Humpback whale	Flukes	Eden, NSW (Group V/BSE)	161	Y	4,854	″
Humpback whale	Flukes	Perth, Exmouth, Shark Bay, WA (Group IV/BS D)	0	Y	765	″
Humpback whale	Flukes,dorsal fin/lateral body marks	Area V/Hervey Bay	833	Y	2,075 (92-06); ~28,251 (92-09)	T. and W. Franklin/TOP
Humpback whale	Fluke	Geographe Bay, W Australia	20	N	2,000	C. Burton/WWR
Humpback whale	Lateral	Geographe Bay, W Australia	25	N	2,500	″
Humpback whale	Fluke	Group E (i)	110	Y	322	P. Beeman/SCUWRC
Minke whale	Lateral	Geographe Bay, W Australia	1	N		C. Burton/WWR
Dwarf minke whale	L+R thorax region; scars; other unique features	Northern GBR	12 analysis in prog.	Y	383 complete IDs	A. Birtles/JCU; S. Sobtzick/JCU
Southern right whale	Head callosity pattern	S Australia, Cape Leeuwin (WA) - Ceduna (SA)	488 photos selected	N	5,826 images ~1,300 ind.	J. Bannister/WAM; J. Bannister (2010)

Cont.

Species	Feature	Area/stock	No. photo-id'd	Catalogue (Y/N)	Catalogue total	Contact person/institute; refs
Australia cont.						
Southern right whale	Head callosity	SE Australia	36	Y	130 min.	M. Watson/DSE
Southern right whale	Callosity aerial	SE Australia	7	Y	91	R. Gales/DPIPWE
Brazil						
Rough-toothed dolphin	Dorsal fin	Rio de Janeiro	50	Y	50	J. Lailson-Brito; A. Azevedo/UERJ
Guiana dolphin	Dorsal fin	Guanabara Bay	32	Y	69	″
Common bottlenose dolphin	Dorsal fin	Itajai River Estuary	1	Y	14	A.S. Barreto/CTTMar-UNIVALI
Humpback whale	Fluke	Abrolhos Bank (BA)	2009/*n*=194	N	> 2.861	M. Neves/IBJ
Humpback whale	Fluke	NE of BA	2009/*n*=61	Y	841	C. Baracho/IBJ
Guiana dolphin	Dorsal	BA	2009/*n*=55	Y	135	L.L. Wedekin/IBJ
Guiana dolphin	Dorsal Fin	Lagamar Estuary (SP and PR)	19	Y	199/SP; 182/PR	M. Santos
Franciscana	Dorsal fin	Lagamar Estuary (PR)	3	Y	8	″
Guiana dolphin	Dorsal fin	Baía da Babitonga, SC	0	Y	55	M.J. Cremer/UNIVILLE
Common bottlenose dolphin	Dorsal fin	Laguna, SC, BR	27	Y	27	″
Bottlenose dolphin	Dorsal fin	Tramandaí Estuary, RS	9	Y	17	A. Giacomo; P.H.Ott/GEMARS
Southern right whale	Head callosities	RS	2	Y	5	F. Sucunza and P.H. Ott/GEMARS
Southern right whale	Head callosities and dorsal marks	SC and RS	~40	N	455** (to 2006)	K.R. Groch/PBF-Brasil
Guiana dolphin	Dorsal fin	Port of Ilhéus, BA	In prog.	Y	40	Y. Le Pendu/GPMAI-UESC
Guiana dolphin	Dorsal fin	Canavieiras Estuary, BA	In prog.	N	In prog.	″
Guiana dolphin	Dorsal fin	Estuarine Complex of Paranaguá, PR	18	Y	18	C. Domit/LEC; CEM/UFPR
Franciscana	Dorsal fin	Estuarine Complex of Paranaguá, PR	2	N	0	″
Chile						
Humpback whale	Fluke	Magellan Strait	9	Y	113	J. Acevedo/CEQUA
Humpback whale	Fluke	Bernardo O'Higgins National Park	4	Y	4	″
Humpback whale	Fluke	Antarctic Peninsula	38	Y	339	″
Antarctic minke whale	Dorsal fin	Antarctic Peninsula	7	Y	7	″
Killer whale	Dorsal fin	Antarctic Peninsula	7	Y	43	″
Chilean dolphin	Dorsal fin	Bernardo O'Higgins National Park	21	Y	21	C. Olavarria/CEQUA
Peale's dolphin	Dorsal fin	Bernardo O'Higgins National Park	In prog.	Y	In prog.	″
Blue whale	Left flank	Los Lagos Region	126	Y	292	B. Galletti/CCC
	Right flank	Los Lagos Region	126	Y	301	″
Fin whale	Chevron, blaze, dorsal fin, flank	Los Lagos Region	3	Y	3	″
Sei whale	Chevron, dorsal fin, flank	Los Lagos Region	1	N	In prog.	″
Orca	Saddle, dorsal fin	Los Lagos Region	2	N	0	″
Croatia						
Common bottlenose dolphin	Dorsal fin	North Adriatic Sea	n/a	Y	527	N. Rako/BWI
Common bottlenose dolphin	Dorsal fin	Central Adriatic Sea	n/a	Y	415	D. Holcer/BWI
Striped dolphin	Dorsal fin	North Adriatic Sea	1	Y	2	N. Rako/BWI
Denmark						
Humpback whale	Fluke	West Greenland	36 (15) individ.	Y	66 (2007-09)	M. Simon/GINR
France						
Common bottlenose dolphin	Dorsal fin	Normandy/NE Atlantic	-	Y	In prog.	F. Gally/GECC
Common bottlenose dolphin	Dorsal fin	Channel/NE Atlantic	In prog.	Y	In prog.	GMN
Common bottlenose dolphin	Dorsal fin	West Brittany	In prog.	Y	In prog.	S. Hassani/LEMM
Long-finned pilot whale	Dorsal fin	Bay of Biscay/NE Atlantic	In prog.	Y	104	O. Van Canneyt (CRMM/ULR)
Risso's dolphin	Dorsal fin and body	NW Mediterranean	11	N	In prog.	GIS3M
Risso's dolphin	Dorsal fin and body	W Mediterranean	In prog.	Y	In prog.	A. Gannier/GREC
Sperm whale	Fluke	W Mediterranean	In prog.	Y	In prog.	″
Common bottlenose dolphin	Dorsal fin	Corsica/NW Mediterranean	2,245	Y	206	F. Dhermain/GECEM
Common bottlenose dolphin	Dorsal fin	Provence/NW Mediterranean	295 selected pictures	Y	43	″
Fin whale	Dorsal fins/sides	NW Mediterranean	In prog.	Y	106	N. Di-Méglio; L. David/ écoOcéan Institut
Risso's dolphin	Dorsal fins/sides	NW Mediterranean	In prog.	Y	421	″
Sperm whale	Fluke/sides	NW Mediterranean	In prog.	Y	24	″
Common bottlenose dolphin	Dorsal fin	Corsica/NW Mediterranean	In prog.	N	In prog.	BREACH; GECEM
Sperm whale	Fluke/sides	NW Mediterranean	3	Y	13	S. Laran/CRC

Cont.

Species	Feature	Area/stock	No. photo-id'd	Catalogue (Y/N)	Catalogue total	Contact person/institute; refs
France cont.						
Long-finned pilot whale	Dorsal fin	NW Mediterranean	In prog. (*c.*20)	N	In prog.	S. Laran/CRC
Fin whale	Sides	NW Mediterranean	≥ 66 selected pics	Y	17	C. Azzinari/BREACH
Common bottlenose dolphin	Dorsal fin	*Golfe du Lion*/ NW Mediterranean	≥ 752 selected pics	Y	66 in prog.	″
Common bottlenose dolphin	Dorsal fin	Guadeloupe/Caribbean	≥ 7,400 selected pics/movies	Y	71 in prog.	N. Gandilhon/BREACH - thesis
Humpback whale	Ventral flukes and dorsal fin	Guadeloupe	≥ 1,122 selected pics	Y	67 in prog. (flukes); 105 dorsal fin	″
Sperm whale	Ventral fluke	Guadeloupe	≥ 287 selected pics	In prog.	≥ 42 in prog.	″
Rough toothed dolphin	Dorsal fin and shape pods	Guadeloupe	≥ 1,500 selected pics	Y	36	″
Beaked whale[§]	Dorsal fins/sides	Guadeloupe	In prog.	Y	9	″
Humpback whale	Ventral fluke	Guadeloupe, St Barthélémy and Caribbean	12	Y	In prog.	C. and R. Rinaldi/AET[≛]
Sperm whale	Ventral fluke	Guadeloupe/Caribbean	230	Y	In prog.	″
Beaked whale and delphinid[§]	Dorsal fins/sides	Guadeloupe and Caribbean	In prog.	Y	In prog.	″
Sperm whale	Fluke	Martinique/Caribbean	15		>25	SEPANMAR
Short finned pilot whale	Dorsal fin	Martinique/Caribbean	30	Y	>40	″
Indo-Pacific bottlenose dolphin	Dorsal fin	Mayotte/SW Indian	In prog.	Y	71	J. Kiszka; C. Pusineri/OMM
Indo-Pacific bottlenose dolphin	Dorsal fin	Réunion/SW Indian	In prog.	Y	76	V. Dulau-Drouot/GLOBICE
Humpback whale	Fluke/dorsal fin	Réunion/SW Indian	In prog.	Y	110	″
Humpback whale	Fluke	New Caledonia/sub-stock E2	45	Y	549	C. Garrigue/OCNC
Indo-Pacific bottlenose dolphin	Dorsal fin	New Caledonia Pacific Ocean	In prog.	Y	304	M. Oremus/OCNC
Spinner dolphin	Dorsal fin	New Caledonia Pacific Ocean	In prog.	Y	83	″
Sperm whale	Fluke and dorsal fin	Crozet and Kerguelen/ Southern Ocean	-	Y	80	C. Guinet/CEBC
Killer whale	Dorsal fin	Crozet and Kerguelen/ Southern Ocean	-	Y	218	″
Iceland						
Minke whale	-	Faxafloi Bay	-	-	Since 2007	UI
Humpback whale	-	Faxafloi Bay	-	-	Since 2007	″
Ireland						
Humpback whale	Fluke	NE Atlantic	1	Y	11	P. Whooley/IWDG
Fin whale	Dorsal fin	NE Atlantic	5	Y	62	″
Bottlenose dolphin	Dorsal fin	Shannon Estuary	47	Y	183	S. Berrow/SDWF
Bottlenose dolphin	Dorsal fin	Irish waters	19	Y	125	″
Bottlenose dolphin	Dorsal fin	Shannon estuary	131	Y	645	E. Rogan/UCC
Bottlenose dolphin	Dorsal fin	Connemara/Mayo	12	Y	97	A. Englund/UCC; Ingram *et al*., 2009
Killer whale	Dorsal fin	NE Atlantic	6	Y	7	S. Berrow/IWDG
Risso's dolphin	Dorsal fin	Irish waters	17	Y	21	″
Long-finned pilot whale	Dorsal fin	NE Atlantic	6	Y	19	″
Bottlenose dolphin	Dorsal fin	Mullet Peninsula	123	Y	218	M. Oudejans/DNT
Killer whale	Dorsal fin	Mullet Peninsula	2	Y	2	″
Bottlenose dolphin	Dorsal fin	NE Ireland	119	Y	157	L. Walshe/UCC
Italy						
Fin whale	Permanent mark dorsal fin	Ligurian/Tyrrhenian Sea, Corsican Sea Sardinian Channel	5	Y	15	A. M. Gattoni/BB
Fin whale	Dorsal fin, blaze/ chevron, scars	Ligurian Sea	In prog.	Y	431	TRI
Sperm whale	Flukes	Ligurian Sea	43	Y	85	TRI
Sperm whale	Flanks and fluke	Ligurian Sea	n/a	Y	n/a	M. Rosso/CIMA RF
Cuvier's beaked whale	Flanks	Ligurian Sea	n/a	Y	115	″
Cuvier's beaked whale	Dorsal fin	Ligurian Sea	4	Y	46	TRI
Long-finned pilot whale	Dorsal fin	Ligurian Sea	In prog.	Y	In prog.	TRI
Risso's dolphin	Dorsal fin, body scars	Ligurian Sea	42	Y	347	TRI
Risso's dolphin	Permanent mark Dorsal fin	Ligurian/Tyrrhenian Sea, Corsican Sea, Sardinian Channel	9	Y	53	A.M. Gattoni/BB
Risso's dolphin	Dorsal fin	Tuscan Archipelago	5	Y	26	S. Nuti; D. Bedocchi/Cetus
Risso's dolphin	Dorsal fin	Ligurian Sea	n/a	Y	85	M. Rosso/CIMA RF
Common bottlenose dolphin	Dorsal fin	Tyrrhenian Sea	12	Y	12	D.S. Pace/OCEANOMARE
Common bottlenose dolphin	Dorsal fin	Versilia coastline.	16	Y	152	S. Nuti; D. Bedocchi/Cetus

Cont.

Species	Feature	Area/stock	No. photo-id'd	Catalogue (Y/N)	Catalogue total	Contact person/institute; refs
Italy cont.						
Common bottlenose dolphin	Dorsal fin	Tuscan Archipelago	6	Y	49	S. Nuti; D. Bedocchi/Cetus
Common bottlenose dolphin	Dorsal fin	Strait of Sicily (Lampedusa Isl.)	51	Y	224	G. La Manna/CTS
Common bottlenose dolphin	Dorsal fin	Archipelago of La Maddalena (Sardinia)	10	Y	10	″
Common bottlenose dolphin	Dorsal fin	Asinara Island (Sardinia)	0	Y	0	″
Common bottlenose dolphin	Dorsal fin	Messina Strait	48	Y	300	R. Mangano/NECTON
Common bottlenose dolphin	Dorsal fin	Cape Milazzo; Eolian Arch.	31	Y	85	R. Mangano/Aeolian Dolphin Center
Common bottlenose dolphin	Dorsal fin	Lampedusa Island	123	Y	164	A. Celona/NECTON
Common bottlenose dolphin	Dorsal fin	Ligurian Sea	20	Y	244	G. Gnone; M. Bellingeri; F. Fossa/ADG
Common bottlenose dolphin	Dorsal fin	NW Greece, Amvrakikos Gulf	69	Y	140	TRI; Bearzi *et. al*. 2005; 2008a; in press
Common bottlenose dolphin	Dorsal fin	E Ionian Sea, Greece	26	Y	101	TRI
Common bottlenose dolphin	Dorsal fin	Greece, Gulf of Corinth	25	Y	25	″
Common bottlenose dolphin	Dorsal fin	Ligurian Sea, Italy	0	Y	68	″
Common bottlenose dolphin	Dorsal fin and body marks	NE coast of Sardinia (Tyrrhenian Sea)	65	Y	69	B. Díaz López/BDRI
Common bottlenose dolphin	Dorsal fin and body marks	NW coast of Sardinia (Gulf of Alghero)	22	Y	22	B. Diaz Lopez; A. Addis/ *bruno@thebdri.com*
Common bottlenose dolphin	Dorsal fin	NE Saridinia	149	Y		F. Magnone; A. Fozzi/CRiMM
Common bottlenose dolphin	Dorsal fin	Ligurian Sea,	n/a	Y	149	M. Rosso/CIMA RF
Short-beaked common dolphin	Dorsal fin	E Ionian Sea, Greece	34	Y	165	TRI; Bearzi *et. al*. 2005; 2008a; in press
Short-beaked common dolphin	Dorsal fin	Greece, Gulf of Corinth	7	Y	7	TRI
Short-beaked common dolphin	Dorsal fin	Ligurian Sea, Italy	0	Y	3	″
Striped dolphin	Dorsal fin	Greece, Gulf of Corinth	226	Y	226	″
Japan						
Bryde's whale	Dorsal fin	Kochi/E China Sea stock	2	Y	55	T. Kishiro/NRIFSF
Bryde's whale	Dorsal fin	Kagoshima/E China Sea stock	0	Y	25	″
North Pacific right whale	Callosities/lip patches	Okhotsk Sea	22	N	0	H. Yoshida/NRIFSF
Blue whale	Body	Area III	3	In prog.	-	S. Nishiwaki/ICR
Blue whale	Body	Area IV	5	In prog.	-	″
Humpback whale	Lateral marking	Area III	17	In prog.	-	″
Humpback whale	Lateral marking	Area IV	45	In prog.	-	″
Humpback whale	Lateral marking	Area V	48	In prog.	-	″
Southern right whale	Head	Area IV	2	In prog.	-	″
Blue whale	Dorsal fin	W N Pacific	1	In prog.	-	T. Bando/ICR
Blue whale	Body	W N Pacific	7	In prog.	-	T. Bando/ICR
Humpback whale	Body	W N Pacific	5	In prog.	-	K. Matsuoka/ICR
Humpback whale	Dorsal fin	W N Pacific	7	In prog.	-	″
N Pacific right whale	Head	W N Pacific (transit)	1	In prog.	-	″
Mexico						
Blue whale	Flank, flukes	Gulf of California/NE Pacific	69	Y	604	D. Gendron/CICIMAR
Fin whale	Chevron, dorsal	Gulf of California/N Pacific	30	N	15+	″
Sperm whale	Fluke	Gulf of California/N Pacific	+ 300	N	840+	″
Humpback whale	Fluke	Banderas Bay/N Pacific	Not ready	Y	Not ready	R. Moncada-Cooley/ITBB
Humpback whale	Dorsal fin	Banderas Bay/N Pacific	Not ready	Y	Not ready	″
Gray whale	Visible whale's backs	San Ignacio Lagoon/E Pacific (wintering breeding ground), 2010 winter season	785	In prog.	3,100	J. Urbán R., A. Gómez Gallardo/PRIMMA-UABCS; S.Swartz/CRA
Humpback whale	Fluke	Mexico/N Pacific	>1,500 photos	In prog.	1,500+	J. Urbán R., A. Gómez Gallardo/PRIMMA-UABCS
Humpback whale	Dorsal fin	Mexico/N Pacific	>1,500 photos	In prog.	206+	″
Bryde's whale	Dorsal fin	Gulf of California/N Pacific	In prog.	In prog.	In prog.	″
Blue whale	Dorsal fin	Gulf of California/N Pacific	In prog.	In prog.	In prog.	″
Netherlands						
Humpback whale	Dorsal fin/fluke	S North Sea	1	N	-	K. Camphuysen/NIOZ
New Zealand						
Southern right whale	Callosities	Auckland Is. NZ	~250	Y	>600	W. Rayment/UO
Southern right whale	Head callosities	Mainland NZ	~26 (2009-2010)	Y	85	L. Boren/DOC
Bottlenose dolphin	Dorsal fins	Hauraki Gulf	10	In prog.	~200	G. Tezanos-Pinto
Humpback whale	Fluke	Cook Strait	15	Y	84	N. Bott/DOC
Bottlenose dolphin	Dorsal fin	Bay of Islands	121	Y	479	R. Constantine; L. Hartel/UA
Bryde's whale	Dorsal fin	Hauraki Gulf	5	Y	77	R. Constantine/UA
Humpback whale	Fluke	Tonga; Group E2	48	Y	685	″

Cont.

Species	Feature	Area/stock	No. photo-id'd	Catalogue (Y/N)	Catalogue total	Contact person/institute; refs
New Zealand cont.						
Humpback whale	Fluke	Ross Sea/Balleny Islands	61	Y	-	S. Childerhouse/AAD
Common dolphin	Dorsal fin	Hauraki Gulf	*ca* 100	Y	*ca* 700	K. Stockin/MU-A
Hector's dolphin	Dorsal fin/body	Akaroa Harbour	50	Y	50	E. Martinez/MU-A
Common dolphin	Dorsal fin	Hauraki Gulf	*ca* 100	Y	*ca* 700	K. Stockin/MU-A
Hector's dolphin	Dorsal fin/body	Akaroa Harbour	50	Y	50	E. Martinez/MU-A
Hector's dolphin	Dorsal fin	Kaikoura	-	Y	-	
Dusky dolphin	Dorsal fin	Kaikoura	-	Y	-	W. Markowitz/MU
Sperm whale	Fluke	Kaikoura	-	Y	23	M. Fernandez/UC
Norway						
Humpback whale	Photo ID	Norway	21	-	-	IMR
Spain						
Cuvier's beaked whale	Body marks	Canary Islands	-	Y	-	*www.cetabase.info* N.Aguilar/ULL*
Blainville's beaked whale	Body marks	Canary Islands	-	Y	-	"
Sperm whale	Fluke	Canary Islands	-	Y	-	A. Fais/ULL**
Bottlenose dolphin	Fin	Canary Islands	-	Y	-	In prep.
Common dolphin	Dorsal fin	Alboran Sea	+2,500 pics	N	In prog.	A. Cañadas/ALNITAK
Long-finned pilot whale	Dorsal fin	Alboran Sea	+8,000 pics	Y	In prog.	"
Bottlenose dolphin	Dorsal fin	Alboran Sea	+4,000 pics	Y	In prog.	"
Risso's dolphin	Dorsal fin	Alborán Sea	+100 pics	Y	In prog.	"
Bottlenose dolphin	Dorsal fin (left)	Coast of Murcia	18	Y	118	J.L. Murcia/ANSE
Bottlenose dolphin	Dorsal fin (right)	Coast of Murcia	24	Y	139	"
Sweden						
Indo-Pacific bottlenose dolphin	Dorsal fin/body	Zanzibar	-	N	170	P. Berggren/SU
Indo-Pacific humpback dolphin	Dorsal fin/body	Zanzibar	-	N	70	"
Humpback whale	Flukes, dorsal fin	Zanzibar/C2	183	N	325	"
UK						
Bottlenose dolphin	Dorsal fin	Scottish W coast (Hebrides)	28	Y	36	L. Mandleberg/HWDT
Humpback whale	Tail fluke/dorsal fin	North E Atlantic	1	N	?	"
Killer whale	Dorsal fin	Scottish W coast (Hebrides)	9	Y	9	"
Minke whale	All parts	Scottish W coast (Hebrides)	9	Y	125	"
Risso's dolphin	Dorsal fin	Scottish W coast (Hebrides)	0	Y	6	"
White-beaked dolphin	Dorsal fin	Scottish W coast (Hebrides)	0	N	0	"
Bottlenose dolphin	Dorsal fin	Cardigan Bay and Anglesey	226 (marked)	Y	469 (marked+ unmarked)	D. Feingold/SWF
Bottlenose dolphin	Dorsal fin, flank marks, tail flukes	Throughout UK	-	Y	c. 600	P.G.H. Evans/SWF
Killer whale	Dorsal fin, flank markings, flukes	Throughout UK	*ca* 60 new during 2009	-	80	"
Risso's dolphin	Dorsal fin, flank markings, flukes	Throughout UK	*ca* 60 new ones 2009	-	55	"
Minke whale	Dorsal fin, flank markings, flukes	Throughout UK	*ca* 60 new ones 2009	-	85	"
Humpback whale	Dorsal fin, flank markings, flukes	Throughout UK	*ca* 60 new ones 2009	-	10	"
Bottlenose dolphin	Dorsal fin	NE Scotland	-	Y	247	CRRU
Minke whale	Dorsal fin	NE Scotland	-	Y	45	"
Risso's dolphin	Dorsal fin	NE Scotland	-	Y	26	"
Common dolphin	Dorsal fin	NE Scotland	-	Y	56	"
Humpback whale	Tail fluke/dorsal fin	NE Scotland	-	Y	3	"
Irrawaddy dolphin	Dorsal fin	Thailand	-	Y	-	K. Robinson/CRRU/WFFT
Bottlenose dolphin	Dorsal finds	NE Scotland	-	-	-	B. Cheney/AULFS
USA						
Humpback whale	Fluke	WN Atlantic	43	Y	n/a	R. Pace/NEFSC
North Atlantic right whale	Callosities	WN Atlantic	99	Y	n/a	"
North Pacific right whale	Head	SE Bering Sea	7	Y	47	A.S. Kennedy; B.K. Rone/ AFSC; NMML
Humpback whale	Fluke	SE Bering Sea	55	Y	n/a	"
Fin whale	Dorsal	Gulf of Alaska	4	N	n/a	B.K. Rone/AFSC; NMML
Killer whale	Dorsal/saddle patch	Gulf of Alaska	19	Y	1069	"
Bowhead whale	Dorsal surface	Bering-Chukchi-Beaufort	63	Y	17,000	J. Mocklin/NMML; NMFS (Rugh, 2010)
Striped dolphin	Dorsal fin; body	Hawaii	147	In prog.	n/a	E. Oleson/PIFSC
Spinner dolphin	Dorsal fin; body	Hawaii; Guam; CNMI	4,197	In prog.	n/a	"
Pantropical spotted dolphin	Dorsal fin; body	Hawaii, Guam	973	In prog.	n/a	"
Rough-toothed dolphin	Dorsal fin; body	Hawaii	3,251	In prog.	n/a	"
Bottlenose dolphin	Dorsal fin; body	Hawaii	784	In prog.	n/a	"
Melon-headed whale	Dorsal fin; body	Hawaii; Guam	8,269	In prog.	n/a	"
False killer whale	Dorsal fin; body	Hawaii; High Seas	7,420	In prog.	n/a	"

Cont.

Species	Feature	Area/stock	No. photo-id'd	Catalogue (Y/N)	Catalogue total	Contact person/institute; refs
USA cont.						
Pilot whale	Dorsal fin; body	Hawaii	6,629	In prog.	n/a	E. Oleson/PIFSC
Blainville's beaked whale	Dorsal fin; body	Hawaii	319	In prog.	n/a	"
Sperm whale	Flukes; body	High Seas; CNMI	711	In prog.	n/a	"
Sei whale	Flukes; dorsal fin; body	High Seas; Wake	284	In prog.	n/a	"
Killer whale	Dorsal fin	Antarctic peninsula	150	Y	400+	R. Pitman; J. Durban/SWFSC
Bottlenose dolphin	Dorsal fin	Coastal CA	200	Y	-	-

France: [§]includes beaked whales, killer whale, pygmy killer whale, short-finned pilot whale, melon-headed dolphin, common bottlenose dolphin, pantropical spotted dolphin, Fraser's dolphin, false killer whale, striped dolphin, spinner dolphin, rough-toothed dolphin, killer whale, *Kogia* sp. [#]includes melon-headed whale, spinner dolphin, Indo-Pacific bottlenose dolphin.
Spain: **www.cetabase.info*. N. Aguilar *et al.* Unpubl. report to the Spanish Ministry of Environment and TRAGSEGA (*naguilar@ull.es.*).
**A. Fais *et al.* Report to the Canary Islands Government (*afais@ull.es*).

ARTIFICIAL MARKING DATA

Species	Tag type/date	No. branded	Location/sex	Brand no.	Contact/comments
Australia					
Bottlenose dolphin	Spaghetti tag; 01/03/09	5	King Island stranding event	-	DPIPWE-TAS
Long-finned pilot whale	Spaghetti tag; 01/03/09	27	King Island stranding event	-	"

TELEMETRY DATA

Species	Tag type	No. successfully deployed	Maximum time transmitting	Contact person/institute; refs
Argentina				
Franciscana	Satellite	4	2	P. Bordino/AquaMarina-CECIM
Southern right whale	GPS-VHF	5	<1 day	D.P. Martinez/DFFS
Australia				
Blue whale	Satellite	3	137 days	N. Gales/Australian Antarctic Division
Humpback whale	Satellite	38	108 days	"
Southern right whale	Satellite	6	170 days	N. Gales; S. Childerhouse/Aus. Ant. Div.
Brazil				
Humpback whale	Satellite	14	139	A. Zerbini; A. Andriolo/IA
Denmark				
Blue whale	Satellite transmitter	2	3 months	M.P. Heide-Jørgensen/GINR
Bowhead whale	Satellite transmitter	30	10 months	"
Harbour porpoise	SPLASH (Wildlife Computers)	7	>365 days	J. Teilmann/NERI
Humpback whale	Satellite transmitter	21	3 months	M.P. Heide-Jørgensen/GINR
Iceland				
Humpback whale	Satellite	4	-	Vikingsson, 2010
Blue whale	Satellite	1	-	"
New Zealand				
Southern right whale	ARGOS satellite tag	6	170	S. Childerhouse/AAD
Spain				
Blainville's beaked whale	Suction-cup attached DTAG	12 tags from 2003 to 2009	1 day, 102hrs/acoustic and movement data	N. Aguilar; P. Arranz/ULL; *http://webpages.ull.es/users/cetaceos/publi.html*
Short finned pilot whales	Suction-cup attached DTAG	-	-	"
USA				
Killer whale	Satellite	6	86 days	B. Hanson/NWFSC
Blainville's beaked whale	Satellite	3	40 days	"
Blue whale	Satellite	2	133 days	"
Pygmy killer whale	Satellite	2	22 days	"
Fin whale	Satellite	10	159 days	"
Humpback whale	Satellite	1	6 days	"
Melon headed whale	Satellite	2	25 days	"
Pilot whale	Satellite	12	109 days	"
False killer whale	Satellite	11	109 days	"
Risso's dolphin	Satellite	2	19 days	"
Sperm whale	Satellite	6	158 days	"
Bottlenose dolphin	Satellite	1	6 days	"
Cuvier's beaked whale	Satellite	3	42 days	"
False killer whale	Satellite	4	3 months	E. Oleson/PIFSC; R. Baird/CRC
Killer whale	Satellite	6	21 days	J. Durban/SWFSC
Gray whale	Satellite	1	12 days	"
Sperm whale	Satellite	4	14 days	"
Blainville's beaked whale	Satellite	2	25 days	"
Cuvier's beaked whale	Satellite	1	15 days	"
Short-finned pilot whale	Satellite	6	28 days	"

BIOPSY SAMPLES (SUMMARY ONLY)

Species	Area/stock	Calendar year/ season (no. collected)	Archived (Y/N)	No. analysed	Total holdings	Contact person/institute
Argentina						
Commerson's dolphin	Bahía San Julián	(1)	Y	0	28	Fundacion Cethus/*cethus@cethus.org*
Southern right whale	SW Atlantic	(25)	Y	22	22	M. Bertellotti/*bertello@cenpat.edu.ar*
Australia						
Australian snubfin dolphin	Western NT	2008	Y	?	?	C. Palmer/NRETAS
Indo-Pacific humpback dolphin	Western NT	2008	Y	?	?	″
Bottlenose dolphin	Western NT	2008	Y	?	?	″
Blue whale	S Australia	(11)	Y	11	?	L. Möller/Flinders Uni
Bottlenose dolphin	Bunbury, WA	2009 (23)	Y	Not yet	91	S. Allen; C. Daniels; L. Bejder/MUCRU
Bottlenose dolphin	Albany, WA	2009 (12)	Y	Not yet	-	″
Bottlenose dolphin	Mandurah, WA	2009 (11)	Y	Not yet	30	″
Bottlenose dolphin	Augusta, WA	2009 (5)	Y	Not yet	12	″
Bottlenose dolphin	Swan River, WA	2009 (4)	Y	Not yet	16	H. Finn/MUCRU
Bottlenose dolphin	Exmouth, WA	2009 (5)	Y	Not yet	5	S. Allen; L. Bejder/MUCRU
Bottlenose dolphin	Cockburn Sound, WA	2009 (4)	Y	Not yet	18	H. Finn/MUCRU
Bottlenose dolphin	Pilbara, WA	2009 (39)	Y	Not yet	91	S. Allen/MUCRU
Humpback whale	Area V; Hervey Bay	(13)	Y	846	1,464	W. Franklin/TOP
Humpback whale	Group V Breeding Stock E (ii)	pre-2009	-	-	7	M. Anderson/SCU; W. Franklin/SCU
Dwarf minke whale	N Great Barrier Reef	(2)	Y	0; sloughed skin	*ca* 50	A. Birtles/JCU.
Southern right whale	Warrnambool/SE Aus.	(3)	Y	-	-	R. Harcourt/MQ
Sperm whale	SW Pacific	2009 (3)	N	3	3	L. Moller/Flinders University
Brazil						
Guiana dolphin	RJ	(20)	Y	20	-	J. Lailson-Brito; A. Azevedo /UERJ
Humpback whale	Abrolhos Bank (BSA)	2009 (91)	Y	91	587	M. Engel/IBJ
Humpback whale	NE of Bahia State/BSA	2009 (2)	Y	2	45	″
Southern right whale	Abrolhos Bank	2009 (1)	Y	1	1	″
Guiana dolphin	Lagamar (SP/PR)	(6)	Y	0	6 recent	M. Santos
Chile						
Humpback whale	Area I	2010 (12)	Y	0	106	C. Olavarria/CEQUA-INACH
Humpback whale	Bernardo O'Higgins National Park/Magellan Strait, Stock G	2010 (1)	Y	0	95	″
Chilean dolphin	Bernardo O'Higgins National Park	2010 (8)	Y	0	13	″
Peale's dolphin	Bernardo O'Higgins National Park	2010	Y	45	104	M.J. Perez/CENTRO EUTROPIA C. Olavarria/CEQUA
Blue whale	Los Lagos Region	2009 (12)	Y	0	12	B. Galletti/CCC
Sei whale	Los Lagos Region	2009 (1)	Y	0	1	″
Croatia						
Bottlenose dolphin	Central Adriatic Sea	2009	Y	6	6	D. Holcer/BWI
Denmark						
Blue whale	West Greenland	2009 (1)	Y	All	1	M.P. Heide-Jørgensen/GINR
Bowhead whale	West Greenland	2009 (71)	Y	All	392	″
Harbour porpoise	Denmark	2009 (15)	Y	All	46	L.F. Jensen/FoS
Harbour porpoise	Kattegat/Belt Seas (Denmark.)	2009 Mar.-Oct. (7)	Y	0	300	J.Teilmann/NERI
Humpback whale	Disko (West Greenland)	2009 (16)	Y	All	29	M.P. Heide-Jørgensen/GINR
Humpback whale	Nuuk (West Greenland)	2009 (1)	Y	0		M. Simon/GINR
Killer whale	North Atlantic	2009	Y	1	3	L.F. Jensen/FoS
Minke whale	North Atlantic	2009	Y	1	6	″
White-beaked dolphin	North Atlantic	2009	Y	5	40	″
Iceland						
Humpback whale	Iceland	2009 (6)	Y	6	-	MRI
Minke whale	Iceland	2009 (1)	Y	1	-	″
Blue whale	Iceland	2009 (1)	Y	1	-	″
Ireland						
Humpback whale	NE Atlantic	2009 (1)	Y	1	4	S. Berrow/IWDG
Bottlenose dolphin	West coast Ireland	2009 (16)	Y	16	66	E. Rogan/UCC; S. Ingram/UP
France						
Fin whale	NW Mediterranean	2006/2009	Y	>80	>80	D. Ody/WWF, GIS3M
Indo-Pacific bottlenose dolphin	Mayotte/SW Indian	2009/year round (6)	Y	110	233	J. Kiszka/OMM
Humpback whale	Adélie land	2009/December	Y	0	1	C. Garrigue/OCNC, MNHN, ULR
Italy						
Fin whale	Ligurian Sea	2009/summer (0)	Y	In prog.	193	TRI; LB-DSA-US; M. Berubé/ University of Stockholm

Cont.

Species	Area/stock	Calendar year/ season (no. collected)	Archived (Y/N)	No. analysed	Total holdings	Contact person/institute
Italy cont.						
Fin whale	Ligurian Sea	2009/summer (4)	Y	4	4	LB-DSA-US, UNIFI, ISPRA, DIP III CRA 15/Lauriano
Sperm whale	Ligurian Sea	2009/summer (0)	Y	3	3	TRI; LB-DSA-US; D. Engelhaupt/ University of Durham
Sperm whale	Ligurian Sea	2009/summer (2)	Y	2	2	LB-DSA-US, UNIFI ISPRA, DIP III CRA 15/Lauriano
Long-finned pilot whale	Ligurian Sea	2009/summer (0)	Y	In prog.	39	TRI
Risso's dolphin	Ligurian Sea	2009/summer (0)	Y	28	28	S. Gaspari/LEM-UNIFI; TRI; LB-DSA-US
Bottlenose dolphin	E Ionian Sea, Greece	2009/summer (0)	Y	-	10	TRI; LB-DSA-US; A. Natoli; University of Durham
Bottlenose dolphin	Adriatic Sea	2009/summer (6)	Y	In prog.	52	LB-DSA-US, UNIFI, ISPRA, DIP III CRA 15; Fortuna
Italy cont.						
Bottlenose dolphin	NW Greece, Amvrakikos Gulf	2009/ summer (0)	Y	-	20	TRI ; K. Viaud-Martinez; A.J. Bohonak/San Diego State University
Bottlenose dolphin	Ligurian Sea	2009/summer (0)	Y	In prog.	1	TRI
Short-beaked common dolphin	E Ionian Sea, Greece	2009/summer (0)	Y	-	15	TRI; LB-DSA-US; A. Natoli; University of Durham
Striped dolphin	Ligurian Sea	2009/summer (0)	Y	In prog.	243	TRI; LB-DSA-US; S. Gaspari/LEM-UNIFI
Striped dolphin	Ligurian Sea	2009/summer (9)	Y	9	314	LB-DSA-US, UNIFI, ISPRA, DIP III CRA 15/Lauriano
Japan						
Humpback whale	Antarctic	2009-10 (21)	Y	0	21	NRIFSF
Southern right whale	Antarctic	2009-10 (26)	Y	0	26	″
Minke whale	Okhotsk Sea	2009	-	-	-	SC/62/IA1
Fin whale	Area III	2009-10 (1)	Y	In prog.	-	S. Nishiwaki/ICR; see SC/62/O3
Humpback whale	Area III	2009-10 (12)	Y	In prog.	-	″
Humpback whale	Area IV	2009-10 (33)	Y	In prog.	-	″
Humpback whale	Area V	2009-10 (39)	Y	In prog.	-	″
Southern right whale	Area IV	2009-10 (1)	Y	In prog.	-	″
Blue whale	Western North Pacific	2009 (6)	Y	In prog.	-	T. Bando/ICR; see SC/62/O4
Sei whale	Western North Pacific	2009 (7)	Y	In prog.	-	″
Sperm whale	Western North Pacific	2009 (1)	Y	In prog.	-	″
Sei whale	Western North Pacific	2009 (2)	Y	In prog.	-	″
Mexico						
Blue whale	Gulf of California/ NE Pacific	2009 (34)	Y	34	0	D. Gendron/CICIMAR
Fin whale	Gulf of California/ N Pacific	2009 (26)	Y	0	26	″
Sperm whale	Gulf of California/ N Pacific	2009 (14)	Y	0	14	″
Bottlenose dolphin	Banderas Bay/N Pacific	2010 (2)	Y	2		R. Moncada/ITBB
Humpback whale	N Pacific/Mexico	Jan-Apr. 2010	Y	0	35	J. Urbán R.; A. Gómez Gallardo/ PRIMMA-UABCS
Bryde's whale	N Pacific/Mexico	Jan-Apr. 2010	Y	0	4	″
Blue whale	N Pacific/Mexico	Jan-Apr. 2010	Y	0	2	″
Sperm whale	Mexico	Jan-Apr. 2010	Y	0	3	″
New Zealand						
Humpback whale	Cook Strait	2009 (20)	Y	-	-	N. Bott/DOC
Southern right whale	Auckland Islands	2009/4 (254)	Y	0	1,187	S. Baker; E. Carroll/UA
Southern right whale	Mainland NZ	2009 (27)	Y	0	50+	″
Maui's dolphin	W Coast, North Island	2010/summer (37)	Y	70	107 (01-10)	R. Constantine, C.S. Baker/UA
Humpback whale	Ross Sea/Balleny Isl.	2010/summer	Y	64	-	S. Childerhouse/AAD
Norway						
Sperm whale	Norway	1	-	-	-	IMR
Pilot whale	Norway	3	-	-	-	″
Sweden						
Humpback whale	Zanzibar/C2	48	Y	0	73	P. Berggren/SU
Indo-Pacific humpback dolphin	Zanzibar	0	-	*	47	″
Indo-Pacific bottlenose dolphin	Zanzibar	0	-	*	6	″
USA						
N Atlantic right whale	W Atlantic	2009 (37)	Y	n/a	n/a	R. Pace/NEFSC
Atlantic white-sided dolphin	N Atlantic	2009 (21)	Y	n/a	n/a	″
Pilot whale	N Atlantic	2009 (4)	Y	n/a	n/a	″
Spotted dolphin	N Atlantic	2009 (4)	Y	n/a	n/a	″

Cont.

Species	Area/stock	Calendar year/ season (no. collected)	Archived (Y/N)	No. analysed	Total holdings	Contact person/institute
USA cont.						
Bottlenose dolphin	Offshore	2009 (3)	Y	n/a	n/a	R. Pace/NEFSC
Fin whale	SE Bering Sea	(5)	Y	0	5	A.S. Kennedy/AFSC/NMML
North Pacific right whale	SE Bering Sea	(3)	Y	0	4	″
Killer whale	NE Pacific/Southern resident	2009/summer (3) winter/spring (3)	Y	5	1	G. Ylitalo/NWFSC
Minke whale	NE Pacific	2009/summer (1)	Y	0	1	″
Spinner dolphin	Guam; CNMI	2010 (10)	Y	0	10	E. Oleson/PIFSC
Spotted dolphin	Hawaii	2009 (1)	Y	0	1	″
Bottlenose dolphin	Hawaii	2009 (4)	Y	0	29	″
Melon-headed whale	Hawaii	2009 (7)	Y	0	12	″
False killer whale	Hawaii	2009 (5)	Y	0	5	″
Short-finned pilot whale	Hawaii	2009 (7)	Y	0	28	″
Sperm whale	Guam; CNMI	2010 (5)	Y	0	5	″
Sei whale	Wake	2010 (1)	Y	0	1	″
Blue whale	N Pacific	(4)	Y	0	1,039	G. Serra-Valente/SWFSC
Fin whale	N Pacific	(3)	Y	3	599	″
Minke whale	N Pacific	(1)	Y	0	91	″
Long-beaked common dolphin	N Pacific	(697)	Y	50	1,196	″
Short-beaked common dolphin	N Pacific	(666)	Y	0	2,458	″
Gray whale	N Pacific	(2)	Y	0	734	″
Risso's dolphin	N Pacific	(4)	Y	0	145	″
Short-finned pilot whale	N Pacific	(2)	Y	0	614	″
N right whale dolphin	N Pacific	(4)	Y	0	240	″
Pacific white sided dolphin	N Pacific	(21)	Y	0	322	″
Killer whale	N Pacific	(16)	Y	5	857	″
Sperm whale	N Pacific	(9)	Y	0	1,938	″
Spotted dolphin	N Pacific	(1)	Y	0	1,556	″
Striped dolphin	N Pacific	(1)	Y	0	579	″
Spinner dolphin	N Pacific	(2)	Y	0	193	″
Bottlenose dolphin	N Pacific	(129)	Y	100	2,629	″
Cuvier's beaked whale	N Pacific	(2)	Y	0	105	″
Cuvier's beaked whale	Bahamas	(6)	Y	0	105	″
Short-finned pilot whale	Bahamas	(9)	Y	0	614	″
Blainville's beaked whale	Bahamas	(10)	Y	0	46	″
Melon-headed whale	Bahamas	(2)	Y	0	2	″
Sperm whale	Bahamas	(26)	Y	0	1,938	″
Bottlenose dolphin	Bahamas	(3)	Y	0	2629	″
Humpback whale	Antarctica	(5)	Y	0	404	″
Killer whale	Antarctica	(8)	Y	0	857	″
Antarctic minke whale	Antarctica	(4)	Y	0	5	″

SAMPLES FROM DIRECTED CATCHES (COMMERCIAL, ABORIGINAL AND SCIENTIFIC PERMITS) OR BYCATCHES

Species	Area/stock	Tissue type(s)	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
Argentina						
Franciscana	Coastal Buenos Aires	Muscle, stomach, liver, kidney, ovaries, testis, skeletons, teeth	48	Y	0	P. Bordino/AquaMarina-CECIM
Australia						
Short-beaked common dolphin	SA	Genetic tissues, reproductives, stomach and intestines, toxic contaminants	8	Y	0	C. Kemper/SAM *[1]
Fin whale	SA	Genetic tissues, reproductives, stomach and intestines, toxic contaminants	1	Y	0	″
Indo-Pacific bottlenose dolphin	SA	Genetic tissues, reproductives, stomach and intestines, toxic contaminants	4	Y	0	″
Belgium (only bycaught, no directed catches)						
Harbour porpoise	NE Atlantic	All relevant tissues	15	Y	Analysed/ tissue bank	T. Jauniaux/ULg; J. Haelters/RBINS
Brazil						
Guiana dolphin	RJ	Kidney, liver, lung, muscle, stomach, intestine, heart, blubber	5	Y	5	J. Lailson-Brito; A. Azevedo/ UERJ
Guiana dolphin	CE	Muscle, liver, blubber, stomach contents, skeleton	3	Y	3	A.C. Meirelles/Aquasis
Guiana dolphin	PR-SWA	Skin, blubber, muscle, teeth, liver, gonads	2	Y	2	C. Domit/LEC/CEM/UFPR
Chile						
Antarctic minke whale	O'Higgins Region	Baleens, blubber, skin	7	Y	0	B. Galletti/CCC

Cont.

Species	Area/stock	Tissue type(s)	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
Croatia						
Bottlenose dolphin	Central Adriatic Sea	Skin, blubber, muscle, kidney, liver, spleen, lung	1	Y	-	H. Gomerčić/VEF
Denmark						
Harbour porpoise	W Greenland	-	Y	0	57	M.P. Heide Jørgensen/ GINR; R. Dietz/NERI
Bowhead whale	W Greenland	-	3	-	-	-
Minke whale	W Greenland	-	97	-	-	-
Minke whale	E Greenland	-	2	-	-	-
Fin whale	E Greenland	-	5	-	-	-
France						
Short-beaked common dolphin	Bay of Biscay	Various*	1	N	In prog.	W. Dabin/CRMM/ULR
Harbour porpoise	Bay of Biscay/ Channel/NE Atlantic	Various*	5	N	In prog.	″
Striped dolphin	Mediterranean	Various*	1	N	In prog.	″
Germany						
Harbour porpoise	Baltic Sea Schleswig-Holstein	All organs, central nervous system, skeletal system	4	4	-	U. Siebert
Harbour porpoise	North Sea Schleswig-Holstein	-	4	4	-	″
Harbour porpoise	Baltic Sea Meckl.-Prepom.	All organs, central nervous system, skeletal system	5	5	-	H. Benke
Iceland						
Fin whale	EGI	Skin, blubber, muscle, gonads, eye lenses	125	Y	125	MRI
Common minke whale	EGI	Skin, blubber, muscle, gonads, eye lenses	9	Y	9	″
Japan						
Antarctic minke whale	Antarctic	Photographic record and external character	504	Y	-	ICR
Antarctic minke whale	Antarctic	Body length and sex	506	Y	-	″
Antarctic minke whale	Antarctic	External body proportion	506	Y	-	″
Antarctic minke whale	Antarctic	Body weight	506	Y	-	″
Antarctic minke whale	Antarctic	Body weight by parts	3	Y	-	″
Antarctic minke whale	Antarctic	Skull measurement (length and breadth)	497	Y	-	″
Antarctic minke whale	Antarctic	Standard measurements of blubber thickness	506	Y	-	″
Antarctic minke whale	Antarctic	Observation of lactation status	269	Y	-	″
Antarctic minke whale	Antarctic	Measurement of mammary gland	269	Y	-	″
Antarctic minke whale	Antarctic	Testis weight	237	Y	-	″
Antarctic minke whale	Antarctic	Weight of stomach content	506	Y	-	″
Antarctic minke whale	Antarctic	Photographic record of foetus	186	Y	-	″
Antarctic minke whale	Antarctic	Foetal length and weight	186	Y	-	″
Antarctic minke whale	Antarctic	Foetal ocular lens for age determination	17	Y	-	″
Antarctic minke whale	Antarctic	Foetal skin for genetic study	182	Y	-	″
Antarctic minke whale	Antarctic	Diatom film observation	506	Y	-	″
Antarctic minke whale	Antarctic	Blood plasma for physiological study	454	Y	-	″
Antarctic minke whale	Antarctic	Earplug for age determination	505	Y	-	″
Antarctic minke whale	Antarctic	Ocular lens for age determination	506	Y	-	″
Antarctic minke whale	Antarctic	Tympanic bulla for chemical analysis	48	Y	-	″
Antarctic minke whale	Antarctic	Largest baleen plate for chemical analysis	506	Y	-	″
Antarctic minke whale	Antarctic	Vertebral epiphyses for biological study	438	Y	-	″
Antarctic minke whale	Antarctic	Observation and collection of ovary	269	Y	-	″
Antarctic minke whale	Antarctic	Histological sample of endometrium	17	Y	-	″
Antarctic minke whale	Antarctic	Histological sample of mammary gland	269	Y	-	″
Antarctic minke whale	Antarctic	Histological sample of testis	237	Y	-	″
Antarctic minke whale	Antarctic	Tissue samples for genetic study	506	Y	-	″
Antarctic minke whale	Antarctic	Blubber, muscle, liver tissues for env. monitoring	506	Y	-	″
Antarctic minke whale	Antarctic	Lung and liver tissues for env. monitoring	39	Y	-	″
Antarctic minke whale	Antarctic	Gross pathological obs. (thyroid/lung/liver)	506	Y	-	″
Antarctic minke whale	Antarctic	Tissues for histopathological study	18	Y	-	″
Antarctic minke whale	Antarctic	Tissues for various study	6	Y	-	″
Antarctic minke whale	Antarctic	Stomach contents for food and feeding study	56	Y	-	″
Antarctic minke whale	Antarctic	Stomach contents for env. monitoring	21	Y	-	″
Antarctic minke whale	Antarctic	Samples of internal and external parasites	15	Y	-	″
Antarctic minke whale	Antarctic	Stomach contents for DNA study	7	Y	-	″
Antarctic minke whale	Antarctic	Gut contents for food and feeding study	21	Y	-	″
Antarctic minke whale	Antarctic	Fundus for food and feeding study	2	Y	-	″
Antarctic minke whale	Antarctic	Tissue samples for monitoring infectious disease	419	Y	-	″
Antarctic minke whale	Antarctic	Tissues for nutrition study	5	Y	-	″
Antarctic minke whale	Antarctic	Uterus and placenta tissues for histological study	5	Y	-	″

Cont.

Species	Area/stock	Tissue type(s)	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
Japan cont.						
Antarctic minke whale	Antarctic	Foetal sample for clarification of hind-limb disappearance mechanism	4	Y	-	ICR
Fin whale	Antarctic	Photographic record and external character	1	Y	-	"
Fin whale	Antarctic	Body length and sex	1	Y	-	"
Fin whale	Antarctic	External body proportion	1	Y	-	"
Fin whale	Antarctic	Body weight by parts	1	Y	-	"
Fin whale	Antarctic	Skull measurement (Length and breadth)	1	Y	-	"
Fin whale	Antarctic	Detailed measurements of blubber thickness	1	Y	-	"
Fin whale	Antarctic	Histological sample of testis	1	Y	-	"
Fin whale	Antarctic	Histological sample of epididymis	1	Y	-	"
Fin whale	Antarctic	Weight of stomach content	1	Y	-	"
Fin whale	Antarctic	Number of ribs	1	Y	-	"
Fin whale	Antarctic	Number of vertebra	1	Y	-	"
Fin whale	Antarctic	Diatom film observation	1	Y	-	"
Fin whale	Antarctic	Diatom film sample	1	Y	-	"
Fin whale	Antarctic	Blood plasma for physiological study	1	Y	-	"
Fin whale	Antarctic	Earplug for age determination	1	Y	-	"
Fin whale	Antarctic	Ocular lens for age determination	1	Y	-	"
Fin whale	Antarctic	Tympanic bulla for chemical analysis	1	Y	-	"
Fin whale	Antarctic	Largest baleen plate for chemical analysis	1	Y	-	"
Fin whale	Antarctic	Vertebral epiphyses for biological study	1	Y	-	"
Fin whale	Antarctic	Histological sample of testis	1	Y	-	"
Fin whale	Antarctic	Histological sample of epididymis	1	Y	-	"
Fin whale	Antarctic	Tissue samples for genetic study	1	Y	-	"
Fin whale	Antarctic	Blubber, muscle, liver tissues for env. monitoring	1	Y	-	"
Fin whale	Antarctic	Lung and liver tissues for env. monitoring	1	Y	-	"
Fin whale	Antarctic	Gross pathological obs.(thyroid, lung, and liver)	1	Y	-	"
Fin whale	Antarctic	Tissues for histopathological study	1	Y	-	"
Fin whale	Antarctic	Muscle, liver, kidney, lumbar and blubber tissues for lipid analysis	1	Y	-	"
Fin whale	Antarctic	Muscle and blubber tissues for various analysis	1	Y	-	"
Fin whale	Antarctic	Stomach contents for food and feeding study	1	Y	-	"
Fin whale	Antarctic	Samples of internal and external parasites	1	Y	-	"
Fin whale	Antarctic	Gut contents for food and feeding study	1	Y	-	"
Fin whale	Antarctic	Fundus for food and feeding study	1	Y	-	"
Fin whale	Antarctic	Tissues samples for monitoring infectious disease	1	Y	-	"
Fin whale	Antarctic	Tissues for nutrition study	1	Y	-	"
Common minke whale	WN Pacific	Body length and sex	43	Y	-	"
Common minke whale	WN Pacific	External body proportion	43	Y	-	"
Common minke whale	WN Pacific	Photographic record and external character	43	Y	-	"
Common minke whale	WN Pacific	Diatom film record	43	Y	-	"
Common minke whale	WN Pacific	Standard measurements/blubber thickness (5 pts)	43	Y	-	"
Common minke whale	WN Pacific	Detailed measurements/blubber thickness (11 pts)	17	Y	-	"
Common minke whale	WN Pacific	Body weight	43	Y	-	"
Common minke whale	WN Pacific	Body weight by parts	17	Y	-	"
Common minke whale	WN Pacific	Skin tissues for DNA study	43	Y	-	"
Common minke whale	WN Pacific	Blubber, muscle, liver and kidney tissues for heavy metal analysis	43	Y	-	"
Common minke whale	WN Pacific	Blubber, muscle, liver and kidney tissues for organochlorines analysis	43	Y	-	"
Common minke whale	WN Pacific	Blubber, muscle tissues for ingredient analysis	43	Y	-	"
Common minke whale	WN Pacific	Tissue for nutritional component analysis	5	Y	-	"
Common minke whale	WN Pacific	Lung tissue for atmospheric analysis	5	Y	-	"
Common minke whale	WN Pacific	Tissues for lipid analysis	17	Y	-	"
Common minke whale	WN Pacific	Tissues for various analysis	43	Y	-	"
Common minke whale	WN Pacific	Tissues for virus test	39	Y	-	"
Common minke whale	WN Pacific	Mammary gland; lactation status, measurement and histological sample	7	Y	-	"
Common minke whale	WN Pacific	Uterine horn; measurement/endometrium sample	7	Y	-	"
Common minke whale	WN Pacific	Collection of ovary	7	Y	-	"
Common minke whale	WN Pacific	Photographic record of foetus	3	Y	-	"
Common minke whale	WN Pacific	Foetal sex (identified by visual observation)	3	Y	-	"
Common minke whale	WN Pacific	Foetal length and weight	3	Y	-	"
Common minke whale	WN Pacific	External measurements of foetus	3	Y	-	"
Common minke whale	WN Pacific	Foetal blubber tissues for DNA study	3	Y	-	"
Common minke whale	WN Pacific	Foetal tissues for various analysis	3	Y	-	"
Common minke whale	WN Pacific	Foetal lens for age determination	3	Y	-	"
Common minke whale	WN Pacific	Testis/epididymis; weight and histological sample	36	Y	-	"
Common minke whale	WN Pacific	Collection of plasma sample	43	Y	-	"
Common minke whale	WN Pacific	Collection of whole blood sample	43	Y	-	"
Common minke whale	WN Pacific	Whole blood samples from umbilical cord	1	Y	-	"
Common minke whale	WN Pacific	Plasma samples from umbilical cord	3	Y	-	"

Cont.

Species	Area/stock	Tissue type(s)	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
Japan cont.						
Common minke whale	WN Pacific	Stomach content, conventional record	43	Y	-	ICR
Common minke whale	WN Pacific	Volume/weight of stomach content in each compartment	43	Y	-	"
Common minke whale	WN Pacific	Stomach contents for feeding study	41	Y	-	"
Common minke whale	WN Pacific	Record of external parasites	43	Y	-	"
Common minke whale	WN Pacific	Collection of external parasites	2	Y	-	"
Common minke whale	WN Pacific	Record of internal parasites	43	Y	-	"
Common minke whale	WN Pacific	Collection of internal parasites	1	Y	-	"
Common minke whale	WN Pacific	Earplug for age determination	43	Y	-	"
Common minke whale	WN Pacific	Tympanic bulla for age determination	41	Y	-	"
Common minke whale	WN Pacific	Lens for age determination	43	Y	-	"
Common minke whale	WN Pacific	Largest baleen plate for morphologic study and age determination	43	Y	-	"
Common minke whale	WN Pacific	Baleen plate measurements (length and breadth)	42	Y	-	"
Common minke whale	WN Pacific	Length of each baleen plate series	43	Y	-	"
Common minke whale	WN Pacific	Vertebral epiphyses sample	42	Y	-	"
Common minke whale	WN Pacific	Number of ribs	43	Y	-	"
Common minke whale	WN Pacific	Brain weight	15	Y	-	"
Common minke whale	WN Pacific	Skull measurements (length and breadth)	43	Y	-	"
Sei whale	WN Pacific	Body length and sex	100	Y	-	"
Sei whale	WN Pacific	External body proportion	100	Y	-	"
Sei whale	WN Pacific	Photographic record and external character	100	Y	-	"
Sei whale	WN Pacific	Diatom film record	100	Y	-	"
Sei whale	WN Pacific	Standard measurements/blubber thickness (5 pts)	100	Y	-	"
Sei whale	WN Pacific	Detailed measurements/blubber thickness (11 pts)	17	Y	-	"
Sei whale	WN Pacific	Body weight	100	Y	-	"
Sei whale	WN Pacific	Body weight by parts	17	Y	-	"
Sei whale	WN Pacific	Blubber tissues for DNA study	100	Y	-	"
Sei whale	WN Pacific	Blubber, muscle, liver and kidney tissues for heavy metal analysis	100	Y	-	"
Sei whale	WN Pacific	Blubber, muscle, liver and kidney tissues for organochlorines analysis	100	Y	-	"
Sei whale	WN Pacific	Tissue for nutritional component analysis	5	Y	-	"
Sei whale	WN Pacific	Lung tissue for chemical analysis	11	Y	-	"
Sei whale	WN Pacific	Tissues for lipid analysis	17	Y	-	"
Sei whale	WN Pacific	Tissues for various analysis	100	Y	-	"
Sei whale	WN Pacific	Tissues for virus test	79	Y	-	"
Sei whale	WN Pacific	Mammary gland; lactation status, measurement and histological sample	54	Y	-	"
Sei whale	WN Pacific	Collection of maternal milk sample	2	Y	-	"
Sei whale	WN Pacific	Uterine horn; measurement/endometrium sample	54	Y	-	"
Sei whale	WN Pacific	Collection of ovary	54	Y	-	"
Sei whale	WN Pacific	Photographic record of foetus	35	Y	-	"
Sei whale	WN Pacific	Foetal sex (identified by visual observation)	32	Y	-	"
Sei whale	WN Pacific	Foetal length and weight	35	Y	-	"
Sei whale	WN Pacific	External measurements of foetus	33	Y	-	"
Sei whale	WN Pacific	Foetal blubber tissues for DNA study	34	Y	-	"
Sei whale	WN Pacific	Foetal tissues for various analysis	32	Y	-	"
Sei whale	WN Pacific	Foetal lens for age determination	32	Y	-	"
Sei whale	WN Pacific	Testis/epididymis; weight and histological sample	46	Y	-	"
Sei whale	WN Pacific	Collection of plasma sample	100	Y	-	"
Sei whale	WN Pacific	Collection of whole blood sample	100	Y	-	"
Sei whale	WN Pacific	Whole blood samples from umbilical cord	27	Y	-	"
Sei whale	WN Pacific	Plasma samples from umbilical cord	32	Y	-	"
Sei whale	WN Pacific	Stomach content, conventional record	100	Y	-	"
Sei whale	WN Pacific	Volume and weight of stomach content in each compartment	100	Y	-	"
Sei whale	WN Pacific	Stomach contents for feeding study	80	Y	-	"
Sei whale	WN Pacific	Record of external parasites	100	Y	-	"
Sei whale	WN Pacific	Collection of external parasites	3	Y	-	"
Sei whale	WN Pacific	Record of internal parasites	100	Y	-	"
Sei whale	WN Pacific	Collection of internal parasites	5	Y	-	"
Sei whale	WN Pacific	Earplug for age determination	100	Y	-	"
Sei whale	WN Pacific	Tympanic bulla for age determination	100	Y	-	"
Sei whale	WN Pacific	Lens for age determination	100	Y	-	"
Sei whale	WN Pacific	Largest baleen plate for morphologic study and age determination	100	Y	-	"
Sei whale	WN Pacific	Baleen plate measurements (length and breadth)	100	Y	-	"
Sei whale	WN Pacific	Length of each baleen plate series	97	Y	-	"
Sei whale	WN Pacific	Vertebral epiphyses sample	100	Y	-	"
Sei whale	WN Pacific	Number of vertebrae	17	Y	-	"
Sei whale	WN Pacific	Number of ribs	100	Y	-	"

Cont.

Species	Area/stock	Tissue type(s)	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
Japan cont.						
Sei whale	WN Pacific	Brain weight	17	Y	-	ICR
Sei whale	WN Pacific	Skull measurements (length and breadth)	98	Y	-	″
Bryde's whale	WN Pacific	Body length and sex	50	Y	-	″
Bryde's whale	WN Pacific	External body proportion	50	Y	-	″
Bryde's whale	WN Pacific	Photographic record and external character	50	Y	-	″
Bryde's whale	WN Pacific	Diatom film record	50	Y	-	″
Bryde's whale	WN Pacific	Standard measurements/blubber thickness (5 pts)	50	Y	-	″
Bryde's whale	WN Pacific	Detailed measurements/blubber thickness (11 pts)	9	Y	-	″
Bryde's whale	WN Pacific	Body weight	50	Y	-	″
Bryde's whale	WN Pacific	Body weight by parts	9	Y	-	″
Bryde's whale	WN Pacific	Blubber tissues for DNA study	50	Y	-	″
Bryde's whale	WN Pacific	Blubber, muscle, liver and kidney tissues for heavy metal analysis	50	Y	-	″
Bryde's whale	WN Pacific	Blubber, muscle, liver and kidney tissues for organochlorines analysis	50	Y	-	″
Bryde's whale	WN Pacific	Tissue for nutritional component analysis	5	Y	-	″
Bryde's whale	WN Pacific	Lung tissue for chemical analysis	3	Y	-	″
Bryde's whale	WN Pacific	Tissues for lipid analysis	9	Y	-	″
Bryde's whale	WN Pacific	Tissues for various analysis	50	Y	-	″
Bryde's whale	WN Pacific	Tissues for virus test	27	Y	-	″
Bryde's whale	WN Pacific	Mammary gland; lactation status, measurement and histological sample	32	Y	-	″
Bryde's whale	WN Pacific	Collection of maternal milk sample	2	Y	-	″
Bryde's whale	WN Pacific	Uterine horn; measurement/endometrium sample	32	Y	-	″
Bryde's whale	WN Pacific	Collection of ovary	32	Y	-	″
Bryde's whale	WN Pacific	Photographic record of foetus	10	Y	-	″
Bryde's whale	WN Pacific	Foetal sex (identified by visual observation)	9	Y	-	″
Bryde's whale	WN Pacific	Foetal length and weight	10	Y	-	″
Bryde's whale	WN Pacific	External measurements of foetus	9	Y	-	″
Bryde's whale	WN Pacific	Foetal blubber tissues for DNA study	10	Y	-	″
Bryde's whale	WN Pacific	Foetal tissues for various analysis	9	Y	-	″
Bryde's whale	WN Pacific	Foetal lens for age determination	9	Y	-	″
Bryde's whale	WN Pacific	Testis/epididymis; weight and histological sample	18	Y	-	″
Bryde's whale	WN Pacific	Collection of plasma sample	50	Y	-	″
Bryde's whale	WN Pacific	Collection of whole blood sample	50	Y	-	″
Bryde's whale	WN Pacific	Whole blood samples from umbilical cord	8	Y	-	″
Bryde's whale	WN Pacific	Plasma samples from umbilical cord	8	Y	-	″
Bryde's whale	WN Pacific	Stomach content, conventional record	50	Y	-	″
Bryde's whale	WN Pacific	Volume and weight of stomach content in each compartment	50	Y	-	″
Bryde's whale	WN Pacific	Stomach contents for feeding study	45	Y	-	″
Bryde's whale	WN Pacific	Record of external parasites	50	Y	-	″
Bryde's whale	WN Pacific	Collection of external parasites	3	Y	-	″
Bryde's whale	WN Pacific	Record of internal parasites	50	Y	-	″
Bryde's whale	WN Pacific	Collection of internal parasites	2	Y	-	″
Bryde's whale	WN Pacific	Earplug for age determination	50	Y	-	″
Bryde's whale	WN Pacific	Tympanic bulla for age determination	50	Y	-	″
Bryde's whale	WN Pacific	Lens for age determination	50	Y	-	″
Bryde's whale	WN Pacific	Largest baleen plate for morphologic study and age determination	50	Y	-	″
Bryde's whale	WN Pacific	Baleen plate measurements (length and breadth)	49	Y	-	″
Bryde's whale	WN Pacific	Length of each baleen plate series	50	Y	-	″
Bryde's whale	WN Pacific	Vertebral epiphyses sample	50	Y	-	″
Bryde's whale	WN Pacific	Number of vertebrae	9	Y	-	″
Bryde's whale	WN Pacific	Number of ribs	50	Y	-	″
Bryde's whale	WN Pacific	Brain weight	9	Y	-	″
Bryde's whale	WN Pacific	Skull measurements (length and breadth)	46	Y	-	″
Sperm whale	WN Pacific	Body length and sex	1	Y	-	″
Sperm whale	WN Pacific	External body proportion	1	Y	-	″
Sperm whale	WN Pacific	Photographic record and external character	1	Y	-	″
Sperm whale	WN Pacific	Diatom film record	1	Y	-	″
Sperm whale	WN Pacific	Standard measurements/blubber thickness (5 pts)	1	Y	-	″
Sperm whale	WN Pacific	Detailed measurements/blubber thickness (11 pts)	1	Y	-	″
Sperm whale	WN Pacific	Body weight	1	Y	-	″
Sperm whale	WN Pacific	Body weight by parts	1	Y	-	″
Sperm whale	WN Pacific	Blubber tissues for DNA study	1	Y	-	″
Sperm whale	WN Pacific	Blubber, muscle, liver and kidney tissues for heavy metal analysis	1	Y	-	″
Sperm whale	WN Pacific	Blubber, muscle, liver and kidney tissues for organochlorines analysis	1	Y	-	″
Sperm whale	WN Pacific	Tissue for nutritional component analysis	1	Y	-	″
Sperm whale	WN Pacific	Lung tissue for chemical analysis	1	Y	-	″

Cont.

Species	Area/stock	Tissue type(s)	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
Japan cont.						
Sperm whale	WN Pacific	Tissues for lipid analysis	1	Y	-	ICR
Sperm whale	WN Pacific	Tissues for various analysis	1	Y	-	″
Sperm whale	WN Pacific	Mammary gland; lactation status, measurement and histological sample	1	Y	-	″
Sperm whale	WN Pacific	Collection of spermaceti sample	1	Y	-	″
Sperm whale	WN Pacific	Uterine horn; measurement/endometrium sample	1	Y	-	″
Sperm whale	WN Pacific	Collection of ovary	1	Y	-	″
Sperm whale	WN Pacific	Collection of plasma sample	1	Y	-	″
Sperm whale	WN Pacific	Collection of whole blood sample	1	Y	-	″
Sperm whale	WN Pacific	Stomach content, conventional record	1	Y	-	″
Sperm whale	WN Pacific	Volume and weight of stomach content in each compartment	1	Y	-	″
Sperm whale	WN Pacific	Stomach contents for feeding study	1	Y	-	″
Sperm whale	WN Pacific	Record of external parasites	1	Y	-	″
Sperm whale	WN Pacific	Record of internal parasites	1	Y	-	″
Sperm whale	WN Pacific	Collection of internal parasites	1	Y	-	″
Sperm whale	WN Pacific	Maxillary teeth for age determination	1	Y	-	″
Sperm whale	WN Pacific	Lens for age determination	1	Y	-	″
Sperm whale	WN Pacific	Vertebral epiphyses sample	1	Y	-	″
Sperm whale	WN Pacific	Number of vertebrae	1	Y	-	″
Sperm whale	WN Pacific	Number of ribs	1	Y	-	″
Sperm whale	WN Pacific	Brain weight	1	Y	-	″
Sperm whale	WN Pacific	Skull measurements (length and breadth)	1	Y	-	″
Common minke whale	WN Pacific	Body length and sex	60	Y	-	″
Common minke whale	WN Pacific	External body proportion	60	Y	-	″
Common minke whale	WN Pacific	Photographic record and external character	60	Y	-	″
Common minke whale	WN Pacific	Diatom film record	60	Y	-	″
Common minke whale	WN Pacific	Body scar record	60	Y	-	″
Common minke whale	WN Pacific	Measurements of blubber thickness (5 points)	60	Y	-	″
Common minke whale	WN Pacific	Whole body weight	60	Y	-	″
Common minke whale	WN Pacific	Skin tissues for DNA study	60	Y	-	″
Common minke whale	WN Pacific	Muscle, liver, kidney, spleen, blubber, heart and ventral groove for various analysis	60	Y	-	″
Common minke whale	WN Pacific	Urine for various analysis	14	Y	-	″
Common minke whale	WN Pacific	Muscle, liver, kidney, and blubber for heavy metal analysis	60	Y	-	″
Common minke whale	WN Pacific	Muscle, liver, kidney, and blubber for organochlorine analysis	60	Y	-	″
Common minke whale	WN Pacific	Collection of blood plasma	54	Y	-	″
Common minke whale	WN Pacific	Mammary gland; lactation status, measurement and histological sample	33	Y	-	″
Common minke whale	WN Pacific	Uterine horn; measurements/endometrium sample	33	Y	-	″
Common minke whale	WN Pacific	Collection of ovary	33	Y	-	″
Common minke whale	WN Pacific	Photographic record of foetus	1	Y	-	″
Common minke whale	WN Pacific	Foetal length and weight	1	Y	-	″
Common minke whale	WN Pacific	External measurement of foetus	1	Y	-	″
Common minke whale	WN Pacific	Collection of foetus	1	Y	-	″
Common minke whale	WN Pacific	Testis and epididymis; weight/histological sample	27	Y	-	″
Common minke whale	WN Pacific	Stomach contents, convenient record	60	Y	-	″
Common minke whale	WN Pacific	Volume and weight of stomach content in each compartment	60	Y	-	″
Common minke whale	WN Pacific	Observation of marine debris in stomach	60	Y	-	″
Common minke whale	WN Pacific	Collection of stomach contents for feeding study	55	Y	-	″
Common minke whale	WN Pacific	Record of external parasites	60	Y	-	″
Common minke whale	WN Pacific	Earplug for age determination	60	Y	-	″
Common minke whale	WN Pacific	Tympanic bulla for age determination	60	Y	-	″
Common minke whale	WN Pacific	Eye lens for age determination	5	Y	-	″
Common minke whale	WN Pacific	Largest baleen plate for morphologic study and age determination	60	Y	-	″
Common minke whale	WN Pacific	Baleen plate measurements (length and breadth)	60	Y	-	″
Common minke whale	WN Pacific	Photographic record of baleen plate series	60	Y	-	″
Common minke whale	WN Pacific	Length of baleen series	60	Y	-	″
Common minke whale	WN Pacific	Vertebral epiphyses sample	57	Y	-	″
Common minke whale	WN Pacific	Number of ribs	60	Y	-	″
Common minke whale	WN Pacific	Skull measurement (length and breadth)	55	Y	-	″
Common minke whale	WN Pacific	Body length and sex	59	Y	-	NRIFSF
Common minke whale	WN Pacific	External body proportion	59	Y	-	″
Common minke whale	WN Pacific	Photographic record and external character	59	Y	-	″
Common minke whale	WN Pacific	Diatom film record	59	Y	-	″
Common minke whale	WN Pacific	Standard measurements/blubber thickness (5 pts)	59	Y	-	″
Common minke whale	WN Pacific	Detailed measurements/blubber thickness (11 pts)	2	Y	-	″
Common minke whale	WN Pacific	Whole body weight	59	Y	-	″

Cont.

Species	Area/stock	Tissue type(s)	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
Japan cont.						
Common minke whale	WN Pacific	Body weight by parts	2	Y	-	NRIFSF
Common minke whale	WN Pacific	Skin tissues (DNA)	59	Y	-	″
Common minke whale	WN Pacific	Blubber, muscle, liver and kidney tissues (Heavy metal analysis)	59	Y	-	″
Common minke whale	WN Pacific	Blubber, muscle, liver and kidney tissues (Organochlorines analysis)	59	Y	-	″
Common minke whale	WN Pacific	Tissues for various analysis	59	Y	-	″
Common minke whale	WN Pacific	Mammary gland; lactation status, measurement and histological sample	23	Y	-	″
Common minke whale	WN Pacific	Uterine horn; measurement/endometrium sample	23	Y	-	″
Common minke whale	WN Pacific	Collection of ovary	23	Y	-	″
Common minke whale	WN Pacific	Testis and epididymis; weight/histological sample	36	Y	-	″
Common minke whale	WN Pacific	Collection of blood plasma sample	58	Y	-	″
Common minke whale	WN Pacific	Stomach content, conventional record	59	Y	-	″
Common minke whale	WN Pacific	Volume and weight of stomach content in each compartment	59	Y	-	″
Common minke whale	WN Pacific	Collection of stomach contents for feeding study	49	Y	-	″
Common minke whale	WN Pacific	Record of external parasites	59	Y	-	″
Common minke whale	WN Pacific	Earplug for age determination	58	Y	-	″
Common minke whale	WN Pacific	Tympanic bulla for age determination	59	Y	-	″
Common minke whale	WN Pacific	Eye lens for age determination	59	Y	-	″
Common minke whale	WN Pacific	Largest baleen plate for morphologic study and age determination	59	Y	-	″
Common minke whale	WN Pacific	Baleen plate measurements (length and breadth)	59	Y	-	″
Common minke whale	WN Pacific	Length of each baleen plate series	59	Y	-	″
Common minke whale	WN Pacific	Photographic record of baleen plate series	59	Y	-	″
Common minke whale	WN Pacific	Vertebral epiphyses sample	59	Y	-	″
Common minke whale	WN Pacific	Number of ribs	59	Y	-	″
Common minke whale	WN Pacific	Brain weight	2	Y	-	″
Common minke whale	WN Pacific	Skull measurement (length and breadth)	59	Y	-	″
Korea						
Common minke whale	East Sea, Korea Strait, Yellow Sea	Skin, blubber, muscle, liver, lung, intestine	54	Y	54	CRI/NFRDI
Killer whale	East Sea	Skin, blubber, muscle, liver, lung, intestine	1	Y	1	″
Long-beaked common dolphin	East Sea	Skin, blubber, muscle, liver, lung, intestine	19	Y	19	″
Mexico						
Common bottlenose dolphin	Banderas Bay/ N Pacific	Skin	1	Y	1	R. Moncada/ITBB
Norway						
Minke whale	N. Altlantic	Tissue materials for DNA studies	485	In prog.	-	IMR
Minke whale	North Sea	Blubber for nutritive status	1	Y	-	IMR
Minke whale	N. Atlantic	Brain for hypoxia study	3	In prog.	-	T. Burmester/Univ. Hamburg; A. Jøssund/UIT-AAB
Sweden						
Harbour porpoise	The Kattegatt	Several	1	Y	0	A. Roos/SMNH
USA						
Harbour porpoise	N Atlantic	Skin	14	Y	Unk	F. Wenzel/NEFSC
Harbour porpoise	N Atlantic	Head	2	Y	Unk	″
Harbour porpoise	N Atlantic	Whole	8	Y	Unk	″
Harbour porpoise	N Atlantic	Blubber	3	Y	Unk	″
Common dolphin	N Atlantic	Skin	3	Y	Unk	″
Common dolphin	N Atlantic	Head	1	Y	Unk	″
Pilot whale spp.	N Atlantic	Skin	2	Y	Unk	″
Atlantic white-sided dolphin	N Atlantic	Muscle	1	Y	Unk	″
Atlantic white-sided dolphin	N Atlantic	Skin	5	Y	Unk	″
Atlantic white-sided dolphin	N Atlantic	Blubber	5	Y	Unk	″
Atlantic white-sided dolphin	N Atlantic	Whole	2	Y	Unk	″
Atlantic white-sided dolphin	N Atlantic	Head	1	Y	Unk	″
Short-beaked common dolphin	EN Pacific	Skin, blubber, muscle, gonads, teeth, head	6	Y	6	K. Danil/SWFSC
Short-beaked common dolphin	EN Pacific	Skin, blubber	2	Y	2	″

Cont.

Species	Area/stock	Tissue type(s)	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
USA cont.						
Northern right whale dolphin	EN Pacific	Skin, blubber, muscle, gonads, teeth, head	1	Y	1	K. Danil/SWFSC
Pacific white-sided dolphin	EN Pacific	Skin, blubber, muscle, gonads, teeth, head	1	Y	1	″

Australia: The list includes: 1. Entanglement probable - for example, animals with net marks/injuries and/or that have had flippers or flukes removed, and full stomachs and sometimes food in the oesophagus, suggesting a sudden death; 2. Entangled in tuna farm anti-predator net; 3. Entanglement in other types of net or line; 4. Accidental or intentional injury by humans. Genetic tissues includes: blood, liver, kidney, muscle, skin, toxic contaminants include: liver, kidney, muscle, blubber. Complete sets of tissue samples were not collected from all animals because in some cases the state of decomposition made this inappropriate.
France: *Typically: skin, blubber, teeth, stomach, muscle, kidney, liver, gonads.
Japan: *All samples and data are currently under analysis.

SAMPLES FROM STRANDED ANIMALS

Species	Area/stock	Tissue type(s)*	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
Argentina						
Southern right whale	SW Atlantic, N Patagonia	Baleen	94	Y	In prog.	M. Uhart/Wildlife Conservation Society *muhart@wcs.org*
Southern right whale	SW Atl./N Pat.	Spleen	6	Y	In prog.	V. Rowntree/ICB-WCI/OA;
Southern right whale	SW Atl./N Pat.	Intestinal content	42	Y	In prog.	University of Utah
Southern right whale	SW Atl./N Pat.	Stomach content	10	Y	In prog.	*rowntree@biology.utah.edu*
Southern right whale	SW Atl./N Pat.	Heart	1	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Brain	8	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Epididymus	2	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Stomach	16	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Fat	144	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Mesenteric glands	1	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Liver	67	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Aqueous humour	4	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Intestines	22	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Milk	12	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Skin wounds	62	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Faeces from live whales	4	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Faeces	62	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Muscle	20	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Bone marrow	31	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Urine	38	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Eyes	10	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Ovary	3	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Skin	136	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Lung	30	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Kidney	75	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Blood smears	4	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Blood cells	12	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Blood spotcards	17	Y	In prog.	″
Southern right whale	SW Atl./N Pat.	Serum	29	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	Spleen	10	Y	In prog.	*muhart@wcs.org*
Pilot whale	SW Atl./N Pat.	Umbilical cord	2	Y	In prog.	*rowntree@biology.utah.edu*
Pilot whale	SW Atl./N Pat.	Brain	13	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	Stomach	2	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	Gonad	1	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	Liver	12	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	Intestines	6	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	Faeces	7	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	Urine	11	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	Parasites	1 vial	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	Kidney	10	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	Blood spotcards	2	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	Content of abdominal cavity	1	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	Cervix swab	1	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	Amniotic liquid	1	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	Uterine mucus	2	Y	In prog.	″
Pilot whale	SW Atl./N Pat.	lung	9	Y	In prog.	″
Franciscana	Coastal B. Aires	Muscle, teeth, skeleton	8	Y	0	P. Bordino/AquaMarina-CECIM
Burmeister's porpoise	Coastal B. Aires	Muscle, teeth, skeleton	2	Y	0	″
Southern bottlenose whale	Los Pocitos, Buenos Aires	Muscle, skin, stomach, kidney, liver, lung, gonads, blubber, teeth, skeleton	1	Y	0	″

Cont.

Species	Area/stock	Tissue type(s)*	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
Argentina cont.						
Minke whale	San Clemente, Buenos Aires	Muscle, skin, blubber, skeleton	1	Y	0	P. Bordino/AquaMarina-CECIM
Commerson's dolphins	SW S Atlantic	All types	21	Y	0	AMMA
Southern right whale dolphin	SW S Atlantic	Skin, bones	1	Y	0	″
Spectacled porpoise	SW S Atlantic	Skin, blubber, skeletal material	6	Y	0	″
Layard's beaked whale	SW S Atlantic	All types	1	Y	0	″
Southern right whale	SW Atlantic	Skin	-	-	-	NEA
Pilot whale	Caleta Malaspina, Chubut	Kidney, liver, spleen, lung, brain, gonads, intestinal contents, urine, parasites	6	-	-	SRWHMP
Australia						
Australian snubfin dolphin	Sir Edward Pellew Is. NT	Skin	1	Y	-	R. Chatto/NRETAS; G. Parra/SARTI SA
Blainville's beaked whale	Birdie Beach, NSW	Skull, skeleton, muscle tissue	1	Y	-	S. Ingleby/Australian Museum
Blue whale (washed up 08/04/09)	Bass Strait, VIC	Skin, blubber, eye, intestinal contents, muscle, bone fragment from injured area, sample from possible foetus	2	Y	1 skin sample in prog.	D. Donnelly/DRI. Samples sent to and stored at Melbourne Museum C. Attard/MU (skin sample analysis)
Pygmy blue whale	Rye Back Beach, VIC	Muscle	1	Y	0	R. O'Brien/MV
Indo-Pacific bottlenose dolphin	Northern NSW	Skin, teeth	1	Y	0	C. Fury/SCU
Indo-Pacific bottlenose dolphin	SA	Genetic tissues, reproductives, stomach/intestines, toxic contaminants*[1]	9	Y	0	C. Kemper/SAM
Bottlenose dolphin	Moreton Bay, QLD	Skin	3	-	-	J. Lanyon/UQ
Bottlenose dolphin	Portland Harbour, VIC	Muscle	1	Y	0	R. O'Brien/MV
Bottlenose dolphin	Gippsland Lakes, Jubilee Head, VIC	Muscle	1	Y	0	″
Bottlenose dolphin (Stranding 22/02/09)	Coastal Victoria, Apollo Bay, VIC	Skin, blubber, kidney, liver, melon	2	Y	In prog.	K. Charlton-Robb/DRI; Monash
Bottlenose dolphin (01/07/09)	Coastal Victoria, Portland , VIC	Brain, liver, kidney, teeth, blubber, skin	1	Y	In prog.	A. Monk/DRI/Monash
Bottlenose dolphin (Stranded 16/08/09)	Gippsland Lakes, Jubilee Pt, VIC	Skin, blubber, left pectoral	1	Y	In prog.	K. Charlton-Robb/DRI; Monash
Bottlenose dolphin (Stranding 2/10/09)	Gippsland Lakes Bunga Arm, VIC	Skin, blubber	Unknown	Not yet	Will be analysed	″ (Samples currently with DSE Barnesdale)
Bottlenose dolphin	Bunbury, WA	Skin, blubber (10), teeth (6) organs: liver, kidneys, lung, heart, gonads (3) stomach (5) Histology/pathology complete. Genetic analysis pending	10	Y	3 (PM)	N. Stephens (pathology); L. Bejder (genetics)/MU; H. Smith (teeth histology)/MU
Bottlenose dolphin	Claisebrook Cove, Windan Brg, Swan River, WA	Pathology work undertaken	1	-	-	D. Coughran/DEC
Bottlenose dolphin	Belvidere Conservation Park, WA	DNA	1	-	-	″
Bottlenose dolphin	SA	Genetic tissues, reproductives, stomach/intestines, toxic contaminants [1]	1	Y	0	C. Kemper/SAM
Common bottlenose dolphin	SA	Genetic tissues, reproductives, stomach and intestines, toxic contaminants [1]	1	Y	0	″
Bottlenose dolphin (W2141)	Sunshine Coast, QLD	Necropsy conducted	1	-	-	Australian Wildlife Hospital
Bottlenose dolphin (W2171)	Moore Park, QLD	Skin	1	-	-	C. Limpus/DERM,
Bottlenose dolphin	Bass Strait, TAS	Skin, blubber, teeth	2	Y	-	R. Gales/DPIPWE
Bottlenose dolphin	NSW	Skull and frozen muscle tissue	1	Y	-	S. Ingleby/Australian Museum
Short-beaked common dolphin	SA	Genetic tissues, reproductives, stomach and intestines, toxic contaminants [1]	8	Y	0	C. Kemper/SAM
Cuvier's beaked whale	Resolute Beach, Pittwater, NSW	Skulls	2	Y	-	S. Ingleby/Australian Museum

Cont.

Species	Area/stock	Tissue type(s)*	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
Australia cont.						
False killer whale (2228)	Sunshine Coast, QLD	Autopsy	1	-	-	Australian Wildlife Hospital
Ginko-toothed beaked whale	Wairo Beach, NSW	Skull, skeleton, frozen muscle tissue	1	Y	-	S. Ingleby/Australian Museum
Gray's beaked whale	TAS	Blubber, muscle, skin, stomach, dorsal fin	Blubber 4, muscle 2, skin 6, stomach 2, dorsal fin 2	Y	-	R. Gales/DPIPWE
Hector's beaked whale	Walpole, WA	DNA	1	-	-	D. Coughran/DEC
Humpback whale	WA	Skin	1	-	-	″
Humpback whale	SA	Some genetic issues [1]	1	N	0	C. Kemper/SAM
Humpback whale	Gold Coast, QLD	Skin	1	-	-	S. Bengton-Nash/UQ
Humpback whale (W2143)	Gold Coast, QLD	Blubber, baleen	1	-	-	D. Blyde; C. Limpus/DERM,
Humpback whale (W2144)	Sunshine Coast, QLD	Blubber, skin, baleen	1	-	-	C. Limpus/DERM,
Humpback whale	TAS	Skin	2	Y	-	R. Gales/DPIPWE
Indo-Pacific humpback dolphin (W2191)	Sunshine Coast, QLD	Necropsy conducted	1	-	-	Australian Wildlife Hospital
Indo-Pacific humpback dolphin (W2175)	Moore Park, QLD	Skin, organs, brain, stomach contents	1	-	-	C. Limpus/DERM,
Indo-Pacific humpback dolphin W2177	Moreton Is. QLD	Skin, blubber	1	-	-	″
Indo-Pacific humpback dolphin W2214	Moreton Bay, QLD	Skin, blubber	1	-	-	″
Long-finned pilot whale	Potter's Hill Beach, VIC	Muscle	1	Y	0	R. O'Brien/MV
Long-finned pilot whale	Kilcunda Beach, VIC	Muscle	1	Y	0	″
Long-finned pilot whale	Williamson's Beach, VIC	Muscle	1	Y	0	″
Long-finned pilot whale	Express Point, VIC	Muscle	1	Y	0	″
Long-finned pilot whale	Dimmick's Beach, VIC	Muscle	1	Y	0	″
Long-finned pilot whale	Augusta WA, Hamelin Bay	Skin, blubber	50 dead, 11 alive,	Y	0	D. Coughran/DEC; P. Spencer/MU
Long-finned pilot whale	WA	DNA sample	-	-	-	D. Coughran
Long-finned pilot whale (wash-ups from King Is. TAS mass stranding?)	Bass Strait, VIC	Blubber, skin, teeth	3	Y	0	Collected by D. Donnelly/DRI. Samples sent to/stored at Melbourne Museum
Long-finned pilot whale	Bass Strait, TAS	Skin, blubber, teeth, stomach	Skin 5, blubber 116, teeth 101, stomach 7	Y	-	R. Gales/DPIPWE
Short-finned Pilot whale, (W2127)	Fraser Island, QLD	Skin	1	-	-	C. Limpus/DERM
Pygmy killer whale	NSW Racecourse Beach, Ulladulla,	-	1	Y	-	S. Ingleby/Australian Museum
Pygmy right whale	SA	Genetic tissues, reproductives, stomach and intestines, toxic contaminants [1]	1	Y	0	C. Kemper/SAM
Pygmy right whale	TAS	Blubber, skin, stomach, muscle	Blubber 1, skin 1, stomach 1, muscle 1	Y	-	R. Gales/DPIPWE
Risso's dolphin	Leschenault Est. Bunbury, WA	Skin, blubber	1	Y	1	D. Coughran/DEC; P. Spencer/MU
Risso's dolphin	WA	DNA sample	1	-	-	D. Coughran/DEC
Sperm whale	Nelson, VIC	Muscle	1	Y	0	R. O'Brien/MV
Sperm whale (W2138)	Moreton Bay, QLD	Skin, vertebrae	1		-	S. van Dyck/QM; C. Limpus/DERM,
Sperm whale	TAS	Jaws, skin, blubber, muscle, stomach	Jaws 37, skin 47, blubber 39, muscle 30, stomach 5	Y	-	R. Gales/DPIPWE
Strap-toothed beaked whale	Warnbro Sound, WA	Skin	1	-	-	D. Coughran/DEC
Striped dolphin	NSW	Skull and frozen muscle tissue	1	Y	-	S. Ingleby/Australian Museum

Cont.

Species	Area/stock	Tissue type(s)*	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
Australia cont.						
Striped dolphin	TAS	Skin, blubber, stomach	Skin 1, blubber 1, stomach 1	Y	-	R. Gales/DPIPWE
Belgium						
Harbour porpoise	NE Atlantic	All relevant tissues, depending on state of decompositon	*ca* 45 animals	Y	Some analysed, rest in tissue bank	T. Jauniaux/ULg
Striped dolphin	NE Atlantic	All relevant tissues	1 animal	Y	-	″
Brazil						
Guiana dolphin	RJ	Kidney, liver, lung, muscle, stomach, intestine, heart, blubber, skin	10	Y	-	J. Lailson-Brito; A. Azevedo/UERJ
Rough-toothed dolphin	RJ	Kidney, liver, lung, muscle, stomach, intestine, heart, blubber, skin	1	Y	-	″
Humpback whale	RJ	Blubber, skin	1	N	-	-
Humpback whale	Bahia and Espirito Santo States (BSA)	Skin, blubber, lung, intestine, stomach, heart, liver, blood, kidney, bones	22	Y	2	M. Marcondes/IBJ
Guiana dolphin	Bahia and Espirito Santo	Skin, blubber, liver, kidney and bones	6	Y	0	″
Dwarf minke whale	Bahia State	Bones	2	Y	0	″
Sperm whale	Bahia State	Skin, stomach	1	N	0	″
Melon-headed whale	Bahia State	Bones, skin, blubber, ovaries, stomach	1	Y	0	″
Franciscana	Litoral norte de Santa Catarina	Bones, skin, blubber, ovaries, stomach	4	Y	0	M.J. Cremer/UNIVILLE
Guiana dolphin	Litoral norte de Santa Catarina	Bones, skin, blubber, ovaries, stomach	1	Y	0	″
Bottlenose dolphin	Litoral norte de Santa Catarina	Bones, skin, blubber, ovaries, stomach	1	Y	0	″
Guiana dolphin	CE	Stomach contents	7	Y	0	A.C. Meirelles/Aquasis
Guiana dolphin	CE	Muscle	14	Y	7	″
Guiana dolphin	CE	Skeleton	14	Y	0	″
Guiana dolphin	CE	Heart, lung, liver, testicles	1	Y	0	″
Sperm whale	CE	Muscle, blubber	3	Y	0	″
Sperm whale	CE	Liver, kidney	1	Y	0	″
Short-finned pilot whale	CE	Skin, muscle, skeleton, lung, pancreas, heart, stomach, intestine, liver, bladder, spleen, kidney, testicles	1	Y	1	″
Rissos's dolphin	CE	Skin	1	Y	0	″
Humpback whale	CE	Muscle, skin, stomach, intestine, spleen, kidney, ovary, uterus, blubber	1	Y	1	″
Dwarf sperm whale	CE	-	-	Y	1	″
Pygmy sperm whale	CE	Muscle, skeleton, spleen, heart, lung, testicles, kidney, blubber	1	Y	1	″
Fraser's dolphin	CE	Muscle, skin, skeleton	1	Y	1	″
Atlantic spotted dolphin	CE	Skin	-	Y	1	″
Clymene dolphin	CE	Muscle, skeleton, heart, lung, intestine, pancreas, liver, spleen, kidney, bladder, ovaries, uterus,	-	-	-	″
Cuvier's beaked whale	CE	Skeleton	-	Y	1	″
Sperm whale	RN	Tooth, bones	1	Y	-	F.J. Lima Silva/PCCB-UERN
Guiana dolphin	RN	Skeleton, blubber, muscle, bones, stomach, teeth, flippers	11	Y	-	″
Spinner dolphin	RN	Skeleton, blubber, muscle, bones, teeth, ovaries, stomach	1	Y	-	″
Franciscana	S Brazil	Skull, teeth, stomach, gonads, liver, kidney, blubber, muscle	61	Y	> 100	P.H. Ott; I.B. Moreno/GEMARS
Baleen whale	S Brazil	Skull, baleen	2	Y	-	″
Bottlenose dolphin	S Brazil	Skull, teeth, stomach, muscle	2	Y	> 50	″
Rough-toothed dolphin	S Brazil	Skull, teeth, skeleton, gonads, stomach, blubber, muscle	2	Y	> 10	″
Kogia sp.	S Brazil	Skull, teeth, skeleton, stomach, intestine, gonads, blubber, muscle	1	Y	-	″
Sperm whale	S Brazil	Teeth, muscle	1	Y	-	″

Cont.

Species	Area/stock	Tissue type(s)*	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
Brazil cont.						
Striped dolphin	S Brazil	Skull, teeth, skeleton, stomach, muscle	1	Y	-	P.H. Ott; I.B. Moreno/GEMARS
False killer whale	S Brazil	Skull, teeth, skeleton, stomach, muscle	1	Y	-	″
Stenella sp.	S Brazil	Skull, teeth, skeleton, muscle	1	Y	-	″
Franciscana	PR	Skin, blubber, muscle, teeth, liver, kidney, stomach, skull	1	Y	-	C. Domit/LEC/CEM/UFPR
Guiana dolphin	PR	Skin, blubber, muscle, teeth, liver, gonads, kidney, stomach, skull	27	Y	-	″
Rough-toothed dolphin	PR	Teeth, skull	1	Y	-	″
Atlantic spotted dolphin	PR	Skin, blubber, muscle, teeth, liver, gonads, kidney, stomach, skull	3	Y	-	″
Common bottlenose dolphin	PR	Skin, blubber, muscle, teeth, liver, gonads, kidney, stomach, skull	2	Y	-	″
Mysticeti	PR	Skin, blubber, muscle	1	Y	-	″
Humpback whale	ES	Blubber, muscle	1	Y	0	L. Barbosa/Instituto ORCA
Guiana dolphin	ES	Skin, blubber, lung, intestine, pancreas, stomach, heart, liver, kidney, bones, muscle, gastric juice	16	Y	0	″
Franciscana	ES	Skin, blubber, lung, intestine, pancreas, stomach, heart, liver, kidney, bones, muscle	2	Y	0	″
Bottlenose dolphin	ES	Skin, blubber, lung, intestine, pancreas, stomach, heart, liver, kidney, bones, muscle, gastric juice	1	Y	0	″
Rough-toothed dolphin	ES	Skin, blubber, lung, intestine, pancreas, stomach, heart, liver, kidney, bones, muscle	2	Y	0	″
Pantropical spotted dolphin	ES	Skin, blubber, lung, intestine, pancreas, stomach, heart, liver, kidney, bones, muscle	1	Y	0	″
Cuvier's beaked whale	ES	Skin, blubber, muscle	1	N	0	″
Sperm whale	S Atlantic	Teeth	1	Y	0	L.R. Alardo Souto/IMA
Pygmy sperm whale	S Atlantic	Skeleton, muscle, skin, blubber	1	Y	1	″
Dwarf sperm whale	S Atlantic	Skeleton, muscle, skin, blubber	1	Y	1	″
Cuvier's beaked whale	S Atlantic	Skeleton, parasites, stomach contents, skin, foetus, muscle	1	Y	1	″
Bottlenose dolphin	S Atlantic	Skeleton, stomach contents, skin, muscle	1	Y	1	″
Rough-toothed dolphin	S Atlantic	Skeleton, parasites, eyes, thymus, pancreas, thyroid, tongue, oesophagus, stomach contents, kidney, testis, bladder, adrenal, penis, liver, lungs, trachea, intestine	2	Y	2	″
Clymene dolphin	S Atlantic	Skeleton, muscle, skin, bubbler, stomach contents, oropharynx, oesophagus, eyes, pancreas, liver, kidney, ovary, uterine horn, adrenal glands, heart, lungs, trachea, parasites	6	Y	6	″
Guiana dolphin	S Atlantic	Skeleton, muscle, skin, bubbler, parasites, lungs, pancreas, ovary	15	Y	11	″
Chile						
Commerson's dolphin	Magellan Strait	Skin	2	Y	0	C. Olavarria/CEQUA
Croatia						
Common bottlenose dolphin	Adriatic Sea	Skin, blubber, muscle, kidney, liver, spleen, lung	7	Y	-	H. Gomerčić/VEF
Denmark						
Harbour porpoise	Denmark	Tissue samples	15	-	-	Fisheries/Maritime Museum, Esbjerg
White-beaked dolphin	Denmark	Tissue samples	5	-	-	″
Killer whale	Denmark	Tissue samples	1	-	-	″
Minke whale	Denmark	Tissue samples	1	-	-	″

Cont.

Species	Area/stock	Tissue type(s)*	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
France						
Cetaceans	Brittany	Various*	38	Y	In prog.	S. Hassani/LEMM
Cetaceans[$]	Bay of Biscay/ Channel/NE Atlantic	Various*	123[$]	Y	In prog.	W. Dabin/CRMM/ULR
Cetaceans	Mediterranean	Various*	150 [$$]	Y	In prog.	F. Dhermain; F. Dupraz/GECEM
Cetaceans[§]	Guadeloupe/ Caribbean	Various*	4[§]	Y	In prog.	C. and R. Rinaldi/AET[§]
Cetaceans[µ]	Martinique/ Caribbean	Various*	10[µ]	N	In prog.	S. Jérémie/SEPANMAR
Humpback whale	Réunion	Bone, blubber	4	N	-	C. Jammes/GLOBICE
Cetaceans#	New Caledonia Pacific Ocean	Various**	4	Y	-	C. Garrigue/OCNC
Germany						
Harbour porpoise	N Sea/Schleswig-Holstein	Tissues for histo-pathology, toxicology, genetics	145	-	-	U. Siebert
Harbour porpoise	Lower Saxony	Lung, liver, different tissues	38	-	-	M. Stede; M. Ramdohr
Harbour porpoise	Baltic Sea/ Schleswig-Holstein	Tissues for histo-pathology, toxicology, genetics	110	-	-	U. Siebert
Harbour porpoise	Baltic Sea/ Meckl.-Prep.	Skeleton, various tissues	47	12	-	H. Benke
Sowerby's beaked whale	North Schleswig-Holstein	Different tissues for toxicology, genetics, skeleton	1	1	-	U. Siebert
Iceland						
Sperm whale	N Atlantic	Skin, blubber, muscle	3	Y	0	MRI
Humpback whale	N Atlantic	Skin, blubber, muscle	1	Y	0	″
Ireland						
Sowerby's beaked whale	Irish coast	Skin	2	Y	0	R. Carden/NMI
Risso's dolphin	Irish coast	Skin	1	Y	0	″
Bottlenose dolphin	Irish coast	Skin	6	Y	0	″
Minke whale	Irish coast	Skin	4	Y	0	″
Northern bottlenose whale	Irish coast	Skin	4	Y	0	″
Sperm whale	Irish coast	Skin	1	Y	0	″
Common dolphin	Irish coast	Skin	4	Y	0	″
Pygmy sperm whale	Irish coast	Skin, blubber etc	1	Y	0	E. Rogan/UCC; R. Carden/NMI
Harbour porpoise	Irish coast	Skin	6	Y	0	R. Carden/NMI
Long-finned pilot whale	Irish coast	Skin	1	Y	0	″
Striped dolphin	Irish coast	Skin	6	Y	0	″
Atlantic white-sided dolphin	Irish coast	Skin	1	Y	0	″
True's beaked whale	Irish coast	Skin	1	Y	0	″
Unid. dolphin species	Irish coast	Skin	4	Y	0	″
Unid. whale species	Irish coast	Skin	4	Y	0	″
Italy						
Sperm whale	Adriatic Sea	I	7	Y	3	M. Giurisato/UNIPD - SperiVET
Sperm whale	Adriatic Sea	I	7	Y	7	LB-DSA-US
Sperm whale	Adriatic Sea	II	3	Y	3	GDG/UT-FVM-DCBS
Cuvier's beaked whale	Ligurian Sea	III	19	Y	n/a	M. Wurtz/DIBIOGE
Common bottlenose dolphin	NW Greece, Amvrakikos Gulf	IV	1	Y	0	TRI; K. Viaud-Martinez; A.J. Bohonak/San Diego State University
Common bottlenose dolphin	Tyrrhenian Sea	V	2	Y	1	LB-DSA-US
Common bottlenose dolphin	Ligurian Sea	VI	27	Y	n/a	M. Wurtz/DIBIOGE
Common bottlenose dolphin	Adriatic Sea, Tyrrhenian Sea	VII	3	Y	3	GDG/UT-FVM-DCBS
Common bottlenose dolphin	Adriatic Sea, Ligurian Sea	I	6	Y	5	M. Giurisato/UNIPD - SperiVET
Striped dolphin	Ligurian Sea, Tyrrhenian Sea	I	5	Y	3	″
Striped dolphin	Tyrrhenian Sea	V	3	Y	3	LB-DSA-US, ISPRA, DIP III CRA 15/Lauriano
Striped dolphin	Ionian Sea, Tyrrhenian Sea	VIII	7	Y	7	GDG/UT-FVM-DCBS
Striped dolphin	Ligurian Sea	Skull	1	Y	0	M. Podestà/MSNM
Striped dolphin	Ligurian Sea	IX	15	Y	n/a	M. Wurtz/DIBIOGE
Japan						
Common minke whale	Okhotsk Sea	Skin and/or muscle	1	Y	-	H. Ishikawa/ICR
Sperm whale	WN Pacific	Skin and/or muscle	1	Y	-	″
Humpback whale	WN Pacific	Skin and/or muscle	1	Y	-	″
Common minke whale	East China Sea	Skin and/or muscle	2	Y	-	″

Cont.

Species	Area/stock	Tissue type(s)*	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
Korea						
Sperm whale	Yellow Sea	Skin, blubber	1	Y	1	CRI/NFRDI
Melon-headed whale	East Sea	Skin, blubber, skeleton	1	Y	1	″
Finless porpoise	Korea Strait	Whole carcases	3	Y	0	″
Mexico						
Common bottlenose dolphin	Banderas Bay/ N Pacific	Skin	1	Y	1	R. Moncada/ITBB
Netherlands						
Harbour porpoise	North Sea	Organs/tissues with pathologic changes; gastric contents; liver, fat/muscle; skin; teeth	92	Y	92	A. Groene/Department of Pathobiology, University of Utrecht
New Zealand						
Hector's dolphin	-	Formalin fixed	12	Y	In prog.	W. Roe/Massey University
Hector's dolphin	-	Frozen tissues	12	Y	In prog.	″
Sperm whale	NZ	Skin, blubber	2	Y	0	E. Beatson/AUT
Sperm whale	NZ	Stomach	1	Y	0	″
Sperm whale	NZ	Muscle	1	Y	0	″
Pygmy sperm whale	NZ	Skin, blubber	2	Y	0	″
Pygmy sperm whale	NZ	Stomach	3	Y	0	″
Pygmy sperm whale	NZ	Muscle	2	Y	0	″
Pygmy sperm whale	NZ	Liver	2	Y	0	″
Pygmy sperm whale	NZ	Kidney	2	Y	0	″
Long-finned pilot whale	NZ	Skin, blubber	101	Y	0	″
Long-finned pilot whale	NZ	Stomach	86	Y	0	″
Long-finned pilot whale	NZ	Muscle	88	Y	0	″
Long-finned pilot whale	NZ	Liver	63	Y	0	″
Long-finned pilot whale	NZ	Kidney	35	Y	0	″
Long-finned pilot whale	NZ	Reproductive	35	Y	0	″
Long-finned pilot whale	NZ	Teeth	99	Y	0	″
Cuvier's beaked whale	NZ	Stomach	1	Y	0	″
Gray's beaked whale	NZ	Skin, blubber	3	Y	0	″
Gray's beaked whale	NZ	Stomach	2	Y	0	″
Gray's beaked whale	NZ	Muscle	3	Y	0	″
Gray's beaked whale	NZ	Liver	3	Y	0	″
Gray's beaked whale	NZ	Kidney	2	Y	0	″
Gray's beaked whale	NZ	Reproductive	2	Y	0	″
Unidentified beaked whale	NZ	Skin, blubber	1	Y	0	″
Unidentified beaked whale	NZ	Stomach	1	Y	0	″
Unidentified beaked whale	NZ	Muscle	1	Y	0	″
Unidentified beaked whale	NZ	Liver	1	Y	0	″
Unidentified beaked whale	NZ	Kidney	1	Y	0	″
Unidentified beaked whale	NZ	Reproductive	1	Y	0	″
Hector's dolphin	NZ	Stomach	5	Y	5	″
Common dolphin	NZ	Skull	14	Y	In prog.	K. Stockin/MU-A
Common dolphin	NZ	Skin, blubber	17	Y	In prog.	″
Common dolphin	NZ	Liver, kidney	14	Y	In prog.	″
Common dolphin	NZ	Teeth	12	Y	12	″
Common dolphin	NZ	Stomach	13	Y	In prog.	″
Common dolphin	NZ	Repro tissues	12	Y	12	″
Common dolphin	NZ	Fixed tissues	7	Y	7	″
Common dolphin	NZ	Pectoral fin	14	Y	In prog.	″
Bottlenose dolphin	NZ	Skull	3	Y	In prog.	″
Bottlenose dolphin	NZ	Skin, blubber	3	Y	In prog.	″
Bottlenose dolphin	NZ	Liver, kidney	14	Y	In prog.	″
Bottlenose dolphin	NZ	Teeth	2	Y	In prog.	″
Bottlenose dolphin	NZ	Stomach	3	Y	In prog.	″
Bottlenose dolphin	NZ	Reproductive	3	Y	In prog.	″
Bottlenose dolphin	NZ	Fixed tissues	2	Y	2	″
Bottlenose dolphin	NZ	Pectoral fin	3	Y	3	″
Pygmy sperm whale	NZ	Skull	3	Y	In prog.	″
Pygmy sperm whale	NZ	Skin, blubber	3	Y	In prog.	″
Pygmy sperm whale	NZ	Liver, kidney	1	3	Y	″
Pygmy sperm whale	NZ	Teeth	1	Y	In prog.	″
Pygmy sperm whale	NZ	Stomach	3	Y	In prog.	″
Pygmy sperm whale	NZ	Reproductive	3	Y	In prog.	″
Pygmy sperm whale	NZ	Fixed tissues	3	Y	In prog.	″
Pygmy sperm whale	NZ	Pectoral fin	3	Y	In prog.	″
Long-finned pilot whale	NZ	Fixed tissues	1	Y	In prog.	″
Long-finned pilot whale	NZ	Skin, blubber	2	Y	In prog.	″
Long-finned pilot whale	NZ	Liver, kidney	2	Y	In prog.	″
Long-finned pilot whale	NZ	Pectoral fin	2	Y	In prog.	″
Long-finned pilot whale	NZ	Skull	2	Y	In prog.	″
Long-finned pilot whale	NZ	Pectoral fin	2	Y	In prog.	″

Cont.

Species	Area/stock	Tissue type(s)*	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
New Zealand cont.						
Humpback whale	NZ	Skin	2	Y	3	R. Constantine; C.S. Baker/UA
Sperm whale	NZ	Skin	3	Y	0	″
Blue whale	NZ	Skin	2	Y	2	″
Bryde's whale	NZ	Skin	1	Y	1	″
Minke whale	NZ	Skin	3	Y	0	″
Strap-toothed whale	NZ	Skin	1	Y	0	″
Shepherd's beaked whale	NZ	Skin	1	Y	0	″
Cuvier's beaked whale	NZ	Skin	4	Y	0	″
Gray's beaked whale	NZ	Skin	8	Y	0	″
Pygmy sperm whale	NZ	Skin	8	Y	0	″
Pilot whale	NZ	Skin	139	Y	0	″
Killer whale	NZ	Skin	1	Y	0	″
Dusky dolphin	NZ	Skin	3	Y	0	″
Bottlenose dolphin	NZ	Skin	4	Y	0	″
Common dolphin	NZ	Skin	16	Y	0	″
Hector's dolphin	NZ	Skin	5	Y	0	″
Unknown species	NZ	Skin	9	y	0	″
Spain						
Common dolphin	Canary Islands	Full necropsy/skin, blubber, muscle, liver, kidney, skeleton	1+1	Y	-	A. Fernández/ULPGC; M. Carrillo/ TENECON
Common dolphin	Southern Spain	Full necropsy	13	Y	13	*eduardo.fernandez.tabales@jutandean dalucia.es* /CMA
Striped dolphin	Canary Islands	Full necropsy/skin, blubber, muscle, kidney, liver, skeleton	9+1	Y	-	A. Fernández/ULPGC; M. Carrillo/ TENECON
Striped dolphin	Spanish Med.	Full necropsy/skin	8+1	Y	7	*Toni.raga@uv.es*
Striped dolphin	Southern Spain	Full necropsy	29	Y	29	*eduardo.fernandez.tabales@jutandean dalucia.es* /CMA
Atlantic spotted dolphin	Canary Islands	Full necropsy/skin, blubber, muscle, kidney, liver, skeleton	1+1	Y	-	A. Fernández/ULPGC; M. Carrillo/ TENECON
Harbour porpoise	Southern Spain	Full necropsy	1	Y	1	*eduardo.fernandez.tabales@jutandean dalucia.es* /CMA
Bottlenose dolphin	Canary Islands	Full necropsy/skin, blubber, muscle, kidney, liver, skeleton	1+2	Y	-	A. Fernández/ULPGC; M. Carrillo/ TENECON
Rough-toothed dolphin	Canary Islands	Full necropsy	1	Y	-	A. Fernández/ULPGC
Risso's dolphin	Canary Islands	Full necropsy	1	Y	-	″
Risso's dolphin	Southern Spain	Full necropsy	1	Y	1	*eduardo.fernandez.tabales@jutandean dalucia.es* /CMA
Short-finned pilot whale	Canary Islands	Full necropsy/skin, blubber, muscle, kidney, liver, teeth, skeleton	5+2	Y	-	A. Fernández/ULPGC; M. Carrillo/ TENECON
Long-finned pilot whale	Southern Spain	Full necropsy	2	Y	2	*eduardo.fernandez.tabales@jutandean dalucia.es* /CMA
Cuvier's beaked whale	Canary Islands	Partial necropsy/skin, skeleton	1+ 2	Y	-	A. Fernández/ULPGC; M. Carrillo/ TENECON
Pygmy sperm whale	Southern Spain	Full necropsy	1	Y	1	*eduardo.fernandez.tabales@jutandean dalucia.es* /CMA
Sperm whale	Canary Islands	Partial necropsy/skin, blubber, muscle, kidney, liver, skeleton	4+3	Y		A. Fernández/ULPGC; M. Carrillo/ TENECON
Sperm whale	Spanish Med.	Skin, teeth	1	Y	0	*Toni.raga@uv.es*
Minke whale	Canary Islands	Full necropsy	2	Y	-	A. Fernández/ULPGC
Fin whale	Spanish Med.	Skin, baleen plates	1	Y	0	*Toni.raga@uv.es*
Sweden						
Harbour porpoise	The Kattegatt	Several	1	Y	0	A. Roos/SMNH
Harbour porpoise	The Skagerrak	Several (probably killed by a boat propeller)	1	Y	0	″
Harbour porpoise	The Skagerrak	Several	1	Y	0	″
Harbour porpoise	Öresund	Several	3	Y	0	″
Harbour porpoise	The Baltic	Several	2	Y	0	″
UK						
Harbour porpoise	UK	Various	55	Y	n/a	R. Deaville/IoZ; B. Reid/SACVSD; R. Penrose/MEM
Harbour porpoise	UK	Skull	44	Y	0	J. Herman/NMS
Short-beaked common dolphin	UK	Various	15	Y	n/a	R. Deaville/IoZ; B. Reid/SACVSD
Short-beaked common dolphin	UK	Skull	3	Y	0	J. Herman/NMS
Striped dolphin	UK	Various	7	Y	n/a	R. Deaville/IoZ; B. Reid/SACVSD
Striped dolphin	UK	Skull	1	Y	0	J. Herman/NMS
Striped dolphin	Hebrides	Skin, teeth	1	Y	n/a	L. Mandleberg/HWDT; B. Reid/SACVSD
White-beaked dolphin	UK	Various	6	Y	n/a	R. Deaville/IoZ; B. Reid/SACVSD
White-beaked dolphin	UK	Skull	3	Y	0	J. Herman/NMS

Cont.

Species	Area/stock	Tissue type(s)*	No. collected	Archived (Y/N)	No. analysed	Contact person/institute
UK cont.						
Northern bottlenose whale	UK	Various	5	Y	n/a	R. Deaville/IoZ; B. Reid/SACVSD
Atlantic white-sided dolphin	UK	Various	2	Y	n/a	B. Reid/SACVSD
Atlantic white-sided dolphin	UK	Skull	5	Y	0	J. Herman/NMS
Bottlenose dolphin	UK	Various	3	Y	n/a	R. Deaville/IoZ; R. Penrose/MEM
Bottlenose dolphin	UK	Skull	2	Y	0	J. Herman/NMS
Minke whale	UK	Various	2	Y	n/a	B. Reid/SACVSD
Minke whale (floating)	Hebrides	Skin, blubber	2	Y	n/a	N. van Geel/HWDT; B. Reid/SACVSD
Minke whale (stranded)	Hebrides	Skin	1	Y	n/a	″
Long-finned pilot whale	UK	Various	1	Y	n/a	R. Deaville/IoZ
Risso's dolphin	UK	Various	1	Y	n/a	″
Humpback whale	UK	Various	1	Y	n/a	″
Sowerby's beaked whale	UK	Various	1	Y	n/a	R. Penrose/MEM
Sowerby's beaked whale	UK	Skull	2	Y	0	J. Herman/NMS
USA						
Atlantic white-sided dolphin	N Atlantic	-	55	Y	n/a	M. Garron/NER Stranding Network
Bottlenose dolphin	N Atlantic	-	188	Y	n/a	″
Fin whale	N Atlantic	-	26	Y	n/a	″
Gervais' beaked whale	N Atlantic	-	4	Y	n/a	″
Harbour porpoise	N Atlantic	-	51	Y	n/a	″
Humpback whale	N Atlantic	-	11	Y	n/a	″
Long-finned pilot whale	N Atlantic	-	37	Y	n/a	″
Minke whale	N Atlantic	-	1	Y	n/a	″
North Atlantic right whale	N Atlantic	-	2	Y	n/a	″
Pygmy sperm whale	N Atlantic	-	10	Y	n/a	″
Risso's dolphin	N Atlantic	-	8	Y	n/a	″
Common dolphin	N Atlantic	-	198	Y	n/a	″
Sowerby's beaked whale	N Atlantic	-	7	Y	n/a	″
Unidentified cetacean	N Atlantic	-	1	Y	n/a	″
Unidentified whale	N Atlantic	-	1	Y	n/a	″
Harbour porpoise	EN Pacific/ Georgia Basin	Muscle (*longissimus dorsi* – neonate, sub-adult, adult)	5	Y	0	D. Noren/NWFSC
Killer whale	EN Pacific, CA	Muscle (*longissimus dorsi* – adult)/blubber, skin	1	Y	0	D. Noren/NWFSC; B. Hanson/NWFSC
Cuvier's beaked whale	EN Pacific, AK	Blubber, skin	1	Y	0	B. Hanson/NWFSC
Fin whale	EN Pacific, WA	Blubber, skin	1	Y	0	″
Bottlenose dolphin	EN Pacific	Skin, blubber, gonad, teeth	7	Y	7	K. Danil/SWFSC
Fin whale	EN Pacific	Skin, blubber	2	Y	2	″
Gray whale	EN Pacific	Skin	1	Y	0	″
Long-beaked common dolphin	EN Pacific	Skin, blubber, gonad, teeth	13	Y	13	″
Pacific white-sided dolphin	EN Pacific	Skin, blubber, gonad, teeth	2	Y	2	″
Short-beaked common dolphin	EN Pacific	Skin, blubber, gonad, teeth	3	Y	3	″
Striped dolphin	EN Pacific	Skin, blubber, gonad, teeth	1	Y	1	″
Unid. common dolphin	EN Pacific	Skin, blubber, gonad, teeth	1	Y	1	″

Argentina: Some spectacled porpoises may have stranded and some may have been caught in shore-based fishing nets. Skeletal material (bone) was collected from all specimens.

Australia: 1.Unknown - no information, too decomposed, incomplete specimen; 2. Diseased - e.g. significant parasites, heart disease, infection; 3. Live stranding - put back to sea and died, euthanased, died after stranding; 4. Other natural - e.g. choked on shark, starved, neonatal death, predator (killer whale, shark). Genetic tissues includes: blood, liver, kidney, muscle, skin; toxic contaminants include: liver, kidney, muscle, blubber. Complete sets of tissue samples were not collected from all animals because in some cases the state of decomposition made this inappropriate.

France: *typically: teeth or baleen plates, skin, blubber, muscle, reproductive organs, stomach contents, kidney, liver. **typically: muscle, teeth, stomach contents, skin, liver, kidney. [$]includes 1 fin whale, 1 humpback whale, 1 Cuvier's beaked whale, 1 bottlenose whale, 1 killer whale, 7 long-finned pilot whale, 12 Risso's dolphin, 81 short-beaked common dolphin, 5 common bottlenose dolphin, 6 striped dolphin, 16 harbour porpoise. [$$]includes mostly striped dolphin and common bottlenose dolphin, 1 Cuvier's beaked whale, 1 sperm whale and 1 minke whale. § Includes 1 melon-headed whale, 1 spinner dolphin, 1 common bottlenose dolphin. µ Includes 1 Gervais's beaked whale, 1 pygmy killer whale, 1 Fraser's dolphin, 1 Atlantic spotted dolphin. # Includes 2 pygmy sperm whales, 2 dwarf sperm whales.

Italy: I = Skin, blubber, muscles and main internal organs (several); II = Blubber, lung, heart, stomach, intestine, liver, kidney, pancreas, testicle, mesentery, mesenteric lymph node, prescapular lymph node, tracheo-bronchial lymph node, pulmonary lymph node; III = Skin+blubber, stomach, melon, brain, muscle; IV = Tooth, skin, blubber; V = Skin, blubber, liver, muscle, brain, genital apparatus, kidney; VI = Skin+blubber, pancreas, liver, lung, kidney, ovary, stomach, spleen, heart, melon, brain, pelvic bones, uterus, urinary bladder; VII = Skeletal muscle, lung, heart, intestine, kidney, urinary bladder, pancreas, adrenal glands, spleen, lymph node, brain; VIII = Skin, mammary gland, skeletal muscle, soft palate, salivary glands, lung, heart, stomach, intestine, liver, kidney, pancreas, adrenal glands, testicle, ovary, spleen, prescapular lymph nodes, tracheo-bronchial lymph nodes, pulmonary lymph nodes, hepatic lymph nodes, mesenteric lymph nodes, thymus, brain; IX = Skin+blubber, pancreas, liver, lung, kidney, ovary, stomach, spleen, heart, melon, brain, pelvic bones, uterus, urinary bladder.

Japan: * Samples are from whales stranded and reported to the Fisheries Agency of Japan as well as from other sources. **Under analysis.

USA: a. Data are entered as represented by the NOAA Fisheries NER Stranding Network and have not been formally reviewed by NOAA Fisheries. b. Samples include some or all of the following: hard parts (i.e. teeth, jaw, skull, baleen, entire skeleton, etc) and/or soft parts (i.e. skin, gonads, muscle, blubber, blood, organs, etc). c. Samples are sent to various educational and scientific collections and number analysed is unknown.

STATISTICS FOR LARGE CETACEANS

Direct catches of large whales (commercial, aboriginal and scientific permits) for the calendar year 2009 or the season 2009/10

Species	Type of catch	Area/stock	Males	Females	Total landed	Struck and lost
Denmark						
Bowhead whale	ASW	West Greenland	1	2	3	0
Fin whale	ASW	West Greenland	1	7	8	2
Minke whale	ASW	West Greenland	47	105	153*	11
Minke whale	ASW	East Greenland	3	1	4	0
Iceland						
Fin whale	Commercial	EGI	66	59	125	0
Common minke whale	Commercial	CIC	64	13	78	3
Japan						
Antarctic minke whale	Scientific permit	Areas IIIE, IV, VW	237	269	506	1
Antarctic fin whale	Scientific permit	Areas IIIE, IV, VW	1	0	1	0
Common minke whale	Scientific permit	W North Pacific	99	63	162	Offshore: 0; Coastal: 3
Sei whale	Scientific permit	W North Pacific	46	54	100	1
Bryde's whale	Scientific permit	W North Pacific	18	32	50	0
Sperm whale	Scientific permit	W North Pacific	0	1	1	0

Norway		Management Areas					Total catch
Species	Type of catch	EB	EN	ES	EW	CM	
Minke whale	Small-type whaling	4	49	250	182	0	485

Denmark: * includes 1 reported catch of unknown gender.

Anthropogenic mortality of large whales for the calendar year 2009 or the season 2009/10

Observed or reported ship strikes of large whales (including non-fatal events)

Whale species	Sex	No.	Date	Location	Vessel type*	Speed	Fate*	How observed	Contact person/institute and refs
Australia									
Blue whale	F	1	08/04/09	Rye Ocean Beach.	U	U	U	Washed up	D. Donnelly/DRI
Fin whale[1]	F	1	02/10/09	34°26'80'S: 138°14'50'E	U	U	D	SAM post mortem	C. Kemper/SAM
Humpback whale[2]	U	1	28/07/09	-25°31'S; 154°06'E	FV	U	X,I	Skipper	J. Johnston/AFMA
Humpback whale[3]	U	1	02/09/09	Exmouth Gulf, W Australia	FV	U	U	Crew	D. Coughran/DEC-WA
Humpback whale[4]	U	1	26/10/09	Fremantle, WA	M	U	D	Crew	"
S Right whale calf[5]	U	1	12/09/09	Ulladulla NSW	PC	Fast	D	Gross examination	#896 G. Ross/DECCW
Belgium									
Fin whale	F	1	22/09/09	E N Atlantic, exact location unknown	LC	Cruise speed 22.5kts	D*	While entering port	J. Haelters/RBINS; T. Jauniaux/ULg; A. de Lichtervelde/FoD Environment
Brazil									
Humpback whale	F	1	11/09/09	19,00625S/039,73150W	O	U	D	Necropsy/stranded calf carcass	M. Marcondes/IBJ
Chile									
Sei whale	F	1	30/01/09	Puerto Montt, Los Lagos Region	PC	U	D	Docked in Puerto Montt	B. Galletti/CCC; R.L. Brownell/NOAA
Southern right whale	U	1	02/07/09	Magellan Straits	U	U	D	Pictures at sea	B. Galletti /CCC
France									
Fin whale	U	1	30/10/09	Eastern English Channel	U	U	D	Stranded/evidence of collision	O. Van Canneyt/ CRMM/ULR
Italy									
Fin whale	U	1	12/06/09	Ligurian Sea (43°21'437'N 07°56'179'E)	U	U	X*	Sighted from *RV Pelagos*	TRI
Sperm whale	U	1	06/08/09	Ligurian Sea (42°44'315'N 08°39'160'E)	U	U	X**	Sighted from *RV Pelagos*	"
Sperm whale (newborn)	U	1	30/07/09	Gulf of Olbia, NE Sardinia	Ferry	U	D*	Scientist	B. Díaz López/BDRI
Spain									
Sperm whale	F	1	13/03/09	354458E; 3108672N	O	U	D	Stranded necropsy	M. Carrillo/Canarias Conservación
Sperm whale	M	1	13/03/09	362416E; 3124799N	O	U	D	Stranded necropsy	"
Fin whale	M	1	03/05/09	Valencia	LC	U	D	Stranded	*Toni.raga@uv.es*
UK									
Minke whale	M	1	20/05/09	Sanham Insir Beach, Rhum, Highland, Scotland	U	U	D	Stranded/diagnosed at necropsy	B. Reid/SACVSD

Australia: [1]Post mortem indicated possible vessel collision. [2] Whale swam away bleeding heavily. [3]Private fishing recreation vessel struck the whale. [4]Struck by HMAS Perth, observed floating with blood and no movement afterwards, presumed dead.
Italy: *Healed wound, hypothesised collision; **half tail cut off (healed), hypothesised collision.

Earlier years ship strikes: 2008 and 2007

Whale species	Sex	No.	Date	Location	Vessel type	Speed	Fate	How observed	Contact person/institute and refs
Italy									
Fin whale	U	1	02/07/08	Ligurian Sea 43°08'588'N 07°45'126'E	U	U	X*	Sighted from *RV Pelagos*	TRI
Sperm whale	U	1	12/06/08	Ligurian Sea 43°30'340'N 07°35'120'E	U	U	X*	Sighted from *RV Pelagos*	"
Mexico									
Humpback whale	U	1	27/02/07	Oaxaca	FV	-	X	-	L. Rojas-Bracho/INE
USA									
Humpback whale	F	1	10/05/07	Off Wachapreague, VA	U	U	D	DA	T. Cole/NEFSC/NEFSC Ref. Doc. 09-04
Humpback whale	M	1	13/05/07	Rockport, MA	U	U	D	DA	"
Humpback whale	F	1	24/06/07	Stellwagen Bank	U	U	D	DA	"
Fin whale	F	1	25/03/07	Norfolk Harbor, VA	U	U	D	DA	"
Fin whale	M	1	24/05/07	Newark Bay, NJ	U	U	D	DA	"
Sei whale	F	1	30/05/07	Off Deer Island, MA	U	U	D	DA	"
Humpback whale[1]	U	1	02/07/07	Maui, Hawaii	O	20kts	I*	U	E. Lyman/HIHWNMS/MMD0792Mn-107
Humpback whale[2]	U	1	02/13/07	Maui, Hawaii	O	U	U*	U	" MMD0794Mn-109
Humpback whale[3]	U	1	03/06/07	Maui, Hawaii	PC	U	X*	Crew	" MMD07108Mn-124
Humpback whale[4]	U	1	04/01/07	Kauai, Hawaii	PC	10kts	X*	Crew	" MMD07121Mn-139
Humpback whale[5]	U	1	04/13/07	Lanai, Hawaii	PC	18kts	I*	Crew	" MMD07123Mn-141
Gray whale	U	1	01/06/07	Marin County, CA	U	U	D	Post mortem	J. Cordaro/NOAA NMFS Southwest Regional Office
Blue whale	U	1	08/09/07	Long Beach Harbor, CA	U	U	D	Post mortem	"
Blue whale	U	1	13/09/07	Ventura, CA	U	U	D	Post mortem	"
Blue whale	U	1	19/09/07	Santa Barbara, CA	U	U	D	Post mortem	"
Humpback whale	U	1	13/10/07	Marin County, CA	U	U	D	Post mortem	"
Blue whale	U	1	30/11/07	San Miguel Island, CA	U	U	D	Post mortem	"
Humpback whale	F*	2	09/05/07	Sacramento River, CA	U	U	X	Direct obs.	"

Italy: *Healed wound, hypothesised collision
USA: [1]Animal struck by vessel while traversing between Lanai and Lahaina at 20 kts. Blood seen in water, but animal itself not observed. [2]Possible ship-strike. [3]30-foot RHI vessel captain noticed a fluke print of a whale off the bow. Captain immediately stopped vessel and on stop a subadult humpback broke the surface and made contact with the hull. Did not observe any signs of injuries (no blood) or distress. Crew also assessed hull and found no damage. [4]Tour vessel felt contact possibly from a juvenile humpback, which surfaced 20 yds behind boat soon after contact. No injuries or blood seen. Depth was 60 feet. [5]Vessel captain felt strike, did not see animal, but one passenger did just prior to strike. Captain noticed blood in the water. Injured calf observed soon after. Capt. and crew observed animal for some time and were able to get photo documentation. Inspected vessel and headed back to Lahaina. On return to Lahaina called USCG to report incident.*Cow/calf pair in Sacramento River for several days, propeller wounds on back of female, non-fatal injury.

Fishery bycatch of large whales

Whale species	Sex	No.	Date	Location	Fate	Targeted fish species	Gear	How observed?	Source or contact
Australia									
Blue whale	U	1	03/02/09	3nm SW of Petrified Forest, Cape Bridgewater	UNK	Southern rock lobster	Pot rope	A	M. Watson/DSE
Humpback whale	U	1	27/09/09	28°03.917'S; 153° 27.063	R	Shark control program	Net	V	QDPI&F
Humpback whale	U	1	01/09/09	28°09.518'S; 153° 31.993	R	Shark control program	Net	V	"
Humpback whale	U	1	03/10/09	28°09.518'S; 153° 31.993	R	Shark control program	Net	V	"
Humpback whale	U	1	08/10/09	28°02.353'S; 153° 26.692	R	Shark control program	Net	V	"
Humpback whale	U	1	13/10/09	28°04.984'S; 153° 27.580	R	Shark control program	Net	V	"
Humpback whale	U	1	07/11/09	28°02.353'S; 153° 26.692	R	Shark control program	Net	V	"
Humpback whale	U	1	14/06/09	-34°13'S; 113°36'E	R	Tuna	LLD	V	J. Johnston/AFMA
Humpback whale		1	13/07/09	Flinders Bay, Augusta, WA	Alive	Incidental	MIS[1]	Entanglem't - A	D. Coughran/DEC
Humpback whale			25/06/09	Grey-10km W in 20 fathoms, WA	Dead	Incidental	Derelict fishing gear[2]	Entanglem't - A	"
Humpback whale			02/08/09	North West Cape, Lighthouse, WA	Alive	Incidental	MIS[3]	Entanglem't - A	"
Humpback whale			20/10/09	Green Head, WA	Dead	Incidental	Derelict fishing gear[4]	Entanglem't - A	"
Humpback whale	U	1	16/07/09	Blowholes, Cape Bridgewater	R	Southern rock lobster	Pot rope	A - DA	M. Watson/DSE
Humpback whale	U	1	11/05/09	South West Rocks, NSW	NRA	U	FPO	DA	G. Ross/DECCW #978
Humpback whale	U	1	16/06/09	Forster, NSW	NRA	U	MIS	A	" #979
Humpback whale	U	1	23/06/09	Jervis Bay, NSW	NRA	U	LX	DA	" #981
Humpback whale	U	1	01/07/09	Byron Coast, NSW	NRA	U	LX	DA	" #1030
Humpback whale	U	1	10/07/09	Cape Solander, NSW	NRA	U	LX	DA	" #982
Humpback whale	U	1	12/07/09	Pacific Palms, NSW	R	U	FIX	DA	" #747
Humpback whale	U	1	19/07/09	Tweed Heads, NSW	NRA	U	FIX	A	" #990

Cont.

Whale species	Sex	No.	Date	Location	Fate	Targeted fish species	Gear	How observed?	Source or contact
Australia cont.									
Humpback whale	U	1	04/08/09	Coffs Harbour, NSW	NRA	U	FIX	DA	G. Ross/DECCW #751
Humpback whale	U	1	26/08/09	Port Macquarie, NSW	R	U	LX	DA	″ #818
Humpback whale	U	1	26/08/09	Jervis Bay, NSW	NRA	U	NK	A	″ #991
Humpback whale	U	1	03/09/09	Solitary Islands, NSW	R	U	FIX	DA	″ #975
Humpback whale	U	1	12/09/09	Arrawarra Headland, NSW	R	U	FIX	DA	″ #895
Humpback whale	U	1	14/09/09	Brooms Head, NSW	NRA	U	NK	DA	″ #898
Humpback whale	U	1	15/09/09	North Solitary Islands, NSW	NRA	U	NK	DA	″ #974
Humpback whale	U	1	29/09/09	Urunga, NSW	NRA	U	NK	DA	″ #992
Humpback whale	U	1	30/09/09	Brooms Head, NSW	NRA	U	NK	DA	″ #993
Humpback whale	U	1	11/10/09	Cabbage Tree Island, NSW	R	U	FIX	DA	″ #948
Short-finned pilot whale	U	1	14/10/09	-18°71'S; 154°95'E	R	Tuna	LLD	V	J. Johnston/AFMA
Short-finned pilot whale	U	1	01/12/09	-20°10'S; 154°63'E	R	Tuna	LLD	V	″
Short-finned pilot whale	U	1	09/12/09	-18°23'S; 155°85'E	R	Tuna	LLD	V	″
Southern right whale	U	1	24/07/09	Marlo, East Gippsland	R **	Southern rock lobster	Rot rope		D. Burton/Parks Victoria
Unid. beaked whale	U	1	13/01/09	-28°2'S; 156°21'E	R	Tuna	LLD	V	J. Johnston/AFMA
Unid. toothed whale	U	1	08/09/09	-27°46'S; 155°41'E	R	Tuna	LLD	V	″
Chile									
Antarctic minke whale[1]	F	1	19/01/09	Coast of Pichilemu, O'Higgins Region	D	Unknown	NK	M	B. Galletti/CCC
Denmark									
Minke whale	F	1	-	-	D	Seal nets	-	-	-
France									
Humpback whale	U	1	2009	Martinique	D	Miscellaneous	FIX	Fishermen network	SEPANMAR
Sperm whale	U	1	2009	Martinique	D	Tuna	MIS*	Fishermen network	″

Whale species	No.	Location	Fate	Target fish species	Gear	How observed	Source or contact
Japan							
Common minke whale	1	Hokkaido	D	n/a	GNS	F	FAJ
Common minke whale	4	Hokkaido	K	n/a	FPN	F	″
Common minke whale	1	Aomori	K	n/a	FPN	F	″
Common minke whale	1	Aomori	D	n/a	FPN	F	″
Common minke whale	15	Iwate	K	n/a	FPN	F	″
Common minke whale	8	Miyagi	K	n/a	FPN	F	″
Common minke whale	1	Ibaraki	K	n/a	FPN	F	″
Common minke whale	1	Chiba	K	n/a	FPN	F	″
Common minke whale	3	Niigata	K	n/a	FPN	F	″
Common minke whale	14	Toyama	K	n/a	FPN	F	″
Common minke whale	22	Ishikawa	K	n/a	FPN	F	″
Common minke whale	2	Fukui	K	n/a	FPN	F	″
Common minke whale	1	Shizuoka	K	n/a	FPN	F	″
Common minke whale	5	Mie	K	n/a	FPN	F	″
Common minke whale	7	Kyoto	K	n/a	FPN	F	″
Common minke whale	5	Wakayama	K	n/a	FPN	F	″
Common minke whale	3	Shimane	K	n/a	FPN	F	″
Common minke whale	3	Yamaguchi	K	n/a	FPN	F	″
Common minke whale	3	Kochi	K	n/a	FPN	F	″
Common minke whale	1	Fukuoka	K	n/a	FPN	F	″
Common minke whale	1	Saga	K	n/a	FPN	F	″
Common minke whale	14	Nagasaki	K	n/a	FPN	F	″
Common minke whale	1	Oita	K	n/a	FPN	F	″
Common minke whale	1	Miyazaki	K	n/a	FPN	F	″
Common minke whale	1	Kagoshima	K	n/a	FPN	F	″
Humpback whale	1	Chiba	K	n/a	FPN	F	″
Humpback whale	1	Okayama	D	n/a	FPN	F	″
Humpback whale	1	Tokushima	K	n/a	FPN	F	″
Humpback whale	1	Nagasaki	K	n/a	FPN	F	″

Whale species	Sex	No.	Date	Location	Fate	Targeted fish species	Gear	How obs.?	Source or contact
Korea									
Common minke whale	M	1	08/01	East Sea	D	Conger eel, crab, octopus	FPO	M	CRI/NFRDI
Common minke whale	F	1	19/01	Korea Strait	D	Mackerel, squid	SX	M	″
Common minke whale	M	1	22/01	Yellow Sea	D	Not known	NK	M	″
Common minke whale	F	1	08/02	East Sea	D	Not known	NK	M	″

Cont.

Whale species	Sex	No.	Date	Location	Fate	Targeted fish species	Gear	How obs.?	Source or contact
Korea cont.									
Common minke whale	M	1	01/03	East Sea	D	Flounder, plaice, porgy	GNS	M	CRI/NFRDI
Common minke whale	F	1	10/03	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	x	1	15/03	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	F	1	16/03	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	F	1	16/03	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	M	1	18/03	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	M	1	31/03	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	M	1	13/04	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	M	1	15/04	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	M	1	24/04	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	F	1	05/05	Korea Strait	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	F	1	05/05	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	F	1	14/05	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	M	1	19/05	Korea Strait	D	Flounder, plaice, porgy	GNS	M	″
Common minke whale	M	1	24/05	East Sea	D	Conger eel, crab, octopus	FPO	M	″
Common minke whale	M	1	26/05	East Sea	D	Conger eel, crab, octopus	FPO	M	″
Common minke whale	M	1	29/05	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	F	1	01/06	Korea Strait	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	F	1	01/06	Korea Strait	D	Mackerel, squid	SX	M	″
Common minke whale	F	1	03/06	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	M	1	04/06	East Sea	D	Conger eel, crab, octopus	FPO	M	″
Common minke whale	F	1	11/06	Yellow Sea	D	Conger eel, crab, octopus	FPO	M	″
Common minke whale	M	1	12/06	Yellow Sea	D	Conger eel, crab, octopus	FPO	M	″
Common minke whale	M	1	13/06	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	F	1	13/06	East Sea	D	Flounder, plaice, porgy	GNS	M	″
Common minke whale	M	1	19/06	East Sea	D	Conger eel, crab, octopus	FPO	M	″
Common minke whale	M	1	23/06	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	M	1	17/07	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	M	1	21/07	Yellow Sea	D	Not known	NK	M	″
Common minke whale	M	1	05/08	East Sea	D	Conger eel, crab, octopus	FPO	M	″
Common minke whale	F	1	15/08	East Sea	D	Conger eel, crab, octopus	FPO	M	″
Common minke whale	F	1	19/08	East Sea	D	Conger eel, crab, octopus	FPO	M	″
Common minke whale	M	1	22/09	East Sea	D	Flounder, plaice, porgy	GNS	M	″
Common minke whale	F	1	23/09	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	M	1	25/09	East Sea	D	Conger eel, crab, octopus	FPO	M	″
Common minke whale	F	1	30/09	Yellow Sea	D	Flounder, plaice, porgy	GNS	M	″
Common minke whale	F	1	17/10	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	M	1	19/10	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	F	1	17/11	East Sea	D	Flounder, plaice, porgy	GNS	M	″
Common minke whale	F	1	24/11	East Sea	D	Flounder, plaice, porgy	GNS	M	″
Common minke whale	F	1	25/11	East Sea	D	Flounder, plaice, porgy	GNS	M	″
Common minke whale	F	1	27/11	East Sea	D	Conger eel, crab, octopus	FPO	M	″
Common minke whale	M	1	30/11	East Sea	D	Flounder, plaice, porgy	GNS	M	″
Common minke whale	M	1	30/11	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	F	1	12/12	East Sea	D	Flounder, plaice, porgy	GNS	M	″
Common minke whale	M	1	12/12	East Sea	D	Flounder, plaice, porgy	GNS	M	″
Common minke whale	F	1	18/12	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	M	1	18/12	East Sea	D	Amberjack, herring, squid	FYK	M	″
Common minke whale	F	1	25/12	East Sea	D	Flounder, plaice, porgy	GNS	M	″
Common minke whale	M	1	30/12	East Sea	D	Flounder, plaice, porgy	GNS	M	″
Mexico									
Gray whale	U	1	19/03/10	27°53'01.02"N; 113°58'23.78"W	R	Lobster	FIX	A	R. Kobelkowsky
Minke whale	U	2	27/02/10	Banderas Bay	R	SX	Net and line	M	R. Moncada
Humpback whale	U	1	17/01/10	23°16'1.56"N; 106°37'26.2"W		-	GN	A	O. Guzón
Humpback whale	U	1	07/02/10	23°7'5.1"N; 106°28'41.7"W	R	-	Stainless steel cable	A	″
Humpback whale	U	1	21/02/10	23°16'29.1"N; 106°34'34.1"W		-	GN	A	″
Humpback whale	U	1	03/02/09	Manzanillo, Colima	R	-	-	A	L. Rojas-Bracho
Humpback whale	U	1	19/02/09	Punta Gorda, Los Cabos, Baja California Sur	R	-	-	A	″
Humpback whale	U	1	13/03/09	Faro de Campos, Manzanillo, Colima	R	-	-	A	″
Humpback whale	U	1	01/01/10	Sur de Punta Campos, Colima	R	-	-	A	″
New Zealand									
Blue whale	F	1	26/05/09	Tehapu, W. South Is.	D	-	-	Washed up	A. Baxter
Spain									
Sperm whale	F	1	27/06/09	369998E; 3161750N	D	-	-	Stranded/ necropsy	M. Carrillo/ TENECON

Chile: [1] Entangled in fishing nets and transported to Capitania de Puerto de Pichilemu, from the Chilean Navy.

France: *Entangled in a fish aggregating device, FAD.
Japan: Gear: FPN = Stationary uncovered pounds nets, GNS = set gillnets. How observed: F = Fishery onboard observer. Fate of whale: D = discarded dead or seriously injured, K = kept for sale or specimen.
Mexico: Gray whale, lobster traps are attached to buys by long string. The string was entangled around whale's tail, tried to cut it off but failed. Contact: R. Kobelkowsky; *rebeca_kobel@hotmail.com*; R. Moncada; *itmar6_mammal@yahoo.com.mx*; Oscar Guzón; oscarguzon@oncaexplorations.com; Lorenzo Rojas-Bracho, lrojas@cicese.mx.
New Zealand: Rope entanglement.
Spain: Nylon in the stomach.

Statistics from 2007

Whale species	Sex	No.	Date	Location	Fate	Targeted fish species	Gear	How observed?	Source or contact
USA									
N Atlantic right whale	M	1	31/03/07	Outer Banks, NC	D	U	U	DA	T. Cole/NEFSC/NEFSC Ref. Doc. 09-04
Humpback whale	U	1	27/01/07	Off Haven Beach, NJ	I	U	U	DA	″
Humpback whale	M	1	23/06/07	Wildcat Knoll	I	U	U	DA	″
Humpback whale	M	1	21/12/07	Ocean Sands, NC	D	U	GN?	DA	″
Fin whale	U	1	25/06/07	Great South Channel	I	U	U	DA	″
Fin whale	U	1	11/08/07	Cabot Strait, Nova Scotia	D	U	U	DA	″
Fin whale	M	1	26/09/07	Off Martha's Vineyard, MA	D	U	U	DA	″
Minke whale	U	1	16/07/07	Trescott, ME	I	U	U	DA	″
Minke whale	F	1	05/08/07	Cape Cod Bay, MA	D	U	U	DA	″
Killer whale	U	1	24/06/07	Bering Sea (59°51',178°53')	R	Greenland turbot	LL	F	J. Breiwick/AFSC
Sperm whale	M	1	13/05/07	Gulf of Alaska (56°46',135°57')	R	Sablefish	LL	F	″
Humpback whale*	U	1	11/01/07	20°44.2'N/156°28.4'W	R	NK	NK	DA	E. Lyman/HIHWNMS/ MMD0785Mn-100
Humpback whale**	U	1	06/02/07	20°02.56'N/155°52.4'W	R	NK	-	DA	″ MMD0791Mn-106
Humpback whale***	U	1	23/02/07	20°48.81'N/156°46.94'W	R	NK	NK	DA	″
Humpback whale****	U	1	02/03/07	20°50.94'N/156°42.49'W	R	NK	NK	DA	″
Humpback whale*****	U	1	17/03/07	21°03.03'N/156°40.85'W	R	NK	NK	DA	″
Humpback whale******	U	1	09/12/07	Maui, Hawaii	R	NK	NK	DA	″

USA: *Comments: Fishing gear (approx. 160ft) trailing from mouth, removed over 110ft, some gear remained. **Comments: Bundled fishing gear trailing from mouth, removed over 300ft, some gear remained. Animal biopsy sampled after disentanglement effort. ***Comments: Multiple wraps around tail stock and blades of flukes of fishing line trailing 60ft and trawl buoys. Line continued in bundle and buoys another 220ft. Lines wrapping tailstock and blades were tight and dug into flesh several inches. Animal totally disentangled. ****Comments: Heavy gauge fishing line entangled through mouth and trailed under flippers to twist together behind dorsal fin forming a bridle another 40-50ft. with two polyballs attached. Animal totally disentangled. Animal biopsy sampled after disentanglement effort. *****Comments: Heavy gauge fishing line trailed from whale cutting into tissue, with several pieces of line or cargo netting hanging of wrap. No response possible and there was no re-sightings to date of an animal meeting this description. ******Comments: Sub-adult entangled in undetermined amount of monofilament line around tailstock and trailing aft. Not life threatening. No response mounted.

STATISTICS FOR SMALL CETACEANS

Corrections to earlier years' statistics for small cetaceans

Species	Type of catch	Area/stock	2007 reported	2007 corrected	2008 reported	2008 corrected
USA						
Beluga	Aboriginal	Beaufort Sea	40	40	48	49
Beluga	Aboriginal	Chukchi Sea	270	270	74	74
Beluga	Aboriginal	E. Bering Sea	203	200	72	119
Beluga	Aboriginal	Kuskokwim	31	32	0	0
Beluga	Aboriginal	Bristol Bay	17	20	19	19

Direct catches of small cetaceans for the calendar year 2009 or the season 2009/10
2009-DRAFT data provided by Kathy Frost, ABWC (Alaska Beluga Whale Committee)

Species	Type of catch	Area/stock	Males	Females	Total landed	Struck and lost
USA						
Beluga	Aboriginal	Beaufort Sea	-	-	16	N/A
Beluga	Aboriginal	Chukchi Sea	-	-	53	N/A
Beluga	Aboriginal	E. Bering Sea	-	-	173	N/A
Beluga	Aboriginal	Kuskokwim	-	-	8	N/A
Beluga	Aboriginal	Bristol Bay	-	-	20	N/A

Anthropogenic mortality of small cetaceans for the calendar year 2009 or the season 2009/10

Observed or reported ship strikes of small cetaceans (including non fatal events)

Species	Sex	No.	Date	Location	Vessel type	Speed	Fate	How observed	Contact person/institute and refs
Australia									
Bottlenose dolphin	F	1	23/01/10	Bunbury, WA	U	U	D	On beach	N. Stephens/MU
Indo-Pacific bottlenose dolphin	M	1	25/08/09	8km NNW Port Adelaide 34°46'28'S;138°29'10'E	U	U	D	SAM post mortem (poss. boat strike)	C. Kemper/SAM
Unid. *Tursiops* sp.	U	1	27/12/09	Old bar beach, NSW	U	U	D	Gross exam.	G.Ross/DECCW #1,000
Mexico									
Common bottle-nose dolphin*	M	1	16/08/09	Banderas Bay, Nayarit	-	-	-	Post mortem	R. Moncada/ ITBB
Spain									
Bottlenose dolphin	U	1	31/12/09	Benidorm (Alicante)	U	U	D	Stranded	*Toni.raga@uv.es*
Sweden									
Harbour porpoise*	M	1	Found dead ¼-2009	N58 56,124 E 11 08.547 The Skagerrak	U	-	-	-	A. Roos/SMNH
UK									
Common dolphin	M	1	20/08/09	Solva, Pembrokeshire, Wales	U	U	D	Stranded/diagnosed at necropsy	R. Deaville/IoZ

Mexico: *Cut in half.
Sweden: *Cut in half - found dead with wounds that looked like those from a boat propeller.

Observed or reported ship strikes of small cetaceans (including non fatal events) for the year 2007

Species	Sex	No.	Date	Location	Vessel type	Speed	Fate	How observed	Contact person/institute and refs
USA									
Harbour porpoise	U	1	24/04/07	Sandy Hook Bay, NJ	U	U	D*	Stranding	M. Garron/NER Stranding Network

*Propeller cuts appear to have been made post-mortem.

Fishery bycatch of small cetaceans

Species	Sex	No.	Date	Location	Fate	Targeted fish species	Gear	How observed?	Source or contact
Argentina									
Franciscana	M U	5 20	Apr. 09-Mar. 10	Southern Buenos Aires Coast, Argentina: Necochea 38°37'S, 58°50'W; Claromecó 38°51'S, 60°04'W; Monte Hermoso 38°59'33'S, 61°15'55'W; Bahía Blanca 38°44'S, 62°14'W.	D	Sharks, teleosts	GNS	M, A	L. Cappozzo; M. F. Negri; M. V. Panebianco; M.N. Paso Viola/MACN
Franciscana	F/M	39/27	Sep. 09-Mar. 10	Bahia Samborombon, Coastal Buenos Aires	D	White croaker (*Micropogoniasfurnieri*), Weak fish (*Cynoscion guatucupa*)	GNS	M and F	P. Bordino/AquaMarina-CECIM

Species	Ratio of male to female (if known)	No.	Year	Range, CI or CV	Date of bycatch	Location (description or lat/long)	Fate	Targeted species	Gear	How observed?	Source or contact
Commerson's dolphin	8/1……….12 ??	21	09-10	-	Oct.-Mar.	Eastern T. del Fuego	dead	Róbalo, merluza	GNT; GNS	Beach survey	AMMA

Species	Ratio M:F (if known)	No.	No. extrapolated to fleet total (point estimate)	Range, CI or CV	Date of bycatch	Location (description or lat/long)	FAO statistical area (if known)	FAO area	Fate	Targeted species	Gear	How observed ?	Source or contact
Australia													
Bottlenose dolphin	-	1	-	-	-	Casuarina Pt, Bunbury, WA	-	-	Dead	Incidental	Monofil't line	Stranded next pm	N. Stephens; L. Bejder/MU
Bottlenose dolphin	-	1	-	-	05/06/09 and 07/06/09	25.89168; 153.09798 (05/06/09) & 25.89637; 153.10045	V	-	R	Shark Control Program	Drum	V	QDPI&F
Bottlenose dolphin	-	1	-	-	-	Burswood, Swan R. WA	-	-	Dead	Incidental	-	Entang't (A)	D. Coughran/ DEC
Bottlenose dolphin	M	1	12/10/09	Harbord Beach	D	Event #963	-	-	-	Shark	NSC	Necropsy	″

Cont.

Species	Ratio M:F (if known)	No.	No. extrapolated to fleet total (point estimate)	Range, CI or CV	Date of bycatch	Location (description or lat/long)	FAO statistical area (if known)	FAO area	Fate	Targeted species	Gear	How observed ?	Source or contact
Australia cont.													
Bottlenose dolphin	M	1	02/02/09	Crook-haven R. NSW	U	Event #610	-	-	-	n/a	NK	A	〃
Indo-Pacific bottlenose dolphin	0:1	1	n/a	n/a	09/01/09	1km WNW Pt Turton, 34°55'47"S 137°20'27"E	n/a	n/a	D	Bather protection nets	NSC	Known entang't, post mortem	C. Kemper/ SAM
Indo-Pacific bottlenose dolphin	1:0	1	n/a	n/a	21/10/09	Fitzgerald Bay, Pt Lowly	n/a	n/a	D	U	NK	Prob. Entang't, post mortem	〃
Short-beaked common dolphin	-	1	-	-	18/10/09	27°58.406'S; 153°26.161'E	V	-	D	Shark control prog.	Net	V	QDPI&F
Short-beaked common dolphin	F	1	-	-	23/08/09	27°58.406'S; 153°26.161'E	V	-	D	Shark control prog.	Net	V	〃
Short-beaked common dolphin	-	1	-	-	25/09/09	27°04.984'S; 153°27.580'E	V	-	D	Shark control prog.	Net	V	〃
Short-beaked common dolphin	M	1	-	-	10/06/09	28°08.067'S; 153°30.602'E	V	-	D	Shark control prog.	Net	V	〃
Short-beaked common dolphin	F	1	-	-	09/04/09	28°09.498'S; 153°32.284'E	V	-	D	Shark control prog.	Net	V	〃
Short-beaked common dolphin	-	1	-	-	21/06/09	25.8942; 153.0970	V	-	D	Shark control prog.	Net	V	〃
Short-beaked common dolphin	-	1	-	-	08/05/09	25.8914; 153.09677	V	-	D	Shark control prog.	Net	V	〃
Short-beaked common dolphin	-	1	-	-	23/02/09	27.06415; 153.20860	V	-	R	Shark control prog.	Drum	V	〃
Short-beaked common dolphin	-	1	-	-	22/04/09	26.37250; 153.10685	V	-	D	Shark control prog.	Net	V	〃
Short-beaked common dolphin	-	1	-	-	21/04/09	26.75111; 153.14078	V	-	D	Shark control prog.	Net	V	〃
Short-beaked common dolphin	2:3	5	n/a	n/a	11/04/09 (3) 2009? (2)	Lower Spencer Gulf	n/a	n/a	D	SA Sardine Fishery	PS1/ PS2	F, SAM post mortem	C. Kemper/ SAM; D. Hamer/ SARDI
Short-beaked common dolphin	2:1	3	n/a	n/a	16/01/09 15/02/09 27/10/09	Fitzgerald Bay, Pt Lowly	n/a	n/a	D	U	U	Probable entangl't. post mortem	C. Kemper/ SAM
Common dolphin	U	1	n/a	n/a	05/05/09	-33.78333'S; 134.03333'E	U	U	D	Shark	GNS	V	J. Johnston/ AFMA
Common dolphin	U	1	n/a	n/a	08/05/09	-33.1'S; 134.16667'E	U	U	D	Shark	GNS	V	〃
Common dolphin	U	1	n/a	n/a	30/05/09	-10.95'S; 131.08333'E	U	U	D	Prawns	PTB	V	〃
Common dolphin	M	1	-	-	04/11/09	Wollongong Beach	-	-	D	Shark	NSC	Necropsy	Event #973
Pantropical spotted dolphin	1:1	2	-	-	23/07/09	28°02.353'S; 153°26.692	-	-	D	Shark control prog.	Net	V	QDPI&F
Pantropical spotted dolphin	M	1	-	-	05/12/09	27°58.406'S; 153° 26.161'E	-	-	D	Shark control prog.	Net	V	〃
Long-beaked spinner dolphin,	-	1	-	-	30/06/09	265.2286; 153.0571	V	-	D	Shark control prog.	Net	V	〃
Long-beaked spinner dolphin	M	1	-	-	13/12/09	28°08.067'S; 153° 30.602'E	V	-	D	Shark control prog.	Net	V	〃
Unid. dolphin	n/a	1	n/a	n/a	28/03/09	Pt Turton swim. pool, 34°55'S, 137°24'E	n/a	n/a	R	Bather protection nets	NSC	Known entang't, A	C. Kemper/ SAM
Unid. dolphin	n/a	1	n/a	n/a	03/10/09	Whyalla Marina	n/a	n/a	R	U	NK	Known entang't, A	C. Kemper/ SAM
Unid. dolphin	n/a	1	n/a	n/a	07/08/09	2.5km WSW Aldinga Beach (PO), 34°17'22'S, 138°26'40'E	n/a	n/a	D	U	NK*	Probable entang't, No post mortem	〃
Unid. dolphin	-	1	-	-	28/05/09	23.12996S; 150.75292	-	-	R	Shark control prog.	Drum	V	QDPI&F

Cont.

Species	Ratio M:F (if known)	No.	No. extrapolated to fleet total (point estimate)	Range, CI or CV	Date of bycatch	Location (description or lat/long)	FAO statistical area (if known)	FAO area	Fate	Targeted species	Gear	How observed ?	Source or contact
Belgium													
Harbour porpoise		15*	-	-	Mostly Mar.-May	Belgian territorial waters	-	-	D	Flatfish (sole, plaice), cod	GTR GNS **	**	J. Haelters/ RBINS
Brazil													
Guiana dolphin	2 F; 1U	3	-	-	May 2009 & Jan.-Feb. 2010	Bahia and Espirito Santo States	?	-	D	?	GN	A *	M.Marcondes/ IBJ
Guiana dolphin	F	1	-	-	Jun. 2009	04°33'S, 37°40'S	-	-	D	-	GN	M	A.C.Meirelles/ Aquasis
Guiana dolphin**	-	1	-	-	Jun. 2009	03°15'S, 39°12'W	-	-	D	-	GN	M	〃
Guiana dolphin **	M	1	-	-	Oct. 2009	03°41'S, 38°35'W	-	-	D	-	GN	M	〃
Guiana dolphin **	-	1	-	-	Oct. 2009	02°55'S, 39°49'W	-	-	D*	-	GN	M	〃
Guiana dolphin **	-	1	-	-	Dec. 2009	04°31'S, 37°41'W	-	-	D**	-	GN	M	〃
Guiana dolphin	F	1	-	-	18/10/09	S Brazil (coast area)	-	-	Dead	Sharks	GND	Landed on boat	C. Domit, LEC/UFPR
Guiana dolphin**	11 M, 1 F & 1 U	13	-	-	Mar.-Dec. 2009	Espírito Santo State	-	-	D	?	-	Net marks on carcass	L. Barbosa/ Inst. ORCA
Bottlenose dolphin**	1 M	1	-	-	16/10/09	Espírito Santo State	-	-	D	?	-	Net marks on carcass	〃
Franciscana**	2 M	2	-	-	Oct. 2009 - Jan. 2010	Espírito Santo State	-	-	D	?	-	Net marks on carcass	〃
Guiana dolphin **	148	1	-	-	05/08/09	Lauro de Freitas, Bahia	-	-	-	-	GN	-	L. R. Alardo Souto/IMA
Clymene dolphin**	119	1	-	-	19/05/09	Camaçari, Bahia (12.7799S, 38.1828W)	-	-	-	-	GN	-	〃
Croatia													
Common bottle-nose dolphin*	?	1	-	-	21/07/ 09	44,816667N; 14,033333E	-	-	D	-	-	Necropsy	FVM
Common bottle-nose dolphin*	M	1	-	-	21/10/09	43,908889N; 15,496389E	-	-	D	-	GN	Necropsy	〃
France													
Harbour porpoise	U	4	300	0.64	2009	Channel/ Atlantic Bay of Biscay, ICES area VII-VIII	27	-	D	Sole, monkfish, sea-bass	GNR/GNS	Observer prog. EU reg.	Y. Morizur/ Ifremer
Common dolphin	U	6	20	0.62	Winter 2009	Channel, ICES area VII	27	-	D	Sea bass	PTM	Obs.EU 812/2004	〃
Common dolphin	U	21	300-400	0.89	Winter 2009	Atlantic, Bay of Biscay, ICES area VIII	27	-	D	Sea bass	PTM	Obs. EU 812/2004	〃
Common dolphin	U	2	20	0.97	Summer 2009	Channel, ICES area VII	27	-	D	Sea bass	PTM	Obs. EU 812/2004	〃
Common dolphin	U	115	900	0.66	Summer 2009	Atlantic, Bay of Biscay, ICES area VIII	27	-	D	Albacore tuna	PTM	Obs. EU 812/2004	〃
Common dolphin	U	1	10	0.80	Summer 2009	Atlantic, Bay of Biscay, ICES area VIII	27	-	D	Misc.	OTM	Obs. EU 812/2004	〃
Striped dolphin	U	3	800?	0.68	2009	Atlantic waters, ICES area VIII	27	-	D	Hake	GNS/ GTR	Obs. EU 812/2004	Y. Morizur/ Ifremer
Common bottle-nose dolphin	U	1	10	0.97	2009	NW Med.	37	-	D	Anchovy	OTM	Obs. EU 812/2004	〃
Striped dolphin	U	5	70	0.53	2009	NW Med.	37	-	D	Hake, pilchard, anchovy	OTM	Obs. EU 812/2004	〃
Germany													
Harbour porpoise	-	4	-	-	-	Baltic Sea Schl.-Holstein	-	-	-	-	gillnet	-	-

Cont.

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Germany cont.													
Harbour porpoise	-	4	-	-	-	Baltic Sea Meckl.-Prep.	-	-	-	-	Fish pods	-	-
Korea													
Long-beaked common dolphin	U	2	-	-	03 Jan.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	CRI/NFRDI
Pacific white-sided dolphin	F	1	-	-	03 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	04 Jan.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	05 Jan.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	05 Jan.	East Sea	-	-	D	Flounder, porgy, rock-fish, greenling	LLS	M	″
Finless porpoise	U	1	-	-	07 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	07 Jan.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Long-beaked common dolphin	U	1	-	-	07 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	09 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	U	1	-	-	09 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	9	-	-	09 Jan.	Yellow Sea	-	-	D	Shrimp, gunnel	FSN	M	″
Harbour porpoise	U	1	-	-	16 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Pacific white-sided dolphin	F	1	-	-	16 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	F	1	-	-	16 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	U	2	-	-	16 Jan.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Harbour porpoise	M	1	-	-	16 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	M	1	-	-	16 Jan.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Harbour porpoise	M	1	-	-	16 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	U	1	-	-	16 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	16 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	M	1	-	-	17 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	F	1	-	-	17 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Killer whale	U	1	-	-	17 Jan.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Harbour porpoise	U	1	-	-	17 Jan.	East Sea	-	-	D	Flounder, porgy, rock-fish, greenling	LLS	M	″
Harbour porpoise	F	1	-	-	18 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	M	1	-	-	18 Jan.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Pacific white-sided dolphin	M	1	-	-	18 Jan.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Harbour porpoise	M	1	-	-	19 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	CRI/NFRDI
Harbour porpoise	F	1	-	-	20 Jan.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	M	1	-	-	20 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	1	-	-	21 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	1	-	-	22 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″

Cont.

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Korea cont.													
Pacific white-sided dolphin	U	1	-	-	22 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	CRI/NFRDI
Long-beaked common dolphin	U	1	-	-	28 Jan.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Harbour porpoise	M	1	-	-	28 Jan.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	M	1	-	-	28 Jan.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Harbour porpoise	M	1	-	-	28 Jan.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Pacific white-sided dolphin	U	1	-	-	28 Jan.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Harbour porpoise	U	2	-	-	29 Jan.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	29 Jan.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Finless porpoise	U	2	-	-	30 Jan.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Pacific white-sided dolphin	U	1	-	-	30 Jan.	East Sea	-	-	D	Flounder, porgy, rock-fish, greenling	LLS	M	″
Finless porpoise	U	2	-	-	30 Jan.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Harbour porpoise	M	1	-	-	02 Feb.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Pacific white-sided dolphin	U	1	-	-	02 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	M	1	-	-	04 Feb.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Killer whale	M	1	-	-	04 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	F	1	-	-	05 Feb.	East Sea	-	-	D	Flounder, porgy, rock-fish, greenling	LLS	M	″
Long-beaked common dolphin	M	1	-	-	06 Feb.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Pacific white-sided dolphin	U	1	-	-	06 Feb.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Finless porpoise	U	1	-	-	06 Feb.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Long-beaked common dolphin	U	2	-	-	07 Feb.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	1	-	-	08 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Pacific white-sided dolphin	M	1	-	-	10 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	2	-	-	11 Feb.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Harbour porpoise	F	1	-	-	11 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	1	-	-	11 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	1	-	-	11 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	2	-	-	11 Feb.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Long-beaked common dolphin	U	2	-	-	12 Feb.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	14 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	F	1	-	-	17 Feb.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	M	1	-	-	17 Feb.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	1	-	-	17 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	18 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	M	1	-	-	18 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″

Cont.

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Korea cont.													
Harbour porpoise	F	1	-	-	19 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	CRI/NFRDI
Harbour porpoise	M	1	-	-	21 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	1	-	-	21 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	22 Feb.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Harbour porpoise	F	1	-	-	22 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	1	-	-	22 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	1	-	-	22 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	M	1	-	-	22 Feb.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Long-beaked common dolphin	U	13	-	-	22 Feb.	East Sea	-	-	D	-	NK	M	″
Long-beaked common dolphin	M	1	-	-	23 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	M	1	-	-	24 Feb.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Finless porpoise	U	1	-	-	25 Feb.	Korea Strait	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	F	1	-	-	27 Feb.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	28 Feb.	East Sea	-	-	D	Flounder, porgy, rock-fish, greenling	LLS	M	″
Indo-Pacific bottlenose dolphin	U	1	-	-	02 Mar.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Indo-Pacific bottlenose dolphin	U	1	-	-	02 Mar.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Finless porpoise	U	1	-	-	04 Mar.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	M	1	-	-	04 Mar.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Finless porpoise	U	1	-	-	04 Mar.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	M	1	-	-	08 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	F	1	-	-	08 Mar.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	1	-	-	08 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	M	1	-	-	09 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	10 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	10 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	3	-	-	10 Mar.	East Sea	-	-	D	-	NK	M	″
Long-beaked common dolphin	M	1	-	-	11 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	F	1	-	-	11 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	12 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Pacific white-sided dolphin	F	1	-	-	12 Mar.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	M	1	-	-	12 Mar.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Finless porpoise	U	1	-	-	13 Mar.	Korea Strait	-	-	D	Shrimp, gunnel	FSN	M	″
Finless porpoise	U	5	-	-	15 Mar.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Long-beaked common dolphin	F	1	-	-	16 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″

Cont.

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Korea cont.													
Long-beaked common dolphin	F	1	-	-	16 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	CRI/NFRDI
Finless porpoise	U	1	-	-	16 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	1	-	-	16 Mar.	East Sea	-	-	D	Mackerel, jack mackerel	TX	M	″
Long-beaked common dolphin	F	1	-	-	18 Mar.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Long-beaked common dolphin	U	1	-	-	18 Mar.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	M	1	-	-	19 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	21 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	3	-	-	23 Mar.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Harbour porpoise	F	1	-	-	24 Mar.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	F	1	-	-	24 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	1	-	-	25 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	3	-	-	26 Mar.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Harbour porpoise	M	1	-	-	26 Mar.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	2	-	-	26 Mar.	East Sea	-	-	D	-	NK	M	″
Long-beaked common dolphin	U	1	-	-	28 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	29 Mar.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	2	-	-	30 Mar.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Finless porpoise	U	1	-	-	30 Mar.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	6	-	-	30 Mar.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Harbour porpoise	F	1	-	-	01 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	7	-	-	02 Apr.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Harbour porpoise	M	1	-	-	03 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	03 Apr.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Long-beaked common dolphin	F	1	-	-	04 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	04 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	M	1	-	-	06 Apr.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Long-beaked common dolphin	F	1	-	-	07 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	F	1	-	-	07 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	08 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	09 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	09 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	M	1	-	-	11 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	12 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	12 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	13 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″

Cont.

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Korea cont.													
Long-beaked common dolphin	U	2	-	-	13 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	CRI/NFRDI
Long-beaked common dolphin	M	1	-	-	15 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	15 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	M	1	-	-	17 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	4	-	-	17 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	F	1	-	-	17 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	18 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	18 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	2	-	-	20 Apr.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Long-beaked common dolphin	U	1	-	-	20 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	1	-	-	22 Apr.	Korea Strait	-	-	D	Conger eel, crab, octopus	FPO	M	″
Finless porpoise	U	1	-	-	22 Apr.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	22 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	3	-	-	22 Apr.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Long-beaked common dolphin	U	1	-	-	23 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	23 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	23 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	23 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	1	-	-	23 Apr.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Long-beaked common dolphin	F	1	-	-	24 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	24 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	F	1	-	-	24 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	25 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	F	1	-	-	27 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	1	-	-	27 Apr.	Korea Strait	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	1	-	-	28 Apr.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Finless porpoise	U	1	-	-	28 Apr.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Finless porpoise	U	1	-	-	28 Apr.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Finless porpoise	U	1	-	-	28 Apr.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Finless porpoise	U	1	-	-	28 Apr.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Finless porpoise	U	1	-	-	28 Apr.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Finless porpoise	U	1	-	-	28 Apr.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Long-beaked common dolphin	U	1	-	-	28 Apr.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	29 Apr.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	01 May	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″

Cont.

Species	Ratio M:F (if known)	No.	No. extrapolated to fleet total (point estimate)	Range, CI or CV	Date of bycatch	Location (description or lat/long)	FAO statistical area (if known)	FAO area	Fate	Targeted species	Gear	How observed ?	Source or contact
Korea cont.													
Indo-Pacific bottlenose dolphin	U	2	-	-	01 May	Korea Strait	-	-	R	Amberjack, herring, squid	FYK	M	CRI/NFRDI
Finless porpoise	U	1	-	-	02 May	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	03 May	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	03 May	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	M	1	-	-	05 May	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Finless porpoise	U	1	-	-	05 May	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	06 May	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Finless porpoise	U	1	-	-	07 May	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Long-beaked common dolphin	U	3	-	-	09 May	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Indo-Pacific bottlenose dolphin	U	3	-	-	10 May	Korea Strait	-	-	D	Amberjack, herring, squid	FYK	M	″
Pacific white-sided dolphin	M	1	-	-	11 May	East Sea	-	-	D	Flounder, porgy, rockfish, greenling	LLS	M	″
Long-beaked common dolphin	U	1	-	-	15 May	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	15 May	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Finless porpoise	U	2	-	-	17 May	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Long-beaked common dolphin	U	1	-	-	19 May	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	F	1	-	-	19 May	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Finless porpoise	U	1	-	-	20 May	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	M	1	-	-	20 May	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	20 May	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Long-beaked common dolphin	U	1	-	-	23 May	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	1	-	-	26 May	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	1	-	-	26 May	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	2	-	-	27 May	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	1	-	-	30 May	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	4	-	-	02 Jun.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Finless porpoise	U	1	-	-	03 Jun.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	3	-	-	04 Jun.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	04 Jun.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	1	-	-	11 Jun.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	1	-	-	12 Jun.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Finless porpoise	U	1	-	-	12 Jun.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	M	1	-	-	12 Jun.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	M	1	-	-	14 Jun.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Long-beaked common dolphin	M	1	-	-	15 Jun.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	16 Jun.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″

Cont.

Species	Ratio M:F (if known)	No.	No. extrapolated to fleet total (point estimate)	Range, CI or CV	Date of bycatch	Location (description or lat/long)	FAO statistical area (if known)	FAO area	Fate	Targeted species	Gear	How observed ?	Source or contact
Korea cont.													
Finless porpoise	U	1	-	-	16 Jun.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	CRI/NFRDI
Long-beaked common dolphin	F	1	-	-	16 Jun.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	〃
Long-beaked common dolphin	F	1	-	-	16 Jun.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	〃
Long-beaked common dolphin	M	1	-	-	21 Jun.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Indo-Pacific bottlenose dolphin	U	2	-	-	24 Jun.	Korea Strait	-	-	R	Amberjack, herring, squid	FYK	M	〃
Pacific white-sided dolphin	M	1	-	-	01 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Pacific white-sided dolphin	M	1	-	-	01 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Finless porpoise	U	1	-	-	02 Jul.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Pacific white-sided dolphin	M	1	-	-	02 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	M	1	-	-	02 Jul.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	〃
Finless porpoise	U	1	-	-	08 Jul.	Korea Strait	-	-	D	Amberjack, herring, squid	FYK	M	〃
Long-beaked common dolphin	U	1	-	-	09 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	U	1	-	-	11 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	M	1	-	-	13 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Finless porpoise	U	2	-	-	14 Jul.	Korea Strait	-	-	D	Mackerel, squid	SX	M	〃
Long-beaked common dolphin	U	1	-	-	14 Jul.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	〃
Finless porpoise	U	1	-	-	14 Jul.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Finless porpoise	U	2	-	-	15 Jul.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	〃
Long-beaked common dolphin	M	1	-	-	16 Jul.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	〃
Finless porpoise	U	3	-	-	17 Jul.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	〃
Long-beaked common dolphin	F	1	-	-	17 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	M	1	-	-	17 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Finless porpoise	U	1	-	-	17 Jul.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Finless porpoise	U	1	-	-	17 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	M	1	-	-	19 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Finless porpoise	U	1	-	-	19 Jul.	Korea Strait	-	-	D	Amberjack, herring, squid	FYK	M	〃
Long-beaked common dolphin	U	1	-	-	20 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Finless porpoise	U	2	-	-	20 Jul.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	F	1	-	-	20 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Finless porpoise	U	3	-	-	21 Jul.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	〃
Long-beaked common dolphin	U	2	-	-	21 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Pacific white-sided dolphin	M	1	-	-	22 Jul.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	〃
Long-beaked common dolphin	M	1	-	-	23 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	U	1	-	-	23 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Finless porpoise	U	4	-	-	24 Jul.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	〃

Cont.

Species	Ratio M:F (if known)	No.	No. extrapolated to fleet total (point estimate)	Range, CI or CV	Date of bycatch	Location (description or lat/long)	FAO statistical area (if known)	FAO area	Fate	Targeted species	Gear	How observed ?	Source or contact
Korea cont.													
Finless porpoise	F	1	-	-	24 Jul.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	CRI/NFRDI
Long-beaked common dolphin	M	1	-	-	25 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Pacific white-sided dolphin	M	1	-	-	25 Jul.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	〃
Finless porpoise	U	7	-	-	25 Jul.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	〃
Long-beaked common dolphin	F	1	-	-	26 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	U	1	-	-	26 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Finless porpoise	U	1	-	-	26 Jul.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	U	1	-	-	26 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Pacific white-sided dolphin	U	1	-	-	27 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	U	1	-	-	30 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	M	1	-	-	31 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	F	1	-	-	31 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	U	1	-	-	31 Jul.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Finless porpoise	U	1	-	-	31 Jul.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Indo-Pacific bottlenose dolphin	U	1	-	-	31 Jul.	Korea Strait	-	-	R	Amberjack, herring, squid	FYK	M	〃
Long-beaked common dolphin	F	1	-	-	01 Aug.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	U	1	-	-	04 Aug.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	U	1	-	-	07 Aug.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	M	1	-	-	08 Aug.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	〃
Finless porpoise	U	5	-	-	11 Aug.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	〃
Long-beaked common dolphin	U	1	-	-	14 Aug.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	U	1	-	-	14 Aug.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	〃
Long-beaked common dolphin	U	1	-	-	15 Aug.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	U	2	-	-	16 Aug.	East Sea	-	-	D	Mackerel, jack mackerel	TX	M	〃
Finless porpoise	U	1	-	-	16 Aug.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	〃
Finless porpoise	U	1	-	-	16 Aug.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	〃
Pacific white-sided dolphin	F	1	-	-	17 Aug.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	M	1	-	-	19 Aug.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	〃
Finless porpoise	U	2	-	-	22 Aug.	Yellow Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	M	1	-	-	23 Aug.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	〃
Finless porpoise	U	1	-	-	26 Aug.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	M	1	-	-	28 Aug.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	〃
Long-beaked common dolphin	U	1	-	-	29 Aug.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	〃
Long-beaked common dolphin	M	1	-	-	03 Sep.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	〃
Finless porpoise	U	3	-	-	04 Sep.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	〃

Cont.

Species	Ratio M:F (if known)	No.	No. extrapolated to fleet total (point estimate)	Range, CI or CV	Date of bycatch	Location (description or lat/long)	FAO statistical area (if known)	FAO area	Fate	Targeted species	Gear	How observed ?	Source or contact
Korea cont.													
Long-beaked common dolphin	M	1	-	-	09 Sep.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	CRI/NFRDI
Long-beaked common dolphin	M	1	-	-	13 Sep.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	2	-	-	13 Sep.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	13 Sep.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	M	1	-	-	16 Sep.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Long-beaked common dolphin	U	1	-	-	18 Sep.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	F	1	-	-	19 Sep.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Finless porpoise	M	1	-	-	19 Sep.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Long-beaked common dolphin	U	1	-	-	22 Sep.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Long-beaked common dolphin	U	1	-	-	26 Sep.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Finless porpoise	U	1	-	-	28 Sep.	Korea Strait	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	M	1	-	-	04 Oct.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	F	1	-	-	05 Oct.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	3	-	-	05 Oct.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	1	-	-	10 Oct.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Finless porpoise	U	1	-	-	10 Oct.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Finless porpoise	U	1	-	-	13 Oct.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	M	1	-	-	18 Oct.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	M	1	-	-	19 Oct.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	19 Oct.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	5	-	-	26 Oct.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	M	1	-	-	26 Oct.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	27 Oct.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Long-beaked common dolphin	F	1	-	-	28 Oct.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	4	-	-	28 Oct.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	4	-	-	29 Oct.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	M	1	-	-	29 Oct.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	1	-	-	30 Oct.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	30 Oct.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	M	1	-	-	30 Oct.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	M	1	-	-	30 Oct.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	F	1	-	-	05 Nov.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	2	-	-	08 Nov.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	F	1	-	-	08 Nov.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	09 Nov.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″

Cont.

Species	Ratio M:F (if known)	No.	No. extrapolated to fleet total (point estimate)	Range, CI or CV	Date of bycatch	Location (description or lat/long)	FAO statistical area (if known)	FAO area	Fate	Targeted species	Gear	How observed ?	Source or contact
Korea cont.													
Long-beaked common dolphin	U	1	-	-	09 Nov.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	CRI/NFRDI
Long-beaked common dolphin	U	1	-	-	14 Nov.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	16 Nov.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	2	-	-	17 Nov.	Korea Strait	-	-	D	Mackerel, jack mackerel	TX	M	″
Long-beaked common dolphin	U	1	-	-	17 Nov.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Long-beaked common dolphin	F	1	-	-	17 Nov.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	20 Nov.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	1	-	-	20 Nov.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	21 Nov.	East Sea	-	-	D	Flounder, porgy, rock-fish, greenling	LLS	M	″
Long-beaked common dolphin	M	1	-	-	22 Nov.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	23 Nov.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	24 Nov.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	2	-	-	24 Nov.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	M	1	-	-	25 Nov.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	2	-	-	25 Nov.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	25 Nov.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	26 Nov.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	1	-	-	26 Nov.	Korea Strait	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	7	-	-	27 Nov.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	F	1	-	-	05 Dec.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	F	1	-	-	07 Dec.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	2	-	-	07 Dec.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	1	-	-	07 Dec.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	M	1	-	-	08 Dec.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Pacific white-sided dolphin	U	2	-	-	08 Dec.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	M	1	-	-	08 Dec.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Long-beaked common dolphin	U	3	-	-	10 Dec.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	M	1	-	-	12 Dec.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	12 Dec.	East Sea	-	-	D	Flounder, porgy, rock-fish, greenling	LLS	M	″
Long-beaked common dolphin	U	1	-	-	13 Dec.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Pacific white-sided dolphin	F	1	-	-	15 Dec.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Pacific white-sided dolphin	M	1	-	-	17 Dec.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	3	-	-	18 Dec.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	F	1	-	-	19 Dec.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″

Cont.

Species	Ratio M:F (if known)	No.	No. extrapolated to fleet total (point estimate)	Range, CI or CV	Date of bycatch	Location (description or lat/long)	FAO statistical area (if known)	FAO area	Fate	Targeted species	Gear	How observed?	Source or contact
Korea cont.													
Finless porpoise	U	1	-	-	19 Dec.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	CRI/NFRDI
Long-beaked common dolphin	F	1	-	-	20 Dec.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Pacific white-sided dolphin	U	1	-	-	21 Dec.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Pacific white-sided dolphin	M	1	-	-	21 Dec.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	21 Dec.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	F	1	-	-	22 Dec.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Common bottle-nose dolphin	U	2	-	-	22 Dec.	East Sea	-	-	D	Mackerel, jack mackerel	TX	M	″
Long-beaked common dolphin	M	1	-	-	22 Dec.	East Sea	-	-	D	Conger eel, crab, octopus	FPO	M	″
Long-beaked common dolphin	F	1	-	-	22 Dec.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	23 Dec.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Long-beaked common dolphin	U	1	-	-	23 Dec.	East Sea	-	-	D	Amberjack, herring, squid	FYK	M	″
Finless porpoise	U	1	-	-	23 Dec.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Common bottle-nose dolphin	F	1	-	-	23 Dec.	East Sea	-	-	D	Mackerel, jack mackerel	TX	M	″
Long-beaked common dolphin	U	1	-	-	24 Dec.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	2	-	-	25 Dec.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Harbour porpoise	M	1	-	-	27 Dec.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Long-beaked common dolphin	U	1	-	-	27 Dec.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Finless porpoise	U	1	-	-	27 Dec.	East Sea	-	-	D	Conger eel, crab,octopus	FPO	M	″
Pacific white-sided dolphin	M	1	-	-	29 Dec.	East Sea	-	-	D	Flounder, plaice, porgy	GNS	M	″
Netherlands													
Harbour porpoise	-	38	-	-	-	-	-	-	D	-	-	Post mortem	A. Groene/ Utrecht Univ.
New Zealand													
Common dolphin	M	1	-	-	07/02/09	West Coast South Island	-	-	D	-	Bot'm Trawl	Gov't obs.	-
Common dolphin	F	1	-	-	07/02/09	West Coast South Island	-	-	D	-	Bot'm Trawl	Gov't obs.	-
Common dolphin	F	1	-	-	17/02/09	West Coast South Island	-	-	D	-	Bot'm Trawl	Gov't obs.	-
Common dolphin	M	1	-	-	17/02/09	West Coast South Island	-	-	D	-	Bot'm Trawl	Gov't obs.	-
Common dolphin	M	1	-	-	21/02/09	West Coast South Island	-	-	D	-	Bot'm Trawl	Gov't obs.	-
Common dolphin	F	1	-	-	26/02/09	West Coast South Island	-	-	D	-	Bot'm Trawl	Gov't obs.	-
Common dolphin	M	3	-	-	26/02/09	West Coast South Island	-	-	D	-	Bot'm Trawl	Gov't obs.	-
Hector's dolphin	M	1	-	-	08/05/09	East Coast South Island	-	-	D	-	Setnet	Gov't obs.	-
Common dolphin		1	-	-	25/10/09	West Coast North Island	-	-	D	Jack mackerel	Mid-water trawl	Gov't obs.	-
Hector's dolphin	M	1	-	-	01/11/09	East Coast South Island	-	-	Dead	-	Setnet	Gov't obs.	-
Dusky dolphin		1	-	-	01/12/09	East Coast South Island	-	-	Dead	-	Setnet	Gov't obs.	-
Spain													
Atlantic spotted dolphin	F	1	-	-	10/01/09	332314E 3101148N	-	-	D	U	U	Cut injuries; necropsy	M.Carrillo/ TENECON

Cont.

Species	Ratio M:F (if known)	No.	No. extrapolated to fleet total (point estimate)	Range, CI or CV	Date of bycatch	Location (description or lat/long)	FAO statistical area (if known)	FAO area	Fate	Targeted species	Gear	How observed?	Source or contact
Spain cont.													
Bottlenose dolphin	M	1	-	-	23/10/09	331216E 3103493N	-	-	D	U	U	Hemat-oma in melon; necropsy	″
Common dolphin	U	1	Unknown	-	13/03/09	Almería (SE Spain)	37	-	-	U	U	M	CMA
Common dolphin	U	1	Unknown	-	06/12/09	Málaga (Alboran Sea)	37	-	-	U	U	M	″
Striped dolphin	U	1	Unknown	-	02/02/09	Málaga (Alboran Sea)	37	-	-	U	U	M	″
Striped dolphin	U	1	Unknown	-	18/02/09	Málaga (Alboran Sea)	37	-	-	U	U	M	″
Striped dolphin	U	1	Unknown	-	05/05/09	Málaga (Alboran Sea)	37	-	-	U	U	M	″
Striped dolphin	U	1	Unknown	-	16/02/09	Níjar (Gulf of Vera)	37	-	-	U	U	M	″
Striped dolphin	U	1	Unknown	-	18/03/09	Algeciras (Strait of Gibraltar)	37	-	-	U	U	M	″
Sweden													
Harbour porpoise	F	1	-	-	06/07/09	Between Falk.+ Glom., Kattegatt	-	-	-	-	Not noted	-	-
UK													
Common dolphin	1:2	9	U	U	U	Stranded - England and Wales	27	IV, VII, VIII	D	U	U	M stranded; necropsy	R. Deaville/ IoZ
Harbour porpoise	1:2	6	U	U	U	Stranded - England, Wales and Scotland	27	IV, VI, VIII	D	U	U	M stranded; necropsy	″
Bottlenose dolphin	M	1	U	U	U	Stranded - Wales	27	VIIa	D	U	U	M stranded; necropsy	″
Harbour porpoise	U	10	616*	CV 0.16	2009	Celtic Sea	27	VII defgh	D	Demersal fish	GEN	M	S. Northridge/ SMRU
Common dolphin	U	3	-	-	2009	Celtic Sea	27	VIIe	R	Demersal fish	PTB	M	″
Common dolphin	U	4	4	+/- 0	2009	Celtic Sea	27	VIIe	D	Bass	PTM	M	″
Common dolphin	U	3	264*	CV 0.24	2009	Celtic Sea	27	VII efgh	D	Demersal fish	GEN	M	″

Argentina: All individuals were entangled in coastal gillnets (samples collected from 48 individuals). AMMA: Some of the spectacled porpoises may have been taken in shore-based nets.
Australia: (*1) There was one reported incident of an illegal killing (many shotgun pellets were found) of a female indo-pacific bottlenose dolphin in the SA region. Contact C. Kemper (SAM) for details.
Belgium: *Preliminary data, the figure includes stranded animals that were bycaught and discarded, and very few animals reported by fishermen. **Mostly indirect evidence from stranded animals.
Brazil: *Necropsy of stranded carcass. **Entangled in gear, cut off and sank.
Croatia: *Entangled in gear, cut off and sank.
Netherlands: 92 stranded animals were examined and by-catch was the cause of death given for 41% of them.
Sweden: Entangled in gear, cut off and sank.
UK: *Estimates based on bycatch rates observed over four years for these species and fisheries.

Anthropogenic mortality of small cetaceans for the calendar year 2007

Fishery bycatch of small cetaceans for the calendar year 2007

Species	Ratio M to F (if known)	No.	No. extrapolated to fleet total (point estimate)	Range, CI or CV	Date of bycatch	Location (description or lat/long)	FAO statistical area (if known)	FAO area	Fate	Targeted species	Gear	How observed?	Source or contact
USA													
Harbour porpoise	U	35	395	0.37	2007	NE US	U	21	D	-	GNS	F	A. VanAtten/ NEFSC
Harbour porpoise	U	1	58	1.03	2007	Mid-Atlantic US	U	21	D	-	GN	F	″
Common dolphin	U	1	11	1.08	2007	NE US	U	21	D	-	GNS	F	″
Common dolphin	U	1	3.2	0.70	2007	Mid-Atlantic US	U	21	D	-	GN	F	″
Common dolphin	U	3	24	0.28	2007	NE US	U	21	D	-	TBB	F	″
Common dolphin	U	0	66	0.27	2007	Mid-Atlantic US	U	21	D	-	TBB	F	″

Cont.

Species	Ratio M to F (if known)	No.	No. extrapolated to fleet total (point estimate)	Range, CI or CV	Date of bycatch	Location (description or lat/long)	FAO statistical area (if known)	FAO area	Fate	Targeted species	Gear	How observed?	Source or contact
USA cont.													
White-sided dolphin	U	1	147	0.35	2007	NE US	U	21	D	-	TBB	F	″
White-sided dolphin	U	1	12	0.98	2007	Mid-Atlantic US	U	21	D	-	TM	F	″
White-sided dolphin	U	2	21	0.24	2007	Mid-Atlantic US	U	21	D	-	TBB	F	″
Pilot whale	U	0	36	0.38	2007	Mid-Atlantic US	U	21	D	-	TBB	F	″
Pilot whale	U	4	12	0.35	2007	NE US	U	21	D	-	TBB	F	″
Pilot whale	U	0	57	0.65	2007	Mid-Atlantic US	U	21	D	-	LL	F	″
Harbour porpoise		1	n/a	n/a	17/07/07	Bering Sea	-		D	Flathead sole	Non-pelagic trawl	F	J. Breiwick/ AFSC
Short-beaked common dolphin	3:6	9	54	0.41	Jan-Aug.	California	-	-	D	Sword-fish + thresher shark	GND	F	*jim.carretta@noaa.gov*
Northern right whale dolphin	0:1	1	6	1.00	Dec.	California	-	-	D	Sword-fish + thresher shark	GND	F	″
Pacific white-sided dolphin	1:0	1	6	1.00	Dec.	California	-	-	D	Sword-fish + thresher shark	GND	F	″

Species	Sex	No	Date	Location	Fate	Targeted fish species	Gear	Source or contact
Risso's dolphin	U	1	21/02/07	N/A	R	Swordfish	LLS	NMFS Observers
Bottlenose dolphin	U	1	22/02/07	N/A	R	Swordfish	LLS	″
Risso's dolphin	U	1	22/03/07	N/A	R	Swordfish	LLS	″
Risso's dolphin	U	1	24/03/07	N/A	R	Swordfish	LLS	″
Bottlenose dolphin	U	1	26/03/07	N/A	R	Swordfish	LLS	″
Bottlenose dolphin	U	1	29/03/07	N/A	R	Swordfish	LLS	″
False killer whale	U	1	19/04/07	N/A	R	Tuna	LLD	″
Unid. dolphin	U	1	06/05/07	N/A	R	Tuna	LLD	″
False killer whale	U	1	26/05/07	N/A	R	Tuna	LLD	″
False killer whale	U	1	16/09/07	N/A	R	Tuna	LLD	″
Unidentified Cetacean	U	1	31/10/07	N/A	R	Tuna	LLD	″
Short-finned pilot whale	U	1	15/11/07	N/A	R	Tuna	LLD	″
False killer whale	U	1	07/12/07	N/A	R	Tuna	LLD	″
Risso's dolphin	U	1	24/12/07	N/A	D	Tuna	LLD	″

STRANDINGS

Species	No. strandings	No. post mortems	Contact person(s)/Institute(s)	Contact email address(es)
Argentina				
Southern right whale	81	81	M. Uhart/Wildlife Conservation Society; V. Rowntree/ICB-WCI/OA; Univ. of Utah	*muhart@wcs.org* *rowntree@biology.utah.edu;*
Pilot whale	52	6	E. Crespo	*SRWHMP*
Franciscana dolphin	6	6	P. Bordino	*bordino@aquamarina.org*
Southern bottlenose whale	1	1	″	″
Burmeisters porpoise	2	2	″	″
Layard's beaked whale	1	1	N. Goodall	*rnp.goodall@gmail.com*
Southern right whale dolphin	1	1	″	″
Spectacled porpoise	6*	6	″	″
Australia				
Bottlenose dolphin	12	2	C. Limpus; M. Boyle/DERM	*col.limpus@derm.qld.gov.au; michelle.boyle@derm.qld.gov.au*
Common dolphin	10	0	″	″
False killer whale	1	1	″	″
Humpback whale	17	0	″	″
Indo-Pacific humpback dolphin	7	2	″	″
Melon-headed whale	2	0	″	″
Minke whale	2	0	″	″
Pantropical spotted dolphin	3	3	″	″
Short-finned pilot whale	2	0	″	″
Sperm whale	2	0	″	″
Long-snouted spinner dolphin	2	0	″	″
Unid dolphin - (unid. sp)	5	0	″	″
Blue whale	1	0	D. Donnelly/DRI	*ddonnelly6@yahoo.com.au research@dolphinresearch.org.au*

Cont.

Species	No. strandings	No. post mortems	Contact person(s)/Institute(s)	Contact email address(es)
Australia cont.				
Pygmy blue whale, (or sub-adult blue whale)**	1	0	K. Greengrass/DSE	*kirsty.greengrass@dse.vic.gov.au*
Bottlenose dolphin	4	2 (Portland/ Apollo Bay)	K. Charlton Robb/Monash; A. Monk/Monash conducted by Padraig Duignan Melbourne University	*kate.charlton@sci.monash.edu.au alissa.monk@sci.monash.edu.au*
Bottlenose dolphin	5	3; 1 full, 2 samples taken	K. Greengrass/DSE	*kirsty.greengrass@dse.vic.gov.au*
Pilot whale	1 (King I. wash up after storm)	0	D. Donnelly/DRI	*ddonnelly6@yahoo.com.au research@dolphinresearch.org.au*
Long-finned pilot whale*	8	3 (samples taken)	K. Greengrass/DSE	*kirsty.greengrass@dse.vic.gov.au*
Sperm whale	1	1 (samples taken)	″	″
Unknown (decomposed)	4	0	″	″
Bottlenose dolphin	10 dead (2 live) 12 total	3	N. Stephens; L. Bejder; H. Smith/MUCRU	*n.stephens@murdoch.edu.au l.bejder@murdoch.edu.au h.smith@murdoch.edu.au c.holyoake@murdoch.edu.au*
Bottlenose dolphin	16 (6 died)	0	D. Coughran/DEC	*douglas.coughran@dec.gov.au*
Dwarf sperm whale	1		″	″
Hector's beaked whale	1	0	″	″
Humpback whale	12 (10 dead)		″	″
Long-finned pilot whale	87 (7 died)		″	″
Pygmy right whale	1		″	″
Risso's dolphin	1 (died)		″	″
Strap-toothed beaked whale	5 (2)	0	″	″
Striped dolphin	1	0	Bunbury Shire Council	*cspencer@bunbury.wa.gov.au*
Andrews' beaked whale	1	0	Event #719	*geoff.ross@environment.nsw.gov.au*
Blainville's beaked whale	2	1	Event #624; 931	″
Bottlenose dolphin	11	2	Event #596; 656; 714; 705; 704; 709; 718; 801; 867; 933; 956	″
Indo-Pacific bottlenose dolphin	2	1	Event #559; 951	″
Common bottlenose dolphin	1	0	Event #976	″
Bryde's whale	1	0	Event #960	″
Short-beaked common dolphin	4	1	Event #953; 957; 977; 996	″
Cuvier's beaked whale	1	1	Event #932	″
Dwarf sperm whale	1	0	Event #712	″
False killer whale	2	0	Event #732; 864	″
Humpback whale	6	0	Event #797; 930; 946; 961; 965; 995	″
Minke whale	1	0	Event #729	″
Pilot whale, short-finned	1	1	Event #954	″
Pygmy killer whale	2	1	Event #720; 998	″
Pygmy sperm whale	1	0	Event #896	″
Bottlenose dolphin	1	0	R. Chatto, NT Parks and Wildlife	*ray.chatto@nt.gov.au*
Humpback whale (section of blubber and bone)	1	0	″	″
Indo-Pacific humpback dolphin	1	0	″	″
Snubfin dolphin	1	0	″	″
Bottlenose dolphin	7	1	C. Kemper/SAM	*catherine.kemper@samuseum.gov.au*
Indo-Pacific bottlenose dolphin	15	13	″	″
Common bottlenose dolphin	1	1	″	″
Short-beaked common dolphin	21	16	″	″
False killer whale	1	0	″	″
Fin whale	1	1	″	″
Humpback whale	1	0	″	″
Pygmy right whale	1	1	″	″
Sperm whale	3	0	″	″
Unid. dolphin	12	0	″	″
Bottlenose dolphin	2 (8)	2	R. Gales/DPIPWE	*rosemary.gales@dpipwe.tas.gov.au*
Short-beaked common dolphin	2 (3)	0	″	″
Gray's beaked whale	3 (2)	2	″	″
Humpback whale	2 (2)	0	″	″
Long-finned pilot whale	2 (170)	117	″	″
Pygmy right whale	1 (1)	1	″	″
Sperm whale	2 (50)	50	″	″
Striped dolphin	1 (?)	1	″	″
Belgium				
All cetaceans (includes discarded bycaught animals)	67	All available ~60	J. Haelters/RBISN; T. Jauniaux/ULg	*j.haelters@mumm.ac.be t.jauniaux@ulg.ac.be*
Brazil				
Guiana dolphin	15	0	J.L. Brito Jr; A. Azevedo; P. R.Dorneles	*lailson@uerj.br; azevedo.alex@uerj.br; dornelespr@gmail.com*
Humpback whale	1	0	″	″
Rough-toothed dolphin	1	0	J.L. Brito Jr; A. Azevedo; P. R.Dorneles	″
Humpback whale	22	20	M. Marcondes/IBJ	*milton.marcondes@baleiajubarte.org.br*

Cont.

Species	No. strandings	No. post mortems	Contact person(s)/Institute(s)	Contact email address(es)
Brazil cont.				
Guiana dolphin	6	6	M. Marcondes/IBJ	*milton.marcondes@baleiajubarte.org.br*
Sperm whale	1	1	″	″
Dwarf minke whale	2	2	″	″
Melon-headed whale	1	1	″	″
Franciscana	4	4	M.J. Cremer/UNIVILLE	*marta.cremer@univille.net*
Guyana dolphin	1	1	″	″
Bottlenose dolphin	1	1	″	″
Sperm whale	3	-	A.C. Meirelles/Aquasis	*cameirelles@yahoo.com.br*
Humpback whale	1	-	″	″
Guiana dolphin	19	-	″	″
Rissos's dolphin	1	-	″	″
Cuvier's beaked whale	1	-	″	″
Atlantic spotted dolphin	1	-	″	″
Clymene dolphin	1	-	″	″
Fraser's dolphin	1	-	″	″
Short-finned pilot whale	1	-	-	-
Pygmy sperm whale	1	-	″	″
Dwarf sperm whale	1	-	″	″
Sperm whale	1	-	F.J. Lima Silva	*flaviogolfinho@yahoo.com.br*
Guiana dolphin	4	7	″	″
Spinner dolphin	1		″	″
Franciscana	61	61	P.H. Ott; I.B. Moreno/GEMARS	*gemars@gemars.org.br; paulo.henrique.ott@gmail.com iggy.moreno@gmail.com*
Balaenoptera sp.	2	2	″	″
Bottlenose dolphin	2	2	″	″
Rough-toothed dolphin	2	2	″	″
Striped dolphin	1	1	″	″
Sperm whale	1	1	″	″
False killer whale	1	1	″	″
Stenella sp.	1	1	″	″
Kogia sp.	1	1	″	″
Bryde's whale	1 (dead adult)	-	K.R.Groch/PBF - Brasil	*krgroch@terra.com.br; karina@baleiafranca.org.br*
Franciscana	1	1	LEC/CEM/UFPR e IPeC	*camila.lec@ufpr.br*
Guiana dolphin	26	26	″	″
Rough-toothed dolphin	1	1	″	″
Atlantic spotted dolphin	3	3	″	″
Common bottlenose dolphin	2	2	″	″
Mysticeti	1	1	″	″
Humpback whale	1	1	L. Barbosa/Instituto ORCA	*instituto@orca.org.br*
Guiana dolphin	16	16	″	″
La Plata dolphin	2	2	″	″
Bottlenose dolphin	1	1	″	″
Rough-toothed dolphin	2	0	″	″
Pantropical spotted dolphin	1	1	″	″
Cuvier's beaked whale	1	0	″	″
Sperm whale	2	2	L.R. Alardo Souto/IMA	*luciano.alardo@mamiferosaquaticos.org*
Pygmy sperm whale	1	1	″	″
Dwarf sperm whale	1	1	″	″
Cuvier's beaked whale	1	1	″	″
Bottlenose dolphin	2	2	″	″
Rough-toothed dolphin	7	7	″	″
Clymene dolphin	11	11	″	″
Guiana dolphin	23	23	″	″
Chile				
Antarctic minke whale	1	1	B. Galletti/CCC	*info@ccc-chile.org*
Southern right whale	1	1	″	″
Humpback whale	1	1	″	″
Sperm whale	1	1	″	″
Pilot whale	1	1	″	″
Unidentified rorqual	1	1	″	″
Croatia				
Common bottlenose dolphin	9	8	H. Gomerčić/FVM	*hrvoje.gomercic@vef.hr*
Denmark				
Harbour porpoise	137	15	L.F. Jensen/FoS	*lfj@fimus.dk*
Killer whale	1	1	″	″
Minke whale	1	1	″	″
Sperm whale	1 male	0	Ministry of Fisheries, Hunting and Agr.	*apnn@nanoq.gl*
White-beaked dolphin	6	5	L.F. Jensen/FoS	*lfj@fimus.dk*
France				
Cetaceans 2009/French Atl.	427[§]	215	O. Van Canneyt/CRMM/ULR	*olivier.van-canneyt@univ-lr.fr*
Cetaceans 2008/French Med.	150[£]	74	F. Dhermain/GECEM	*frank.dhermain@wanadoo.fr*

Cont.

Species	No. strandings	No. post mortems	Contact person(s)/Institute(s)	Contact email address(es)
France cont.				
Cetaceans/Guadeloupe	4[#]	-	C. and R. Rinaldi/AET	*evastropic@wanadoo.fr*
Cetaceans/Martinique	1*	-	S. Jérémie/SEPANMAR and collaborators	*reseau_cetaces972@hotmail.com*
Cetaceans/Réunion	3	0	C. Jammes/GLOBICE	*globice@globice.org*
Cetaceans/New Caledonia	4	0	C. Garrigue/OCNC	*op.cetaces@lagoon.nc*

Species	Total	North Sea/Lower Saxony	North Sea/Schl.-Holstein	Baltic/Schl.- Holstein	Baltic/Meck.-Prep,
Germany					
Harbour porpoise	358	56	145	110	47
Sowerby's beaked whale	1	1			

Species	No. strandings	No. post mortems	Contact person(s)/Institute(s)	Contact email address(es)
Italy				
Sperm whale	7	3	G. Di Guardo/Univ. of Teramo S. Mazzariol/SperiVet M. Podestà/MSNM/BDS	*gdiguardo@unite.it*
Cuvier's beaked whale	2	2	M. Wurtz/DIBIOGE; A. Moulins/CIMA R.F. Savona/BDS	*wurtz-ge@unige.it aurelie.moulins@cimafoundation.org*
Common bottlenose dolphin	3	3	G. Di Guardo/Univ. of Teramo	*gdiguardo@unite.it*
Common bottlenose dolphin	1	1	Cetus; BDS	*cetus@supereva.it http://mammiferimarini.unipv.it*
Common bottlenose dolphin	6	5	SperiVet; BDS	*http://mammiferimarini.unipv.it*
Common bottlenose dolphin	2	2	F. Magnone; A. Fozzi/CRiMM onlus	*fra.magnone@crimm.org; a.fozzi@crimm.org*
Common bottlenose dolphin	2	2	M. Wurtz/DIBIOGE; A. Moulins/CIMA	*wurtz-ge@unige.it; aurelie.moulins@cimafoundation.org*
Common bottlenose dolphin	18	9	BDS	*http://mammiferimarini.unipv.it*
Striped dolphin	7	7	G. Di Guardo/Univ. of Teramo	*gdiguardo@unite.it*
Striped dolphin	9	3	SperiVet; BDS	*http://mammiferimarini.unipv.it*
Striped dolphin	1	1	Cetus; BDS	*cetus@supereva.it*
Striped dolphin	4	4	F. Magnone; A. Fozzi/CRiMM onlus	*fra.magnone@crimm.org; a.fozzi@crimm.org*
Striped dolphin	1	1	M. Wurtz/DIBIOGE; A. Moulins/CIMA R.F. Savona/BDS	*Wurtz-ge@unige.it; aurelie.moulins@cimafoundation.org*
Striped dolphin	8	0	BDS	*http://mammiferimarini.unipv.it*
Undetermined	11	0	″	″
Japan				
Common minke whale	4	4	FAJ	-
Fin whale	1	1	″	-
Sei whale	1	1	″	-
North Pacific right whale	1	1	″	-
Humpback whale	1	1	″	-
Sperm whale	8*	7*	″	-
Korea				
Common minke whale	5	5	CRI/NFRDI	*rock@nfrdi.go.kr*
Bryde's whale	1	1	″	″
Sperm whale	1	1	″	″
Baird's beaked whale	1	1	″	″
Melon-headed whale	1	1	″	″
Long-beaked common dolphin	10	0	″	″
Indo-Pacific bottlenose dolphin	1	0	″	″
Finless porpoise	58	0	″	″
Mexico				
Humpback whale	10	8	L. Rojas-Bracho/INE	*lrojas@cicese.mx*
Sperm whale	1	1	″	″
Fin whale	1	1	″	″
Blue whale	1	1	″	″
Blue whale	1	1	I. Fuentes	*isa_allen05@yahoo.com.mx*
Short finned pilot whale	1	1	L. Rojas-Bracho/INE	*lrojas@cicese.mx El vigia 190ct09*
Gray whale	2	2	R. Kobelkowsky/Mario's Tours	*rebeca_kobel@hotmail.com*
Common bottlenose dolphin	1	1	R. Moncada/ITBB	*itmar6_mammal@yahoo.com.mx*
Gray whale	1 calf + 3 adults	4	J. Urbán R.; A. Gómez Gallardo PRIMMA-UABCS; S. Swartz/CRA	*jurban@uabcs.mx; eagg@uabcs.mx Kabloona15@comcast.net*
Bryde's whale	11	10	J. Urbán R.; A. Gómez Gallardo/ PRIMMA-UABCS	*jurban@uabcs.mx; eagg@uabcs.mx*
Killer whale	1	1	″	″
Dwarf sperm whale	1	1	″	″
Minke whale	1		F. Valverde/CONANP; G. Cárdenas/INE	*fjvals@hotmail.comgcardena@cicese.mx*
Netherlands				
Harbour porpoise	478	92	Naturalis	*naturalis@naturalis.nl*
White-beaked dolphin	3	0	″	″
Killer whale	1	0	″	″
Sowerby's beaked whale	1	0	″	″

Cont.

Species name	No. strandings	No. animals stranded	No. refloated	No. restranded	No. successfully refloated
New Zealand					
Blue whale	2	2	0	0	0
Balaenoptera sp.	1	1	1	0	1
Beaked whale	1	1	0	0	0
Pygmy right whale	1	1	0	0	0
Hector's dolphin	3	3	0	0	0
Common dolphin	24	28	6	0	6
Dolphin	1	1	0	0	0
Long-finned pilot whale	10	254	80	1	79
Pygmy sperm whale	2	3	0	0	0
Dusky dolphin	2	2	1	1	0
Humpback whale	2	2	0	0	0
Gray's beaked whale	9	10	2	2	0
Mesoplodon sp.	2	2	0	0	0
Killer whale	1	1	0	0	0
Sperm whale	2	2	0	0	0
Shepherd's beaked whale	1	1	0	0	0
Bottlenose dolphin	3	4	4	1	3
Unknown	1	1	0	0	0
Cuvier's beaked whale	2	2	1	1	0

Species	No. strandings	No. post mortems	Contact person(s)/Institute(s)	Contact email address(es)
Spain				
Striped dolphin	10	9	A. Fernández/ULPGC	*afernandez@dmor.ulpgc.es*
Spotted dolphin	2	1	″	″
Common dolphin	2	1	″	″
Rough-toothed dolphin	1	1	″	″
Bottlenose dolphin	2	1	″	″
Risso's dolphin	2	1	″	″
Short-finned pilot whale	5	5	″	″
Sperm whale	4	4	″	″
Minke whale	2	2	″	″
Balaenopteridae	1	1	″	″
Striped dolphin	36	9	J. Jiménez/GVA	jimenez_juaper@gva.es
Bottlenose dolphin	2	0	″	″
Sperm whale	3	0	″	″
Fin whale	1	0	″	″
Common dolphin	38	13	CMA	*eduardo.fernandez.tabales@ jutandeandalucia.es*
Striped dolphin	76	29	″	″
Bottlenose dolphin	11	0	″	″
Harbour porpoise	7	1	″	″
Long-finned pilot whale	7	2	″	″
Risso's dolphin	5	1	″	″
Sperm whale	1	0	″	″
Cuvier's beaked whale	2	0	″	″
Minke whale	1	0	″	″
Pigmy sperm whale	1	1	″	″
Unid. small cetaceans	28	0	″	″
Striped dolphin	18	-	CAIB	*jaoliver@dgcapea.caib.es*
Bottlenose dolphin	5	-	″	″
Risso's dolphin	1	-	″	″
Cuvier's beaked whale	1	-	″	″
Long-finned pilot whale	1	-	″	″
Sperm whale	1	-	″	″
Unid. small cetaceans	8	-	″	″
Sweden				
Harbour porpoise	8	8	A. Roos/SMNH	*anna.roos@nrm.se*
UK				
Harbour porpoise	248	50	R. Deaville/IoZ; B. Reid/SACVSD; M. Stemp/NHM; R. Penrose/MEM	*rob.deaville@ioz.ac.uk; bob.reid@sac.co.uk;*
Short-beaked common dolphin	54	15	″	*m.stemp@nhm.ac.uk;*
White-beaked dolphin	21	6	″	*rodpenrose@strandings.demon.co.uk* ″ ″
Striped dolphin	13	7	″	″
Bottlenose dolphin	9	2	″	″
Minke whale	8	2	″	″
Atlantic white-sided dolphin	8	2	″	″
Northern bottlenose whale	8	5	″	″
Risso's dolphin	7	1	″	″
Long-finned pilot whale	4	1	″	″
Sowerby's beaked whale	3	0	″	″

Cont.

Species	No. strandings	No. post mortems	Contact person(s)/Institute(s)	Contact email address(es)
UK cont.				
Sperm whale	3	0	″	″
Cuvier's beaked whale	2	0	″	″
Fin whale	1	0	″	″
Humpback whale	1	1	″	″
Cetacean (indet. species)	42	0	″	″

Argentina: *Not known if stranded or by-caught in shore-based nets.
France: §includes 9 unidentified small cetaceans, 1 fin whale, 1 humpback whale, 2 Cuvier's beaked whale, 1 bottlenose beaked whale, 28 unidentified dolphin, 1 killer whale, 12 long-finned pilot whale, 4 Risso's dolphin, 21 common bottlenose dolphin, 240 short-beaked common dolphin, 17 striped dolphin, 90 harbour porpoise; £includes 113 striped dolphin, 10 common bottlenose dolphin, 1 sperm whale, 2 Cuviers's beaked whale, 1 minke whale, 22 unid. small delphinids; #includes 1 melon-headed whale, 1 common bottlenose dolphin, 1 spinner dolphin. *Includes 1 pantropical spotted dolphin.
Japan: *One sperm whale had strayed into harbour but was safely driven back to sea.

Earlier years statistics - 2008

Species	No. strandings	No. post mortems	Contact person(s)/Institute(s)	Contact email address(es)
USA				
Atlantic white-sided dolphin	38	18	M. Garron/NER Stranding Network	*mendy.garron@noaa.gov*
Bottlenose dolphin	93	70	″	″
Cuviers beaked whale	1	1	″	″
Dwarf sperm whale	2	1	″	″
Fin whale	3	3	″	″
Gervais' beaked whale	1	1	″	″
Harbour porpoise	52	17	″	″
Humpback whale	13	3	″	″
Long-finned pilot whale	7	5	″	″
Melon-headed whale	2	2	″	″
Minke whale	6	1	″	″
Pygmy sperm whale	3	2	″	″
Risso's dolphin	10	7	″	″
Striped dolphin	10	6	″	″
Unid. baleen whale	1	0	″	″
Unid. cetacean	3	0	″	″
Unid. delphinid	3	0	″	″
Unid. dolphin	1	0	″	″
Unid. marine animal	3	0	″	″
Unid. rorqual whale	1	0	″	″
Unid. whale	4	0	″	″
White-beaked dolphin	2	2	″	″
Humpback whale	2	1	D. Schofield/NOAA PIRO	*david.schofield@noaa.gov*
Spinner dolphin	3	3	″	″
Killer whale	1	1	″	″
Unid. beaked whale	1	0	″	″
Bottlenose dolphin	5	2	K. Danil/SWFSC	*kerri.danil@noaa.gov*
Long-beaked common dolphin	12	5	″	″
Northern right whale dolphin	1	1	″	″
Pacific white-sided dolphin	3	3	″	″
Risso's dolphin	2	1	″	″
Short-beaked common dolphin	2	1	″	″
Short-finned pilot whale	1	0	″	″

REFERENCES

Bannister, J.L. 2010.Southern right whale aerial survey, southern Australian coast, August 2009. Final Report on work funded by the Island Foundation, Massachusetts, USA. 17pp. Unpublished. [Available from bannisj@bigpond.com]

Bearzi, G., Agazzi, S., Bonizzoni, S., Costa, M. and Azzellino, A. 2008. Dolphins in a bottle: abundance, residency patterns and conservation of bottlenose dolphins *Tursiops truncates* in the semi-closed eutrophic Amvrakikos Gulf, Greece. *Aquatic Conservation: Marine and Freshwater Ecosystems* 18(2):130-140.

Bearzi, G., Politi, E., Agazzi, S., Bruno, S., Costa, M. and Bonizzoni, S. 2005. Occurrence and present status of coastal dolphins (*Delphinus delphis* and *Tursiops truncatus*) in the eastern Ionian Sea. *Aquatic Conservation: Marine and Freshwater Ecosystems* 15: 243-257.

Bearzi, G., Agazzi, S., Gonzalvo, J., Bonizzoni, S., Costa, M. and Petroselli, A. In Press. Biomass removal by dolphins and fisheries in a Mediterranean Sea coastal area: do dolphins have an ecological impact on fisheries? Aquatic *Conservation: Marine and Freshwater Ecosystems.*

Ingram, S., Kavanagh, A., Englund, A. and Rogan, E. 2009. Report for the National Parks and Wildlife Service of Ireland. University College Cork. November 2009. 34pp.

Rugh, D. (Ed.) 2010. Bowhead Whale Feeding Ecology Study (BOWFEST) in the Western Beaufort Sea; 2009 Annual Report. MMS-4500000120. Produced through the National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600.

Annex P

Online Submission of Progress Report Data and Proposed Changes to the Progress Report Template

Greg Donovan, Caterina Fortuna, Jason Gedamke, Russell Leaper, William Perrin, Mark Tandy and Jemma Jones

This group was formed to examine various suggestions and recommendations made in recent years (e.g. in the Working Group on Bycatch and the Sub-committee on Small Cetaceans) with respect to online submission of various types of data included in the Progress Reports and the ability to quickly obtain summary tables of information on, for example, bycatch, ship strikes and directed catches. In view of this, the group examined the existing requirements for Progress Reports in the light of possible online submission, recognising that this must balance the needs of the progress report compilers as well as the Committee.

What follows are our suggestions for streamlining the Progress Reports and developing a prototype online system in conjunction with data providers.

SUBMISSION OF DATA

After a discussion about the collection and input of the data that forms the basis of the National Progress Reports, it was suggested that the most efficient method to collect this data electronically would be the use of country-specific web applications that could be completed by the National Compiler or disseminated in parts by that Compiler to those individuals or organisations that input the data at source.

The Compiler would be able to send a web URL to the source data-collectors, which would link to a web page containing data-entry tables similar to the paper versions currently used. Each application would then aggregate the data for that country and store the data temporarily allowing for the National Compiler to have final review before submitting them to a Global Progress Report Database stored at the Secretariat. At this submission stage the Compiler would also have the opportunity to export their data to any external national or other database if they so choose.

This global database could then be queried to provide any live summary data that were requested by the Scientific Committee. Live summary tables would be displayed on the IWC website, which may negate the need to have them published in the Supplement to the *Journal* and printed at the Scientific Committee Meeting. The Secretariat would have final editorial control of the data and would present them as was necessary. This approach would provide the flexibility to help reduce the workload of the National Compilers and allow them more time to follow up on missing or erroneous data from the source.

PROPOSED CHANGES TO PROGRESS REPORT TEMPLATE

A standardisation and reorganisation of the existing tables was recommended in order to streamline and simplify both the data-entry process and database design. In some cases this reorganisation would bring the database into line with existing IWC database standards (e.g. Entanglement, Ship Strikes, Catch data, etc.) and would aid interaction between them and recycle existing 'lookup' data.

The current Progress Template allows for a large amount of free-text footnotes, which are of limited use in creating useful data summaries, and also contains some out-dated or redundant fields.

Consequently, a discussion was held to decide on a new standard format for the tables and how best to incorporate necessary comments. It was also agreed that some sections, primarily relating to reporting results, should be deleted as such information was better provided by submitting papers or referring to publications.

The following tables represent the recommended changes to each section of the Progress Report, with drop-down fields linked to standard lookup lists highlighted in grey. Where appropriate these will be hierarchical.

PROPOSED TIMELINE

The design and implementation of the database and web application represents a significant amount of work that could be contracted out to the consultant who created the IWC Ship Strikes database and subsequently maintained by the Secretariat. The consultant has stated that it would take between six to twelve months to complete the work from design to implementation. A small group of compilers could pilot-test the application before next year's meeting to test before going live the following year. Intersessional discussions will establish whether existing templates (e.g. for the EU) may be used to minimise work for National Compilers.

Given the new proposed changes to the format of the tables, the work can be completed in two stages:

(1) using the existing data-collection methods with the new amended tables for next year's Progress Reports for publication at the 2011 Annual Meeting; and
(2) implementing the web application with the new amended tables to collect data for the Progress Reports for the 2012 Annual Meeting.

Using the existing data-collection methods with the amended tables in the first year would allow the data collectors to familiarise themselves with the changes while work on building the web applications and database was underway. Any fine-tuning to the tables could be decided at the 2011 Annual Meeting before the database was finalised, aiding design at the root-level.

Proposed Changes to the Progress Report Template

1. DATA PROVIDERS/COMPILERS

Country	Compiled by	Affiliation	Address

This report summarises information obtained from:

Name of agency/institute	Abbreviation (use in rest of report)	Contact e-mail address

2. SIGHTINGS DATA

Give brief details of systematic surveys, when and where held and references to cruise reports if applicable. Systematic surveys will be defined and the table will also include appropriate data from platforms of opportunity.

Species	Date	Large Area	Comments	Survey type	Contact	References (e.g. IWC paper)
[Drop down menu]	[Drop down menu: from/to dates]	[Drop down menu]	E.g. further area info	[Drop down] e.g. Platform of Opportunity, systematic-line transect		

3. MARKING DATA

3.1 Field work

3.1.1 Natural marking data

Species	Feature	Large Area	Comments	Years over which catalogue existed (range)	No. Individuals in catalogue	Contact	References
[Drop down menu]	[Drop down menu] e.g. fluke	[Drop down menu]	E.g. further area info				

3.1.2. Artificial marking data

This would include such things as Discovery marks (especially recovery information) or external artificial tags.

3.1.3 Telemetry data

Include both satellite and radio-tags.

Species	Large Area	Small Area	Comments	Tag type	No. successfully deployed*	Contact	References
[Drop down menu]	[Drop down menu]	[Drop down menu]	E.g. further area info	[Drop down menu]			

*successfully deployed is defined as those deployed and successfully providing data.

4. TISSUE/BIOLOGICAL SAMPLES COLLECTED

Species	Large Area	Small Area	Comments	Source	Purpose of study	Number collected	Tissue type	In tissue bank/register	Total holdings	Contact	Refs
[Drop down menu]	[Drop down menu]	[Drop down menu]	E.g. further area info	[Drop down menu] Commercial, aboriginal etc.	[Check boxed for pollutants, age study etc.]		[Check boxes for skin, blubber etc.]	[Drop down menu] Yes/ No			

5. STATISTICS FOR LARGE CETACEANS

5.1 Corrections to earlier years' statistics for large whales

This is the correct place to include any corrections to statistics presented in earlier years. It is also appropriate to include references to studies that utilise time series of data here [existing database entries manually edited by Secretariat].

Species	Date	Large Area	Correction details	Contact person	References
[Drop down menu]	[Drop down menu: from/to dates]	[Drop down menu]			

5.2 Direct catches of large whales (commercial, aboriginal and scientific permits) for the calendar year 20XX or the season 20XX/XX

It must be noted that this summary is not considered to fulfil the obligation to supply data to the Commission as specified in the Schedule.

Species	Type of catch	Large Area	IWC Small Area	Comments	Males	Females	Total landed	Struck and lost
[Drop down menu]	[Drop down menu] e.g. aboriginal	[Drop down menu]	[Drop down menu]	e.g. further area info				

5.3 Non-direct anthropogenic mortality of large whales for the calendar year 20XX or the season 20XX/XX

5.3.1 Observed or reported ship strikes of large whales (including non-fatal events)

The inclusion of this data was agreed by the Committee in 2004 (IWC, 2005). If available, please use latitude and longitude for location or else specify as much detail as possible.

Species	Large Area	IWC Small Area	Comments	Date	Sex	No.	Fate	Submitted to IWC ship strikes database	Contact person	References
[Drop down menu]	[Drop down menu]	[Drop down menu]	E.g. long/lat	[Drop down menus: from/to dates]	[Drop down menu] M, F, U			[Drop down menu] Yes, No		

5.3.2 Fishery bycatch of large whales

The inclusion of this data was agreed by the Committee in 2004 (IWC, 2005). If available, please use Latitude and Longitude for location. The Committee also agreed that types of fishing gear involved in bycatch should be documented (IWC, 2005). More detailed information and illustrations of the different types of fishing gear can be found on the FAO/FIGIS website[1]. Please also include any instances of entanglement in shark exclusion nets, which are another important source of bycatch. **If no mortality has been reported then please state this in the table (do not leave blank).**

Species	Large Area	IWC Small Area	Comments	Date	Sex	No.	Fate	Targeted fish species	Gear	How observed	Contact person	Refs
[Drop down menu]	[Drop down menu]	[Drop down menu]	e.g. long/lat	[Drop down menus: from/to dates]	[Drop down menu] M, F, U				[Drop down menu] FAO codes	[Drop down menu] FAO codes		

6. STATISTICS FOR SMALL CETACEANS

It was first agreed to include this information in a Commission resolution in 1976 (IWC, 1977, p.31). Furthermore, in 2005 (IWC, 2006) it was agreed that these data should be brought into line with those reported for large cetaceans. **Therefore, this section should be completed using the same guidelines as given in Section 5 above, *Statistics for large cetaceans.* If no mortality has been reported then please state this in the table (do not leave blank).**

6.1 Corrections to earlier years' statistics for small cetaceans

This is the correct place to include any corrections to statistics presented in earlier years. It is also be appropriate to include references to studies that utilise time series of data here [database entry manually edited by Secretariat].

Species	Date	Large Area	Correction details	Contact person	References
[Drop down menu]	[Drop down menu: from/to dates]	[Drop down menu]			

6.2 Direct catches of small cetaceans for the calendar year 20XX or the season 20XX/XX

Species	Type of catch	Large Area	IWC Small Area	Comments	Males	Females	Total landed	Struck and lost
[Drop down menu]	[Drop down menu] e.g. aboriginal	[Drop down menu]	[Drop down menu]					

6.3 Anthropogenic mortality of small cetaceans for the calendar year 20XX or the season 20XX/XX

6.3.1 Observed or reported ship strikes of small cetaceans (including non-fatal events)

Species	Large Area	IWC Small Area	Comments	Date	Sex	No.	Fate	Submitted to IWC ship strikes database	Contact	Refs
[Drop down menu]	[Drop down menu]	[Drop down menu]	E.g. long/lat	[Drop down menus: from/to dates]	[Drop down menu] M, F, U		[Drop down menu]	[Drop down menu] Yes, No		

6.3.2 Fishery bycatch/entanglement of small cetaceans

Species	Large Area	IWC Small Area	Comments	Date	Sex	No.	Fate	Targeted fish species	Gear	How observed	Contact person	Refs
[Drop down menu]	[Drop down menu]	[Drop down menu]	E.g. long/lat	[Drop down menus: from/to dates]	[Drop down menu] M, F, U				[Drop down menu] FAO codes	[Drop down menu] FAO codes		

[1]*http://www.fao.org/figis/servlet/static?dom=root&xml=tech/gears_search.xml.*

There will be intersessional discussions on if and how to incorporate the EU table below.

Incidental catch rates by fleet segment and target species

Metier	*Fishing area*	*Main target species*	*Incidentally caught cetaceans species*	*Number of incidents*	*Number of specimens incidentally caught by species*		*Incidental catch rates*		*Total incidental catch estimate*	*CV*
					With pingers	*Without pingers*	*With pingers*	*Without pingers*		
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*

There will be intersessional discussions on if and how to incorporate information from monitoring programmes e.g. ICES.

7. STRANDINGS

Give a paragraph detailing the nature of the strandings reporting process (e.g. completely opportunistic, one or more networks, coastline covered, seasonal coverage). Then complete the following summary table with information where people can go for more details.

Species	Total no. individuals stranded reported to national authority in calendar year	Total no. stranding events	Contact person(s)/ institute(s)	References
[Drop down menu]				

*Note the IWC keeps an up-to-date list of national stranding networks. Please check the information for your country is up to date HERE [link to database of networks].

8. LITERATURE CITED

Include all references cited in the text here. Please follow the official IWC style guide for references (*http://www.iwcoffice.org/publications/styleguide.htm*). Please include information as to where the documents may be obtained **and if possible, pdf versions or reprints for the library.**

Reference in full	Cited in tables	Publication status	Where document can be obtained
	[Drop down menu] Yes/No	[Drop down menu] published, in press etc.	

REFERENCES

International Whaling Commission. 1977. Chairman's Report of the Twenty-Eighth Meeting. *Rep. int. Whal. Commn* 27:22-35.

International Whaling Commission. 2005. Report of the Scientific Committee. Annex J. Report of the Sub-Committee on Estimation of Bycatch and Other Human-Induced Mortalities. *J. Cetacean Res. Manage. (Suppl.)* 7:254-62.

International Whaling Commission. 2006. Report of the Scientific Committee. Annex J. Report of the Working Group on Estimation of Bycatch and Other Human-Induced Mortality. *J. Cetacean Res. Manage. (Suppl.)* 8:177-84.

Annex Q

E-mail Correspondence Groups and Terms of Reference

Group		Terms of Reference	Membership
(1)	Aboriginal Subsistence Whaling Management Procedure (Steering Group)	Continue progress towards development of an AWMP and plan for intersessional Workshop.	Donovan (Convenor), Allison, Brandão, Breiwick, Butterworth, Cooke, George, Givens, Heide-Jørgensen, Laidre, Punt, Schweder, Walløe, Witting, Zeh.
(2)	Greenlandic common minke whale sex-ratio (Working Group)	Refine the specifications and implement the assessment methods and robustness tests.	Allison (Convenor), Punt, Schweder, Witting.
(3)	Calving rates and intervals (Working Group)	Finalise the analyses of the calving rate and calving interval data.	Punt (Convenor), Brandon, Cooke, Kitakado.
(4)	*Pre-Implementation assessment* of western North Pacific common minke whales (Steering Group)	Coordinate intersessional work and facilitate holding the Preparatory Meeting and the First Intersessional Workshop.	Butterworth (Convenor), Allison, An, Baker, de Moor, Donovan, Double, Hammond, Kitakado, Park, Pastene, Punt, Wade, Waples.
(5)	MSYR for baleen whales (Steering Group)	Facilitate finalisation of analyses related to MSYR.	Butterworth (Convenor), Allison, Brandon, Cooke, Donovan, Kitakado, Punt, Walløe.
(6)	North Atlantic fin whale advisory committee	Advise Icelandic scientists as needed whilst the Icelandic research programme is being developed.	Allison, Butterworth, Donovan, Punt, Skaug.
(7)	Assessment of Southern Hemisphere Humpback Whale Breeding Stock B	Prepare to complete assessment of humpback whale breeding stock B during IWC/63.	Zerbini (Convenor), Best, Barendse, Butterworth, Carvalho, Cerchio, Collins, Donovan, Findlay, Jackson, Johnston, Muller, Palka, Punt, Robbins, Rosenbaum, Weinrich.
(8)	Assessment of Southern Hemisphere Humpback Whale Breeding stocks E and F	Collate information needed for the assessment of breeding stocks E and F.	Jackson (Convener), Bannister, Baker, Butterworth, Clapham, Holloway, Kaufman, Muller, Pastene, Robbins, Weinrich, Zerbini.
(9)	Blue whale abundance mark-recapture group	To obtain mark-recapture abundance estimates in west Australia and Chile and elsewhere as possible.	Bannister (Convener), Brownell, Double, Galetti, Hammond, Hucke-Gaete, Olson, Matsuoka, Pastene, Williams.
(10)	Blue whale sample depletion group	Discuss approaches towards mitigating depletion of blue whale biopsy samples from SOWER cruises.	Donovan (Convenor), Baker, Brownell, Double, Rosenbaum.
(11)	Southern Hemisphere right whales (Working Group)	Plan towards an assessment of southern right whale populations.	Brownell (Convenor) Bannister, Best, Burnell, Childerhouse, Groch, Kitakado, Pastene, Reeves, Sironi.
(12)	Commemoration of SOWER cruises (Steering Group)	To commemorate the IWC-IDCR/SOWER research surveys consider updating the IWC website and creating a special volume of the *Journal of Cetacean Research and Management*.	Bannister, Donovon (co-Convenors), Best, Burt, Ensor, Hedley, Hughes, Kato, Matsuoka.
(13)	Abundance estimation methods (Working Group)	(1) Run sensitivity tests on modified real datasets to understand differences between OK and SPLINTR; (2) as above, to understand differences between OK/SPLINTR and Standard; (3) following identification of the underlying statistics/parameters where big differences occur, develop ways to cross-check against empirical data; and (4) if necessary, design further simulation trials to test robustness.	Walløe (Convenor), Branch, Bravington, Butterworth, Cooke, Hedley, Kitakado, Okamura, Palka, Skaug, Wade.
(14)	Catch-at-age analyses (Working Group)	Continue work on catch-at-age models.	Punt (Convenor), Butterworth, Kitakado, Polacheck.
(15)	IWC North Pacific Survey Planning (Steering Group)	(1) Identify medium and long term research objectives for the IWC-Japanese North Pacific surveys; and (2) develop a (multi-year) research plan to achieve these objectives.	Kato (Convenor), An, Brownell, Clapham, Donovan, Ensor, Matsuoka, Miyashita, Murase, Pastene, Wade.
(16)	Survey design for 2010/11 Antarctic minke whale survey (Working Group)	(1) Consider survey design with respect to spatial and temporal coverage, and ice extent, to reduce ambiguities in interpretation of abundance estimates; and (2) evaluate and consider adapting survey protocols to facilitate flexible and improved analyses.	Matsuoka (Convenor), Bravington, Ensor, Hedley, Kitakado.
(17)	SOWER database validation (Working Group)	Validate full IDCR-SOWER database (CP I, II, III) to allow finalisation of abundance estimates for CPII and CPIII.	Butterworth (Convenor), Bravington, Burt, Donovan, Hughes, Okamura
(18)	DNA data quality (Working Group)	Further develop guidelines in SC/60 Annex I, Appendix 2, including initial suggestions for numerical guidelines where appropriate.	Tiedemann (Convenor), Bachmann, Baker, Cipriano, Double, Hoelzel, Morin, Natoli, Palsbøll, Pampoulie, Pastene, Postma, Skaug, Waples.

Cont.

Group	Terms of Reference	Membership
(19) Ship Strike Review (Working Group)	(1) Review all data entries including standardisation of codes from earlier data entries. Enter data from National Progress Reports and papers presented to IWC/62; (2) develop a database handbook describing and listing all the fields and field codes; and (3) develop written definitions for determining whether an incident was classified as a definite, probable or possible strike.	Leaper (Convenor), Cañadas, Donovan, Double, Ferguson, Mattila, Panigada, Ritter, Rowles, Weinrich.
(20) Progress Reports (Working Group)	Develop and implement a template for online submission of progress reports.	Donovan, Fortuna, Gedamke, Jones, Leaper, Perrin, Tandy.
(21) State of Cetacean Environment Report (SOCER) (Working Group)	Collate information for production of the SOCER report.	Parsons/Rose/Stachowitsch (co-Convenors).
(22) POLLUTION 2000+ Phase II (Steering Group)	(1) Complete the chemical prioritisation survey and analyses; and (2) risk assessment modelling to determine the impact of pollutants on cetacean populations.	Ylitalo (Convenor), Burkhardt-Holm, Donovan, Fossi, Hall, Rowles, Rosa, Simmonds.
(23) Cetacean Emerging and Resurging Diseases (Working Group)	(1) Complete the identification of diagnostic laboratories by region, ocean basin or country; (2) build on a One Health concept, coordinate with other wildlife disease surveillance efforts; (3) complete the prioritisation of pathogens survey and analyses and provide a report at SC/63; (4) enhance capacities and communications between stranding networks; (5) provide scientific advice and experts for investigations of die-offs or outbreaks; and (6) create a CERD website.	Rowles/Van Bressem (co-Convenors), Bolaños, Brownell, Carlson, Di Guardo, Fernández, Galletti, Iñíguez, Marcondes, Mattila, Robbins, Rojas-Bracho, Rosa, Sanino, Uhart, Vély.
(24) Climate change and small cetaceans (Working Group)	(1) Collate and review existing research, taking into account the IWC climate change Workshop report; (2) identify key studies, species and areas and opportunities for further research; and (3) develop recommendations for future research.	Simmonds (Convenor), Alter, Bjørge, Murphey, Ritter, Rogan, Rose, Scheidat, Suydam.
(25) Small cetaceans in the North Atlantic (Working Group)	(1) Explore possibility of a joint workshop on monodontid with NAMMCO SC and the Canada-Greenland Joint Commission on Narwhal and Beluga; and (2) facilitate exchange of data between IWC and NAMMCO.	Bjørge (Convenor), Acquarone, Donovan, Fortuna, Reeves, Rosing-Asvid.
(26) LaWE Steering Group	(1) Initiate collaboration request and report on responses; (2) develop procedural mechanisms to centralise data received from identified collaborators; (3) utilise received data to commence power analysis for key parameters; develop matrix to categorise populations for site selection; (4) initiate contact with field researchers to inform options for site matrix; and (5) continue to facilitate comm-unication on LaWE progress with members of the sub-committee.	Lusseau (Convenor), Bejder, Bjørge, Bolaños, Carlson, Robbins, Rose, Sironi, Weinrich, Williams.
(27) LaWE budget development (Steering Group)	Advance development of a draft budget and funding mechanisms for the LaWE.	Weinrich (Convenor), Kaufman, Lusseau.
(28) On-line data base for world-wide tracking of commercial whalewatching and associated data collection (Working Group)	Advise on the design of a database of whalewatching activities and associated data.	Robbins (Convenor), Bejder, Bolaños, Carlson, Kaufman, Lusseau, Simmonds, Weinrich, Williams.
(29) Swim-with-whale operations (Working Group)	Field-test a questionnaire intended to assess the extent and potential impact of swim-with-whale operations and refine as needed.	Rose (Convenor) Parsons, Ritter, Sironi, Weinrich.

Annex R

Proposed Funding Mechanism for Allocation of IWC SORP Funds

The process for the allocation of funds from the IWC Southern Ocean Research Partnership (SORP) Research Fund is given below. The background to SORP, its objectives and a description of any funded projects are available on the SORP website[1] hosted by the Australian Antarctic Division.

1. Review by the SORP Steering Group (SSG)

1.1 All project descriptions and applications for funding will initially be sent to the SSG in accordance with the *pro forma* given as Appendix 1. The SSG is a Working Group of the IWC Scientific Committee with representatives from various countries that have expressed an interest in being involved with SORP. A list of the members of the SSG is included as Appendix 2.

1.2 The SSG will review the proposal and the budgetary requests taking into account:
- the objectives of SORP and the research priorities of the IWC;
- the likelihood of success of the researchers in meeting the stated objectives in the proposed timeframe;
- the degree to which the proposal is multinational;
- the geographical range of the field work and/or the researchers;
- any broader applications of the work for cetacean conservation biology; and
- the overall level of the budget compared to the available funds.

The SSG may suggest improvements to proposals where they believe this is appropriate and may solicit the assistance of other researchers in the review process.

Upon receipt of a final revised proposal (if necessary), the SSG will provide a short review of the proposal to the IWC Scientific Committee for consideration at its next meeting, including comments on the issues outlined above and a concluding section recommending that the proposal and budget is fully supported, partially supported or declined.

2. Review by the IWC Scientific Committee

2.1 The SSG will present the recommended projects and budgets to the Scientific Committee in Plenary under a standing SORP Agenda item.

2.2 Following consideration (and potential revision) by the Scientific Committee, approved requests will be added to the Scientific Committee budget as a specific request to the SORP Research Fund (i.e. outside the normal Scientific Committee research budget)[2].

2.3 This final budget request will then form part of the Report of the Scientific Committee and will be presented to the Commission for approval.

3. Review by the Commission

3.1 The Scientific Committee Report and associated budget will be considered by the Commission and the SORP funding requests will be approved during normal business.

4. IWC Secretariat to develop funding agreements with approved projects

4.1 Based on the proposals approved by the Commission, the Secretariat will organise contracts with the successful projects.

In addition to the normal funding process, the SSG is able to allocate a small discretionary amount (i.e. less than £4,000*) for 'emergencies' or for issues that require urgent action (e.g. cannot wait until the next Scientific Committee meeting for approval). Such grants will be consistent with the objectives of SORP and the IWC, will be discussed and agreed by the SSG, and reported in the annual SORP report to the next Scientific Committee meeting.

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[1] *http://www.marinemammals.gov.au/southern-ocean-research-partnerships-sorp.*

[2] This is similar to the present process for the Small Cetaceans Fund and will ensure that the IWC SORP funds are only allocated to SORP projects.

*Editor's note: This was amended to £15,000 by the Commission.

Appendix 1

SORP RESEARCH PROPOSAL REQUEST *PRO FORMA*

International Whaling Commission, 135 Station Road, Impington, Cambridge, UK, CB24 9NP;
Tel: +44 1233971 Fax: +44 1223 232876 E-mail:iwc@iwcoffice.org

SORP Research Proposal Request

Please complete the following sections in full and do not exceed the word limits indicated.

1. TITLE OF PROJECT (do not exceed 30 words)

2. DETAILS OF NAMED INVESTIGATORS (Principal Investigator first)

Name	
Address	
Email	
Nationality	
Domicile	

Name	
Address	
Email	
Nationality	
Domicile	

Please use one table per investigator.

3. DESCRIPTION OF PROJECT (do not exceed 3,000 words)
This should adequately explain the following aspects:
(i) background to the proposal, underlying rationale **and relevance to SORP objectives and IWC needs;**
(ii) specific objectives;
(iii) scientific methodology and approach;
(iv) programme or plan of research;
(v) requirement for resources sought in this application; and
(vi) any wider justification for the project.

4. CURRICULUM VITAE OF NAMED INVESTIGATORS (1 page per investigator)

5. BUDGET (If for more than 1 year, present annual budgets)
(i) Salaries/wages (include name/position of each individual and breakdown of time and duties involved.
(ii) Travel (breakdown by person and justification).
(iii) Services (e.g. aircraft/vessel time; consultancy fees etc.).
(iv) Non-expendable capital equipment (becomes IWC property upon completion).
(v) Expendable capital equipment.
(vi) Itemised shipping costs.
(vii) Itemised insurance costs.
(viii) OVERHEADS (Note: it is not standard IWC policy to pay overheads – however, in special circumstances these may be negotiated on a case-by-case basis with the secretariat. Inclusion of overheads may affect the likely success of the application).

6. OTHER GRANTS HELD FOR THIS OR OTHER RESEARCH, OBTAINED OR SOUGHT WITHIN THE PREVIOUS THREE YEARS (Provide details of amount, title of project and completion date)

7. PERMITS
(i) Do you have the appropriate permits to carry out the field work, including, if NECESSARY, animal welfare considerations? Give details and enclose copies.
(ii) Do you have the appropriate permits (e.g. CITES) for the importation of ANY samples? Give details and enclose copies if appropriate.

8. SCHEDULE OF WORK, REPORTING AND USE OF RESULTS

(i) Expected completion of final report (note that an annual progress report is required).
(ii) Will you submit a manuscript on the results to the *Journal of Cetacean Research and Management* upon completion of the work? (Whilst this is not a pre-requisite of a successful application, it will be taken into account). If not please state your publication plans.
(iii) Will you agree to the use of the results of your study, if requested by the IWC Scientific Committee under its Data Availability Agreement that protects first publication rights of the researchers? Note that for fully funded IWC research, the data shall become publicly available after a mutually agreed period.

	Yes		No

9. TWO REFEREES WHO COULD BE APPROACHED

Name	
Address	
Email	

Name	
Address	
Email	

Appendix 2

MEMBERS OF THE SORP STEERING GROUP

The following is a list of the current members of the SORP Steering Group.

South American Representation:
Barbara Galletti (Chile)
Miguel Iñíguez (Argentina)
Fábia Luna (Brazil)

North American Representation:
Bob Brownell (USA)

European Representation:
Jean-Benoît Charrassin (France)
Karl-Hermann Kock (Germany)

African Representation:
Herman Oosthuizen (South Africa)

Oceania Representation:
Simon Childerhouse (Australia – and co-ordinator role)
Nick Gales (Australia)
Vacant position (New Zealand or South Pacific)

IWC Representation:
Alex Zerbini (Chair of the Sub-committee on Other Southern Hemisphere Whale Stocks)
Debra Palka (Chair of the Scientific Committee)
Greg Donovan (IWC Head of Science)

Annex S

Terms of Reference and Guidance for Discussions under Item 20

ANNEX S1. TERMS OF REFERENCE AND GUIDANCE FOR THE SCIENTIFIC COMMITTEE'S WORK WITH RESPECT TO THE FUTURE OF THE IWC DISCUSSIONS[1] TAKEN FROM DOCUMENT IWC/62/6

(1) Review of the scientific aspects of the draft in the Chair's Report to the SWG (IWC/M10/SWG4)
The Scientific Committee shall review, for clarity and completeness:

(1) Annex {DNA} – DNA registry and market sampling scheme (this is based on the work of an earlier specialist group (IWC/55/COMMS3) and the objective is to ensure that it remains up-to-date and complete, representing a cost-effective, robust, independent and transparent system in conjunction with the other monitoring and control measures).

In particular the review of the proposed mechanism (for national schemes with international audit) will ensure that the technical specifications:

- under Section 1 (specifications for the establishment/ maintenance of a diagnostic DNA register/tissue archive) remain adequate, suggesting improvements if necessary, including the clarification of details, including appropriate auditing mechanisms, such that appropriate auditing can begin during the first season of an interim arrangement; and
- under Section 2 (specifications for the establishment/ maintenance of market sampling schemes) remain adequate, and in particular that a process to allow effective market sampling to occur at the start of the interim period is established, recognising, as stated under Item 2.1 that this will be an iterative process.

(2) Annexes {SI} and {OI} – Scientific information and operational information (this is again based on earlier work of the Scientific Committee and the objective is to ensure that it remains up-to-date and complete).
(3) Appendix B – the potential work plan for the Scientific Committee's assessment work on non-indigenous whaling for the period up to 2020 (the work plan comes from the Report of the Scientific Assessment Group [SAG], see below).
(4) The SAG report will be reviewed when there are numbers in Table 4 (see below).

[1]At the meeting of the Support Group held on 5 March 2010 and when commenting on the draft SWG report, Australia noted its concern regarding the decision at the SWG meeting to table the report of the Scientific Assessment Group (IWC/M10/SWG6) without the prior agreement of all of the Support Group (see p.3 of the SAG Report). It has written to the Chair of the Commission outlining its concerns. Given this, Australia has indicated that it is not in a position to agree to the Terms of Reference and guidance in Annex G of IWC/62/6 believing the matter needed careful consideration within the Support Group at its April meeting.

(2) Review of the SAG Report (IWC/M10/SWG6)[2]
As part of the process on discussions on the Future of the IWC, a Scientific Assessment Group (SAG) was established comprising scientists from Australia, Brazil, Germany, Iceland, Japan, Mexico, Norway and the USA and one invited participant. The consensus report of that Group is given as IWC/M10/SWG6. Its Terms of Reference are given in detail in Annex B of that report and can be summarised as:

> 'to provide a concise scientific review on whether it believes that any proposed catches are such that the **long-term** status of the populations concerned will not be negatively affected. This evaluation will recognise that there will be an RMP *Implementation* or *Implementation Review* during the interim period, as outlined in a draft schedule of relevant work of the Scientific Committee. The SAG may undertake its own analyses in addition to those presented in proposals.'

The SAG noted that it was not appropriate for its report to provide a fully documented scientific analysis for each stock as would be the case for a full Scientific Committee Report; the primary objective was to provide the Support Group with concise advice on either proposed short-term catches for the period before the full RMP would be implemented or the results of RMP runs where practical.

For cases where there is no RMP *Implementation*, the SAG **agreed** that it would examine all the available information and provide an integrated, common-sense view on whether the proposed short-term catches are likely to negatively affect the long-term status of the stock, given that such short-term catch limits will only be used until an RMP *Implementation* has been completed and implemented and that the full RMP *Implementation* will take into account any catches between now and the RMP *Implementation* in determining new catch limits.

The SAG had recognised that there are a number of different approaches to evaluating short-term catches; it did not try to develop a single method - indeed there is a wide range of catch levels that may meet the general criterion of not negatively affecting the long-term status of the stock, given that they will only be used until an RMP *Implementation* has been completed and the RMP implemented. In such cases, the SAG's conclusions are general and based on its cumulative overview of the available information.

In providing the general advice given in its report, the SAG **had stressed** that the future efforts of the full Scientific Committee should focus on completing RMP-related work as soon as possible rather than re-examining any advice on short-term catches.

[2]See footnote 1.

Terms of Reference for the Scientific Committee

The SWG **requests** that the Scientific Committee reviews the report of the SAG at its meeting in Agadir. In undertaking this review, the Scientific Committee shall follow the Terms of Reference of the SAG *[Given as Annex S2 below]*, recognising: (a) the need to be concise; (b) the fact that there are a number of different approaches to evaluating short-term catches and no single method will be appropriate in all circumstances; and (c) that the report should provide an integrated, pragmatic view on whether or not the proposed short-term catches (i.e. before the RMP can be used) are likely to negatively affect the long-term (i.e. RMP simulation framework timeline of 100 years) status of the stock *given* the timetable for RMP work. The SWG **agrees** that the Chair of the Scientific Committee shall ensure that the time spent on this review should be such that it does not interfere with the Committee's focus on completing RMP-related work as soon as possible.

ANNEX S2. TERMS OF REFERENCE FOR THE SCIENTIFIC ASSESSMENT GROUP (SAG) - GUIDANCE FROM THE SUPPORT GROUP (SEE IWC/M10/6)

A group of scientists nominated by the Support Group[3] will participate in a closed meeting on 24-26th January 2010 in Hawaii in order to provide scientific advice to the Support Group on any proposed interim whale catch levels for discussion by the Support Group. Note that the scientific group will not be asked to comment upon proposed catches for indigenous whaling; these will be based upon existing and approved AWMP processes.

The following principles will guide the scientific review.

The IWC has been agreed that long-term management will be based on the IWC's management procedures/ algorithms such as the RMP or AWMP. As long-term management advice will not be available for all whale populations for which catches are proposed at the time of the assessment, it will be necessary to assess short-term catch levels with other mechanisms until such time as the long-term advice is available. It has been agreed that any such short-term assessment will reflect policy decisions such that the numbers will be less than catch limits based on the best available science. Taking into account the likely limitations of available data for some populations, the assessment will be precautionary and will determine if the interim catches are set at levels that will not negatively affect the long-term status of the stock, given that such short term catch limits will only be used until an RMP *Implementation* or *Implementation Review* has been completed and implemented. As part of the arrangement, there will be an overall strategy that allows for completion of an RMP *Implementation* or *Implementation Review* as soon as possible, and in any case before the completion of the interim period. Any RMP *Implementation* or *Implementation Review* will take into account the actual catches taken during the interim period. If catch levels determined by the RMP processes are lower than the agreed catch levels, then the catch limits will be adjusted accordingly.

Member Governments proposing interim catch levels must provide appropriate (see below) documentation to the Secretariat for circulation to the Scientific Assessment Group by Monday 18th January 2010. The proposal documents will remain entirely confidential until and if the Support Group determines otherwise.

It is thus the task of the Scientific Assessment Group to review any proposals by Members States and provide a *concise* scientific review on whether it believes that any proposed catches are such that the **long-term** status of the populations concerned will not be negatively affected. This evaluation will recognise that there will be an RMP *Implementation* or *Implementation Review* during the interim period, as outlined in the schedule of relevant work of the Scientific Committee. The group may undertake its own analyses in addition to those presented in proposals.

Guidelines for the contents of the proposal to be submitted to the scientific review

(1) The species and number of whales to be taken in each year of the arrangement by stock(s) and geographical area(s) and the time period (e.g. months) that the whaling will occur.
(2) Any other limitations that may be imposed on the whaling operation(s).
(3) Scientific justification that the proposed catches fall within the principles for 'interim measures' outlined above. This will include:
    - reference to any work on the affected stock or stocks undertaken by the Scientific Committee in the context of the RMP or an In-depth Assessment;
    - a summary of knowledge of the population size and stock structure of the whale population from which the whales are proposed to be taken, including consideration of uncertainty;
    - scientific justification for the conclusion that the catches will not negatively affect the long-term status of the stock, including consideration of all anthropogenic mortality (e.g. bycatch, ship strikes), not only that from the whaling proposed in the interim arrangement; and
    - specification of any research work that will be undertaken to facilitate the conduct of an *Implementation* or *Implementation Review*, including the timeframe for such work.

[3]The Scientific Assessment Group will be kept as small as possible. Proposed representation is from: Australia, Germany, Iceland, Japan, Mexico, Norway, the USA and the Secretariat plus one other scientist external to the Support Group. The group may select an independent scientist and get him/her to sign an agreement of confidentiality.

Annex T

Final Proposed Annexes for Item 20

Annex {DNA} dated *day/month/year*

Specifications and requirements for diagnostic[17] DNA registers and market sampling schemes

1. SPECIFICATIONS FOR THE ESTABLISHMENT/ MAINTENANCE OF A DIAGNOSTIC DNA REGISTER/TISSUE ARCHIVE

1.1 Laboratories

1.1.1 Minimum laboratory requirements

(1) Laboratories performing DNA analysis shall be recognised by the Contracting Government under whose jurisdiction whales are harvested.
(2) Quality control and quality assurance features shall ensure that:

 (a) analysts have acceptable education, training and experience for the task;
 (b) reagents and equipment are properly maintained and monitored;
 (c) procedures used are generally accepted in the field and have been approved by the IWC Scientific Committee (see Items 1.2-1.5); and
 (d) appropriate controls are used.

(3) Thorough laboratory records (protocols, notes, worksheets, etc.) shall be maintained and archived for possible inspection (see Item 1.7).
(4) Changes in equipment and approved methods shall be recorded and reported annually to the IWC to allow ongoing standardisation among registers (see Item 1.7).
(5) A suitable inventory management system shall be in place so that the whereabouts and use of each sample/aliquot over time during storage and analysis can be traced.
(6) Portions of the tissue samples and DNA extracts should be retained and stored indefinitely or until advised by the Scientific Committee, using an appropriate preservation method (see Item 1.2.2).
(7) The probability of genotyping errors occurring should be estimated and minimised, using standard procedures and also including provisions for detection of mis-labelling, duplicate samples, data entry errors, etc. DNA sample quality should be checked routinely prior to genetic analysis to ensure adequate accuracy in the genotyping of degraded samples (as recommended in IWC (2009), and subsequent updates to the genetic analysis guidelines). DNA data quality/acceptability should be addressed in accordance with generally accepted rules and reported annually where possible (e.g. PHRED scores for sequences, SDs of fragment length measurements for microsatellite alleles, means and SDs of peak heights for microsatellites, some evaluation of stutter for each microsatellite locus). This information should be reported annually to the IWC (see Items 1.5 and 1.7).
(8) A reference set of samples should be designated for allelic standards and an equimolar allelic ladder should be constructed by cloning and sequencing a range of alleles for each microsatellite locus.
(9) The laboratory shall participate in calibration exercises with other laboratories if requested to do so by the IWC (see Item 1.1.2), and taking into account both the analysts involved, the methods and/or software used for binning alleles, and the type of equipment used for genotyping.
(10) The laboratory should be available for external evaluation and participate regularly in proficiency tests such as double-blind comparisons (e.g. see Item 1.7).

1.1.2 Calibration of laboratories if more than one is used

Where more than one laboratory is used to generate a single register or a group of registers, or for the comparison of samples (e.g. under Item 1.8 or Item 2), appropriate calibration of microsatellite genotype scoring (e.g. absolute size or binning) must be undertaken and the results reported to the IWC. The details of the calibration exercise shall be determined by the international expert group (see Item 1.7). The calibration exercise will primarily comprise a double blind experiment with known individuals. Cloned alleles should be used to construct an allelic ladder for calibration purposes. The results of calibration exercises must be reported to the IWC. In designing calibration exercises and reviewing the results, it must be remembered that the primary function of diagnostic DNA registers is to determine whether illegal activity is taking place and that the default position is no match=illegal activity. In this regard it is important to estimate the likelihood of:

- erroneously failing to match products to an animal in the register when it is actually there – i.e. falsely implying an infraction;
- erroneously matching products to an individual in the register when it is not actually there – i.e. missing an infraction when one has occurred.

[17]A diagnostic DNA register is one that contains DNA profiles of all animals from which products might legally appear on the market (e.g. from legal direct catches, legal imports, bycatches, ship strikes etc.). DNA profiles from legally imported whales should thus be included in the importing country's registry as one of the conditions for importation. On this basis, any products found on the market that were from whales not included in the register will be from illegally taken or illegally imported whales.

[18]Contracting Governments under whose jurisdiction bycaught/stranded whales and their products may be legally marketed are responsible to develop a technical manual for collecting samples and ancillary data for inclusion in DNA registries, and for disseminating such materials and training to others who may be involved in the collection of genetic samples for such use.

1.2 Sample collection
Samples for DNA registry should be collected by trained personnel[18] before products from them can enter the market.

1.2.1 Size of samples
At least two samples of skin/muscle of at least 5x5x5mm must be collected from each animal for each register/archive. In addition, where possible, at least four muscle samples of 20x20x20mm should be taken. Where possible, a sample of tissue from any foetuses detected should be collected. All samples should be taken as quickly as possible and immediately placed in an appropriate preservative, and then frozen as quickly as possible at or below -20°C.

1.2.2 Preservation
Samples should initially be preserved in 95% ethanol (in at least five times the volume of the sample, due to potential problems of dilution and evaporation) or in five times the volume of NaCl-saturated DMSO (dimethyl-sulfoxide). If not able to be frozen immediately, the samples should be shipped as soon as possible (preferably within 7 days) to the analysing laboratory. This temporary storage and shipping should be in temperatures <25°C to minimise the possibility of degradation of the sample.

Long-term storage of skin/muscle samples should be in 95% ethanol or NaCl-DMSO at or below -20°C. The additional muscle samples should be frozen in liquid nitrogen; transport should be with dry ice. For best preservation long-term storage of frozen tissue samples should be at or below -80°C or if that is not possible at or below -20°C.

1.2.3 Labelling
Reliable labelling of the sample is essential. The container should be labelled on both the inside and the outside with a unique identifying code that can be related directly to the biological and other information collected for the individual (see Item 1.2.4). The label on the inside must be indelible and insoluble in alcohol to ensure that the number remains legible after storage in ethanol. The label on the outside must also be robust and remain legible if exposed to ethanol or water.

1.2.4 Information to be collected
In addition to the information noted in Annex {SI} dated *day/month/year* to be collected for each whale (including date, locality, species, sex, and body length), the unique identifier (see Item 1.2.3) and the name (plus address if non-nominated person, e.g. in the case of bycatch) of sampling person must be recorded.

1.3 Tissue analysis
1.3.1 Extraction of DNA
Extraction of DNA should be carried out using standard methods which have been reviewed and approved by the IWC Scientific Committee. Extracted DNA aliquots should be stored in freezers at or below -80°C.

1.4 Markers and methods of analysis
Analysis of samples should be undertaken without knowledge of the biological and other information available for the whale from which the sample was taken.

Samples should be analysed for (at least):

(1) mitochondrial DNA - primarily for identification to species and population but also contributes to profiling;
(2) microsatellites (or Short Tandem Repeats, STRs) - for DNA profiling; and
(3) Y chromosomes - sex identification which also contributes to profiling.

1.4.1 Mitochondrial DNA
Analytical methods adhering to the quality standards as specified in the IWC genetic data quality guidelines (IWC, 2009 or subsequent updates) must be approved by the international expert group (see Item 1.7). Species identification should be accomplished with an approximately 500bp fragment of the 5'-end of the control region and sequencing should occur in both directions.

1.4.2 Microsatellites
Analytical methods adhering to the quality standards as specified in the IWC genetic data quality guidelines (IWC, 2009 or subsequent updates) must be approved and reviewed annually by the international expert group (see Item 1.7). Fluorescent techniques that allow electronic records to be kept should be used. This group will ensure that the number and degree of variability of loci used in DNA registers will be sufficient to allow for an acceptable level of average probability of correctly identifying an individual.

1.4.3 Sex identification
Analytical methods adhering to the quality standards as specified in the IWC genetic data quality guidelines (IWC, 2009 or subsequent updates) must be approved by the international expert group (see Item 1.7). Sex is an additional genotype that may prove useful to identify market samples and may also serve as a check on field data. Error rates (obtained by comparison with reliable field identification of sex) should be estimated and reported to the international expert group (see Item 1.7).

1.5 Format of individual records
Each whale is given a unique identifier that can be cross-referenced back to the biological and associated data for that animal. Records must contain:

(a) a microsatellites and sex profile, in which each whale profile is given one row, with one column for each allele (two columns for each microsatellite marker and the sex locus); and
(b) a mtDNA sequence file, in which each profile has one row, and one column for each site where the sequence deviates from the reference sequence.

In addition, the following must be archived:

General information for each sample:
- genotyping system; and
- software system.

'Raw' data:
- electropherograms;
- quality scores;
- raw allele sizes;
- peak heights;
- gel image (depending on platform used); and
- number of times the genotype replicated.

Summary data on each locus:
- error rate and how determined;
- allele frequencies in a given population;
- deviations from Hardy-Weinberg equilibrium; and
- evidence of null-alleles, short-allele dominance (or short-allele bias due to preferential amplification) or other artefacts.

1.6 Matching

The international expert group (see Item 1.7) will agree on software packages to be used for matching purposes.

1.7 External audit of DNA registers

An international expert group established pursuant to paragraph 42 shall:

- review and approve the initial technical specifications for the register(s) and any changes to those protocols;
- where necessary, decide on appropriate laboratories;
- where necessary, design calibration exercises for laboratories and review the results of those exercises;
- review annually specific information and statistics formally reported by the register(s) under Items 1.4-1.6;
- design and undertake periodic technical audits including the provision for trials using 'blind' control samples; and
- design and arrange for periodic site visits to examine whether the agreed protocols (under Items 1.2-1.5) are being followed.

The international expert group shall submit an annual report to the Secretariat of the IWC for distribution to Contracting Governments and the Commission (and, if necessary subsidiary bodies of the Commission) at least two months before it must be considered.

1.8 Mechanism for comparing samples to the IWC's central register, further to domestic market survey systems

A Contracting Government may request the IWC to compare any appropriately-documented tissue sample against the IWC's electronic register, regardless of where the sample was collected. The tissue sample should be sent to a qualified laboratory[19], not necessarily associated with the national registry. The associated documentation, which is specified below, should be sent to the Secretariat. The laboratory should send the DNA profiles (see Item 1.5) to the Secretariat as soon as possible, and the sample should be kept in long-term storage (see Items 1.1.1 and 1.2.3).

The associated documentation shall describe chain of custody from time of collection to submission, including the following information:

- name and address of 'collector';
- location obtained;
- type of vendor;
- date and time of collection;
- label, if present (or verbal description of nature and origin of product offered by vendor);
- where possible, photographs; and
- comments by the Contracting Government where the market sample was collected.

Analysis of the samples shall be carried out following the same quality control, sample handling and calibration procedures specified above in Items 1.1-1.4 by a qualified laboratory[19]. Officially-attested documentation of chain of custody must be established for the period between submission and provision of analytical results.

The comparison of the DNA profile against the IWC's central register shall be made using agreed software (see Item 1.6) [Option 1: after the annual update from the relevant national register.] [Option 2: Profiles that do not match would be held in a database that would be checked against the annually-updated registry each year.] The Secretariat shall make public the results within one week.

[19]A qualified laboratory is one recognised by a Contracting Government that meets the standards of Items 1.1.1 and 1.1.2 as specified by the international expert group.

1.9 Submission of DNA profiles to the IWC's central registry

Contracting Governments under whose jurisdiction whales and whale products may be legally marketed shall maintain a diagnostic DNA register and tissue bank. Before any products from a whale enter the market, samples for the DNA registry shall be collected from that whale, and submitted for inclusion in the domestic registry. DNA profiles shall be transmitted annually to a centralised archive maintained by the Secretariat.

2. SPECIFICATIONS FOR THE ESTABLISHMENT/ MAINTENANCE OF MARKET SAMPLING SCHEMES

The purpose of market sampling is twofold: to act as a deterrent to illegal activity and to detect whether such activity is occurring. Market sampling in its initial stage is not intended to determine the precise number of animals that may be involved. Rather, if illegal products are discovered, a targeted method of detecting the origin of the products and the extent of the illegal operation specific to the case should be developed.

2.1 Design principles

(1) Market sampling schemes shall be case-specific. Their design shall be based on the best available information on the temporal and geographical nature of the particular market(s) and product pathways. Power to detect/deter will increase with the geographical and temporal scope of the surveys.
(2) The design of market sampling schemes will be iterative and schemes should be reviewed periodically. Experimental testing of their potential to detect illegal products should be undertaken and reported. This should include estimation of the possibility of falsely suggesting illegal activity and missing illegal activity when it occurs.
(3) Appropriate (e.g. not highly processed products from which it is difficult to obtain reliable microsatellite profiles) products should be chosen.
(4) A balance between deterrence (sampling carried out openly and with publicity) and detection (undercover sampling) shall be maintained and reported.
(5) The full range of cetacean products shall be sampled in case mislabelling occurs.
(6) An officially-attested documentation of chain of custody from time of collection to results of matching must be collected and archived, including the information given in Item 2.3.
(7) Analysis and matching must be carried out in an IWC-approved laboratory (with appropriate calibration if necessary) following the procedures given in Item 1 above.

2.2 Development of appropriate market sampling schemes including audit

The international expert group (see Item 1.7) under the auspices of the IWC shall:

(1) co-operate in the design of and approve any market sampling scheme before it is implemented and review the associated results;

(2) co-operate in the design of and approve experimental work and review results referring to Item 2.1 (2) above;
(3) design and arrange for periodic site visits to ensure that the approved scheme is being implemented; and
(4) experimental procedures should reflect the need for a standardised set of markers suited to the generation of accurate data from degraded source materials.

2.3 Data to be collected

- Product or sample of product of sufficient size to obtain DNA sample (see Item 1.2.2).
- Location obtained.
- Date and time.
- Label (or verbal description of nature and origin of product offered by vendor).
- Source (e.g. wholesale market, shop, dockside etc.).
- Photograph of product before sub-sampling.
- Name and contact information of person collecting.

This information should be archived in an appropriate electronic manner.

2.4 Reporting

The authorities responsible for undertaking the market sampling schemes in accordance with Paragraph 42 of the Schedule shall submit an annual report of their market sampling activities to the international expert group via the IWC Secretariat at the end of February of each year. That report shall include: details of the methods used; a summary of the number and nature of the products sampled, and the geographical and temporal spread of sampling; the results of the matching exercise.

The international expert group shall submit an annual report to the Secretariat of the IWC for distribution to contracting governments and the Commission (and, if necessary subsidiary bodies of the Commission) at least two months before it must be considered.

REFERENCE

International Whaling Commission. 2009. Report of the Scientific Committee. Annex I. Report of the Working Group on Stock Definition. Appendix 2. Guidelines for DNA data quality control for genetic studies relevant to IWC management advice. *J. Cetacean Res. Manage. (Suppl.)* 11: 252-256.

Annex {SI} dated *day/month/year*

Scientific Information

1. The following information shall be provided by Contracting Governments for all whaling operations and, where possible, for mortalities due to bycatches and ship strikes:
   (a) date of capture, striking or discovery;
   (b) species;
   (c) sex;
   (d) position of capture or striking or discovery to the nearest minute of latitude and longitude[1]; and
   (e) number of whales struck but lost.

   A set of verified records shall be submitted to the Secretariat within 30 days of the end of each season, in an electronic format to be provided by the Secretariat. These records shall be publicly available.
2. In addition, the following samples and/or information shall be collected/reported in formats to be provided by the Secretariat.
   (a) The length of all whales caught shall be obtained, measured in a straight line parallel to the whale from the tip of the upper jaw to the notch of the flukes to the nearest 0.5 feet or nearest 0.1m[2]. These data shall be reported to the Secretariat within 30 days of the end of each season and included in the IWC database. These data shall be publicly available.
   (b) Where possible, at least one earplug shall be collected from each whale caught. The resultant age estimations and the identity of the reader(s) shall be reported to the Secretariat in a timely fashion, normally within one year of collection and included in the IWC database for use under the Scientific Committee's Data Availability Agreement.
   (c) Where possible, both ovaries shall be collected from each female caught. Corpora counts shall be reported to the Secretariat normally within one year of collection and included in the IWC database for use under the Scientific Committee's Data Availability Agreement.
   (d) If sufficiently trained personnel are present, the presence, length and sex of foetuses shall be recorded, assigned to the appropriate female. If it is not possible for such personnel to be present, these data should still be recorded where possible, and the lack of trained personnel noted. These data shall be forwarded to the Secretariat within 30 days of the end of the season and included in the IWC database. These data shall be publicly available.
   (e) Lactation shall be recorded, assigned to the appropriate female and reported to the Secretariat within 30 days after the close of the season and included in the IWC database[3]. This information shall be publicly available.
   (f) At least 5cm^3 of skin shall be collected from each whale caught and, where possible, a sample of tissue from the foetus should be collected. Long term archiving of all samples with appropriate identifying information is the responsibility of the harvesting nation. A list of archived samples shall be forwarded to the Secretariat within 30 days of the end of each season. This information shall be publicly available.

[1]For whales taken under paragraph 13, position shall be given at least to the nearest settlement and, where possible, to the nearest minute of latitude and longitude.

[2]Onboard small coastal whaling vessels such as those participating in Norwegian and Icelandic operations, it may be difficult to obtain accurate length measurements because whales are handled on a limited space. It is recognised that measurements in these cases may not be as accurate as those taken in ideal situations.

[3]For whales taken under paragraph 13, this information shall be provided where possible and an indication given of the experience of the data collector.

Annex {OI} dated *day/month/year*

Operational Information

1. All Contracting Governments under whose jurisdiction whales are harvested shall report to the Commission the following information:
   (a) the name and gross tonnage of each factory ship; and
   (b) a list of the land stations that were in operation during the period concerned.
2. All Contracting Governments shall report to the Commission for each whale catcher attached to a factory ship or land station:
   (a) the dates on which each is commissioned and ceases whaling for the season;
   (b) the number of days on which each is at sea on the whaling grounds each season; and
   (c) the gross tonnage, horsepower, length and other characteristics of each.
3. The information required under paragraphs 1(a) and (b) shall also be recorded together with the operational information specific in a log book format similar to that shown in Table 1. A set of verified records shall be submitted to the Secretariat within 30 days of the end of each season, in an electronic format to be provided by the Secretariat. These records shall be publicly available.

Annex U

Statements on the Agenda

ANNEX U1. COMMENT ON THE USE OF ARTICLE VIII BY THE GOVERNMENT OF JAPAN

P. Clapham, C. Scott Baker, R.L. Brownell, Jr., S. Childerhouse, N. Gales and P. Wade

Since 1987, under Article VIII of the Convention, Japanese special permit programmes in the North Pacific and Antarctic have together killed more than six times the number of whales that were taken between 1952 and 1986 by all other nations combined. We reiterate our position from previous years that Article VIII was never intended to permit such large-scale catches, or research programs that lasted for decades with no apparent end point. As noted three years ago by Lars Walløe, the originator of Article VIII, Birger Bergersen (the first Chair of the IWC) 'was thinking that the number of whales a country could take for science was less than 10; he didn't intend for hundreds to be killed for this purpose … he had in mind, for instance, the possibility of finding a new animal and thus needing to take some in order to describe them scientifically' (Morrell, 2007).

In 1946, the only way to study whales was to kill them. This is no longer the case, and as we have previously noted there is virtually nothing important to management that cannot be learned using non-lethal techniques. This is significant, because the IWC's guidelines for scientific whaling include the provision that lethal sampling should be conducted only if non-lethal alternatives are unavailable (Donovan, 2001).

ANNEX U2. RESPONSE TO ANNEX U1

H. Hatanaka, J. Morishita, D. Goodman, L.A. Pastene and Y. Fujise

Based on the reported views of the first Chair of the IWC, the authors of Annex U1 contend that Article VIII was not intended to permit large catches for scientific research, or ongoing research programs. Scientific knowledge related to cetaceans and resource management has progressed dramatically since the 1940s. A scientist at that time could not have imagined the research objectives being currently pursued. Both the number of whales taken and the duration of the current research programmes should be determined by the needs for scientific information in the 21st century. In fact the specific language of Article VIII in no way constrains either the numbers of samples or the duration of research.

Catch levels under JARPA II and JARPN II have been calculated as the minimum required to obtain statistically significant data. Given that some of the stocks concerned (e.g. Antarctic humpback and minke whales) are abundant and increasing rapidly, it is quite logical that the sample sizes are correspondingly large. These calculations and their rationale together with an examination of the effects of these catches on the stocks have been clearly presented in the research plans provided to the Scientific Committee (Government of Japan, 2002; 2005).

We do not agree that the main objectives of the JARPA II and JARPN II studies (feeding ecology of minke, fin, sei, Bryde's and sperm whales) can be achieved by exclusively non-lethal means, although both JARPA II and JARPN II have incorporated non-lethal components. Quantitative data on diets for model input cannot be obtained by non-lethal means and data on additional parameters of importance to management, notably age structure of populations, can be collected only through lethal sampling.

The Scientific Committee has noted that data from both the Antarctic and North Pacific research permit programs have made major contributions to the understanding of certain biological parameters and have provided considerable data which could be directly relevant to management (IWC, 1998; 2001). The Scientific Committee has also noted that non-lethal means to obtain some of this information are unlikely to be successful particularly in the Antarctic (IWC, 1998; 2008). Similar views were expressed by an 'Expert Panel' that reviewed the JARPN II program. The panel also concluded that JARPN II pollutant studies represent a valuable contribution to knowledge in this area (IWC, 2010).

ANNEX U3. STATEMENT BY THE ICELANDIC, JAPANESE AND NORWEGIAN DELEGATIONS CONCERNING DNA REGISTER SYSTEMS

Members of the Scientific Committee and the Commission are aware that the Governments of Iceland, Japan and Norway have, on a voluntary basis, implemented national DNA register systems to provide for effective monitoring of whale meat products in the market and that information on these DNA register systems has been provided to the Commission.

This statement is to reassert the position of the Governments of Iceland, Japan and Norway that the monitoring of markets is outside the jurisdiction and competence of the IWC and that for this reason, inclusion of items related to DNA identification of market products on the agenda of the Scientific Committee and its Working Groups is inappropriate. For this reason, representatives of the Governments of Iceland, Japan and Norway and their appointed scientists will not participate in Scientific Committee discussions of this matter.

However, the Governments of Iceland, Japan and Norway will provide additional information on their DNA register systems as they deem appropriate including information on technical aspects of these systems. Further, we urge that the future work of the Scientific Committee on matters related to the use of DNA technologies and analyses take the position of our Governments into account. In this regard, documents dealing with the marketing of whale meat products should not be submitted to or discussed by the Scientific Committee.

ANNEX U4. STATEMENT BY THE JAPANESE DELEGATION CONCERNING WHALEWATCHING

It is the Government of Japan's position that whalewatching is outside the competence of the IWC. Further, the IWC has limited financial and human resources and should be focusing its efforts on important matters such as stock assessments.

ANNEX U5. STATEMENT BY THE JAPANESE DELEGATION CONCERNING SMALL CETACEANS

Resolution 1999-9 on Dall's porpoise is clearly outside the jurisdiction of the IWC, and therefore Japan continues not to provide data concerning small cetaceans at this year's Scientific Committee meeting. Furthermore, Japan will not participate in the meeting of the Standing Sub-Committee on Small Cetaceans this year. It is unfortunate that the political attempt to expand the scope of the IWC's influence to include small cetaceans by Resolution 1999-9 has prevented the continued voluntary scientific co-operation of Japan in the field of small cetaceans.

However, Japan will make its data on small cetaceans available following this year's Scientific Committee meeting through appropriate means, such as the website of the Fisheries Agency of Japan.

Finally, although Japan may not make any comments on the draft report of the Standing Sub-Committee on Small Cetaceans, this should in no way be taken to mean that Japan concurs with or supports the contents of the report.

REFERENCES

Donovan, G. 2001. Report of the Scientific Committee. Annex Y. Guidelines for the Review of Scientific Permit Proposals. *J. Cetacean Res. Manage. (Suppl.)* 3: 371-72.

Government of Japan. 2002. Research plan for cetacean studies in the western North Pacific under special permit (JARPN II). Paper SC/54/O2 presented to the IWC Scientific Committee, April 2002, Shimonoseki, Japan (unpublished). 115pp. [Paper available from the Office of this Journal].

Government of Japan. 2005. Plan for the Second Phase of the Japanese Whale Research Program under Special Permit in the Antractic (JARPA II) - monitoring of the Antarctic ecosystem and development of new management objectives for whale resources. Paper SC/57/O1 presented to the IWC Scientific Committee, June 2005, Ulsan, Korea (unpublished). 99pp. [Paper available from the Office of this Journal].

International Whaling Commission. 1998. Report of the Scientific Committee. *Rep. int. Whal. Commn* 48:53-118.

International Whaling Commission. 2001. Report of the Workshop to Review the Japanese Whale Research Programme under Special Permit for North Pacific Minke Whales (JARPN), Tokyo, 7-10 February 2000. *J. Cetacean Res. Manage. (Suppl.)* 3:375-413.

International Whaling Commission. 2008. 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. 2010. Report of the Expert Workshop to Review the Ongoing JARPN II Programme, 26-30 January 2009, Yokohama, Japan. *J. Cetacean Res. Manage. (Suppl.)* 11(2):405-50.

Morrell, V. 2007. Killing whales for science? *Science* 316: 532-34.

Report of the Southern Right Whale Die-Off Workshop

Report of the Southern Right Whale Die-Off Workshop

1. INTRODUCTION

At its 61st Annual Meeting in Madeira in June 2009 the Scientific Committee of the International Whaling Commission (IWC SC) received data on exceptionally high mortality ('die-offs') of southern right whales (*Eubalaena australis*) in the region of Península Valdés, Argentina, during the period from 2005–08 (Uhart *et al.*, 2008; 2009). It recommended that a Steering Committee be formed (R.L. Brownell, Jr. [Convener], V. Rowntree, T. Rowles, M. Uhart and H.C. Rosenbaum) to plan a workshop in 2011 to review possible causes and impacts of this mortality and to identify future research needs. By August 2009 it had become clear that another year of high mortality was underway (see the following paragraph) and the Steering Committee, in consultation with the IWC Head of Science (Greg Donovan), decided to hold the Workshop in the first quarter of 2010.

Since 2003, when the Southern Right Whale Health Monitoring Program (SRWHMP) was established for the Península Valdés region by a consortium of local NGOs, a total of 366 right whale deaths has been recorded, with peaks in 2003 (31), 2005 (47), 2007 (83), 2008 (95) and 2009 (79). Most (91%) of the animals dying have been first-year calves. The Península Valdés population was increasing at a rate of approximately 6.8% from the early 1970s to 2000 (Cooke *et al.*, 2003; 2001). The rate of increase has not been estimated since the die-offs started, but if the population has continued to increase at the same rate since Cooke's estimates, it may now number around 6,100 whales (Rowntree, pers. comm.). Therefore, the average annual recorded calf mortality in the Península Valdés region from 2007–2009 (presumably not all dead calves are observed and reported) would be around 1.4% of the estimated population size. The number of live calves counted has been increasing at a rate of 6.8% annually since 1971. Over the period from 2003–09, the count of live calves increased at 11% per year while the number of dead calves counted increased at 25% per year.

The general aim of the Workshop was to obtain a better understanding of all aspects of the recent high mortality of right whales in Argentina. Towards this end, it brought together three groups of scientists: (1) local experts with direct knowledge of the ecology and marine environment of the Península Valdés region; (2) experts studying right whales in the region; and (3) international experts on whales and mortality factors such as disease and biotoxins. Specifically, the Workshop sought to determine the cause(s) of the recent high mortality and the implications of this mortality for the right whale population as well as to develop a future research and monitoring programme.

The Workshop was hosted by the Centro Nacional Patagónico (CENPAT) in Puerto Madryn, Argentina, and local arrangements were handled by Enrique Crespo of that institute. Crespo and Reeves were added to the Steering Committee for the Workshop in early 2010. Workshop funding was provided by the IWC, NOAA Fisheries, and the US Marine Mammal Commission. The Workshop was held from 15–18 March 2010 at CENPAT, Puerto Madryn, Argentina.

1.1 Opening and welcome address

Dr. Mirtha Lewis, Director of the Centro Nacional Patagónico, welcomed participants to the host laboratory. Further words of welcome and introduction were given by Crespo and Brownell.

The list of participants is given as Annex A and the meeting Agenda is given as Annex B.

1.2 Meeting arrangements

Reeves was appointed Chair. Thomas agreed to serve as the lead rapporteur, with various other participants helping to draft parts of the report on an as-needed basis.

1.3 Documents and document control

No new documents were prepared specifically for the Workshop and therefore no document numbering system was established. Most of the new material was presented in the form of slide presentations, of which summaries have been incorporated into this report.

1.4 Report

The Workshop report was to be completed in time for submission as a document to the 62nd IWC Scientific Committee meeting in May–June 2010. Responsibility for preparation and editing of the draft final report was assigned to Reeves, Thomas and Brownell on the understanding that it would be circulated to participants for review prior to final revision. Note that the headings in the published report will follow the IWC report style of numbering.

2. BACKGROUND ON SOUTHERN RIGHT WHALES AROUND PENÍNSULA VALDÉS

2.1 History of the population around Península Valdés and in the South Atlantic

Brownell gave an overview of this topic, noting that most of the global population of southern right whales was historically, and remains today, centred in the South Atlantic Ocean. Early whaling in coastal Brazilian waters has been summarised by Richards (2009). Shore whaling had started near Bahia by 1603 with Basque whalers providing instruction and guidance. This hunt was directed mainly at females with calves and took place between May and November. By 1678, three whaling stations operated in Bahia, one in Rio de Janeiro and one on Ilha de Santa Catarina (a decade later several were operating on the island) in southern Brazil. Until 1770, catch levels were 20–30 per year, but after that year they jumped to more than 1,000 per year for all operations combined. The right whale population in Brazil became depleted and whaling there had all but stopped by the early 19th century. Townsend (1935) plotted catches of right whales by American ship whalers in the late 18th, 19th and early 20th centuries, centred mainly in two large areas: (1) Brazil Banks (covering a larger area from southern Brazil to central Argentina) and False Banks (east and south of the La Plata River, between Uruguay and Argentina); and (2) around the Falkland (Malvinas) Islands at about 52°S. Southern right whales were a very minor component of the worldwide commercial catch in the early part of the 20th century and by the mid 1930s they were generally protected because of their extremely depleted status.

Tormosov *et al.* (1998) reported that between 1951/52 and 1970/71 at least 3,368 right whales were taken by Soviet factory-ship operations in the Southern Hemisphere. Most of them were taken in the 1960s with over a third (1,315) caught by the *Sovietskaya Ukraina* during the 1961/62 season in the western South Atlantic off Argentina.

A team led by R.M. Gilmore, aboard the US National Science Foundation's research vessel *Hero*, searched for whales along the coast of Argentina and Uruguay between 9 June and 7 August 1969 (Gilmore, 1969). A concentration of 20–25 right whales was observed near shore at the entrance of Golfo Nuevo. According to Brownell, who was on the cruise, it covered waters along the Argentine coast from just south of Mar del Plata to Tierra del Fuego. The first right whale was observed in mid-July, west of the entrance of Golfo San José. There were no further sightings as the vessel passed Punta Norte and came to anchor near the mouth of Golfo Nuevo for the night. The next morning, the vessel searched the perimeter of Golfo Nuevo and it was only while preparing to depart from the gulf in the afternoon that the 20-25 right whales were encountered inside its western entrance.

2.2 Long-term studies by non-governmental groups (NGOs) since 1971

Rowntree summarised the long-term research programme initiated by Roger Payne in 1970 at Península Valdés (Payne, 1986). This region is a calving/nursery ground for southern right whales. Calves are born and spend their first two to three months of life in waters bordering the peninsula (Thomas and Taber, 1984; Whitehead and Payne, 1981). The whale season in the region extends from May (possibly even April) to December, with peak numbers present in late September (Whitehead and Payne, 1981). Most calves are born in August or September. The whales are primarily fasting while on the nursery ground but may feed ocasionally on early spring plankton blooms by late September (Hoffmeyer *et al.*, 2010; Payne, 1995; Sironi, 2004). The only definite connection between the Peninsula Valdés whales and a feeding ground comes from four re-sightings of known individuals off South Georgia in the region of the western South Atlantic with the highest abundance of krill (*Euphausia superba*; Atkinson *et al.*, 2001; Bonner, 1987; Moore *et al.*, 1999; Rowntree *et al.*, 2008). As mentioned earlier, Soviet whaling operations removed 1,312 right whales on the Patagonian Shelf (centred around 42°S) in November–December 1961 (Tormosov *et al.*, 1998), suggesting that the whales forage there immediately after leaving Península Valdés. Around South Georgia, right whales appear to arrive in January and reach peak numbers in March (Bonner, 1987) although they have been sighted there in every month of the year (Moore *et al.*, 1999).

In discussion, Brownell pointed out that three right whales taken in either the 1927/28 or 1928/29 whaling season had been feeding on post-larvae of lobster krill (*Munida gregaria*) on the Patagonian Shelf (Matthews, 1932) and a right whale taken off South Georgia in 1926 reportedly had krill (*Euphausia superba*) in its stomach (Matthews, 1938). Also, a 6.5m calf taken at South Georgia on 26 August 1926 had milk in its stomach (Matthews, 1938).

Rowntree presented data on demographic parameters of the right whale population that visits Península Valdés. Every year since 1971, surveys have been flown along the perimeter of the peninsula and each whale encountered has been documented by photographing the individually distinctive pattern of callosities on its head and recording its location and the presence or absence of a calf (Payne *et al.*, 1983). From these data, the population size was estimated at 2,577 whales in 1997 (Cooke *et al.*, 2001; IWC, 2001, p.19), 3,346 in 2000 and, extrapolating at a growth rate of 6.8% per year, 6,100 in 2009 (Rowntree, pers. comm.).

The almost 40-year dataset also illuminates the reproductive histories of known individual females. A three-stage model of the adult female population has been used to fit the observed calving histories (Cooke *et al.*, 2003). The modal calving interval is considered to be three years with one year spent in each of three stages: calving, resting and receptive. Population parameters were estimated by fitting the models to the individual sighting histories. Cooke *et al.*'s (2003) most recent updated estimates of demographic parameters through the year 2000 were presented to the Workshop by Rowntree and include: mean calving interval 3.42yr (SE = 0.11yr); mean age of first calving 9.yr (SE = 0.4yr); annual adult female mortality rate 0.020 (SE = 0.004); annual rate of population increase 6.8% (SE = 0.5%); reproductive female population size in 2000, 697 (SE = 48).

In discussion following Rowntree's presentation, it was noted that right whale distribution around Península Valdés had changed from the 1970s to the 1990s, with a shift of occupancy from the outer coast into the two gulfs, especially the more southerly Golfo Nuevo, but there is no obvious connection to the recent high mortality of calves. According to Moore, Lysiak (2009) found evidence of a recent decline in isotopic carbon in the baleen of North Atlantic right whales, possibly linked to climatic shifts. No similar decline has been reported for southern right whales.

In response to a question of whether right whale calves feed on anything other than milk while in the area of Península Valdés, it was noted that this had not been observed directly (Thomas and Taber, 1984) nor had evidence of solid foods been found in the stomachs of necropsied calves.

2.3 Long-term studies by the Marine Mammal Laboratory, CENPAT

Crespo summarised the unpublished results of aerial surveys around Península Valdés during the period 1999–2008 by a team of scientists affiliated with the Marine Mammal Laboratory, Centro Nacional Patagónico (CONICET) and the University of Patagonia (Enrique A. Crespo, Susana N. Pedraza, Silvana L. Dans, Mariano A. Coscarella and Guillermo M. Svendsen).

He noted that this programme is designed to monitor trends in numbers, seasonal changes within and through years, changes in distribution and seasonal patterns of arrival and departure of whales in the area. Twelve aerial surveys were conducted between May 1999–December 2000 and 29 between October 2004–November 2008, flying parallel to the coastline at an altitude of 500 feet with a strip width of 1,500m, from the mouth of Chubut River (42°30'S) to Puerto Lobos (42°S) for a total coastal strip length of 620km. Whales were classified as: (a) mother-calf pairs; (b) solitary individuals; or (c) breeding groups considered as one female and *n–1* males. Around 95% of the whales were within the strip and the number of whales in the strip can be considered a measure of relative abundance. The interval between flights ranged from 45–50 days. Crespo considered this to be beyond the average residence times of whales in the area, so ideally during each census new individuals were being counted; however other Workshop participants noted that mother-calf pairs have longer residency times, e.g. a mean of 77 days in 1973; see Rowntree *et al.* (2001). Every year a bell-shaped curve of whale numbers was obtained with the first whales arriving in May and the last departing in December with the peak in late September.

The maximum counts occurred in September: 556 in 1999, 543 in 2000, 724 in 2005, 786 in 2006, 777 in 2007 and 673 in 2008. The rate of increase for the period 1999–2006 was estimated from the slope of the linear regression of the log-number of newborn calves in the peak of the season through time (r = 4.4, Lower CI 95% = 0.5, Upper CI = 8.3; R^2 = 0.71, n = 6) and the log-number of whales in the peak of the season through time (r = 3.7, Lower CI 95% = 0.7, Upper CI = 6.8; R^2 = 0.74, n = 6). The observed rate of increase is lower and probably underestimated relative to that estimated by mark-recapture methods but with similar confidence intervals. The estimated cumulative number of calves present was 335 in 1999 and 553 in 2008, while the estimated cumulative number of whales was 1,318 in 1999 and 2,507 in 2007. It should be noted, however, that mothers and calves have longer average residence times than other whales and therefore the calf numbers are probably positively biased.

In addition to the whales observed along Península Valdés, aerial surveys of Golfo San Matías to the north encountered more than 120 whales in the peak of the season. The whales counted there, primarily single individuals and courting groups, are additional to those counted along Península Valdés.

2.4 Prior documentation/history of stranding events

Rowntree reported that, before 1994, records of strandings were maintained on an opportunistic basis. It was stressed that in the early years of the right whale photo-identification project, when the whale population may have numbered only about 500, one would not expect many strandings to have occurred. If there had been large numbers, she is confident this would have been noticed during the multiple aerial surveys conducted along the coast at the time. Beginning in 1994, A. Carribero, M. Rivarola and A. Arias made a concerted effort (supported in part by a grant from the National Geographic Society) to record strandings, began developing a reporting network, conducted visual surveys of some beaches and took measurements and collected tissue samples and baleen from stranded whales to support studies of toxins, genetics and isotopes. A marked increase in survey effort occurred in 2003 with the initiation of the Southern Right Whale Health Monitoring Program (SRWHMP).

Harris reported counts of live and dead right whale calves in the eastern portion of Golfo San José between 1982 and 1988 (Table 1; Harris and Garcia, 1990). During this 7-year period, counts of live calves ranged from 11–20 (mean of 15) and counts of dead calves ranged from 0–6 (mean of 3). The highest observed mortality rate (dead calves counted/live calves counted) in one year was 42% in 1987, followed by 30% in 1985.

However, the calf counts reported by Harris were from a limited area, made from a cliff-top observatory on the eastern edge of the gulf, and only those counts made on calm days at high tide with the best opportunities for observing whales were used. Comparisons with aerial surveys made at the same time in the same area indicated that total counts of live calves from the observatory were similar to those from the aircraft. Most of the dead calf carcasses were visited and measured. They were also observed during subsequent counts and if a carcass had moved with high tides, this was noted to avoid the possibility of double counting.

Table 1

Cliff-top counts of live and dead calves (0-3 months of age) in Golfo San José between June and December of 1982-88 (Harris, 1990).

Year	Number of live calves	Number of dead/ stranded calves	Mortality rate	Survival rate
1982	14	3	21.4	0.786
1983	14	1	4.14	0.929
1984	15	0	0	1
1985	20	6	30	0.700
1986	17	3	17.6	0.824
1987	12	5	41.66	0.583
1988	11	1	9	0.910
Average	14.71	2.7	18.11	0.819

3. BACKGROUND INFORMATION SPECIFIC TO THE SOUTHERN RIGHT WHALE POPULATION AND PENÍNSULA VALDÉS

3.1 Predation by killer whales

Sironi presented information (Sironi *et al.*, 2008) on killer whale predation on southern right whales between 1972–2000. In the 1980s, right whales abandoned the area with the highest occurrence of killer whales (the Eastern Outer Coast [EOC] of Península Valdés) and moved into Golfo San José and Golfo Nuevo, where killer whales are rarely seen (Rowntree *et al.*, 2001). A total of 117 killer whale/right whale encounters were reported between 1972 and 2000 off the coast of Península Valdés. Of 112 encounters, 63 (56%) were grade 1 (no behavioural changes observed), 37 (33%) were grade 2 (behavioural changes observed), and 12 (11%) were grade 3 (actual attacks by killer whales on right whales were observed). Adult right whales with or without calves were the main targets of the attacks; in fact, 80% of the attacked whales were adults. Right whale calves were seen in only two attacks (16.7%). The number of encounters per decade decreased with time, from 68 encounters in the 1970s and 26 in the 1980s to 23 in the 1990s. At the EOC the frequency decreased significantly from 11 encounters per year in the late 1970s to 2.3 per year in the late 1990s. Also, in the late 1970s, the encounters occurred over 8 months each year, from May to December, whereas in the late 1990s the 'time window' of encounters was reduced to only 4 months each year, from August to November.

Península Valdés has features that are advantageous for right whales. Mothers and calves aggregate in shallow bays, which may be an effective anti-predator strategy (Thomas and Taber, 1984). In fact, calves were not the main targets during the observed attacks. It is possible that the relatively lower predation risk in the gulfs promoted the abandonment of the EOC by right whales. Although killer whale predation pressure can influence habitat choice by right whales, other causes for the observed changes in right whale distribution around Península Valdés cannot be ruled out. The predation rate decreased between 1972 and 2000, a trend that likely continues to the present. Only one dead calf in 2003 and two in 2009 had wounds that could be attributed to killer whale bites (SRWHMP; Sironi, unpublished data). Thus, attacks by killer whales may represent a minor threat to right whales at Península Valdés compared to the yet unknown causes for the unusual mortality levels recorded in recent years.

3.2 Parasitism by kelp gulls

Sironi updated information on gull harassment of right whales at Península Valdés (Sironi *et al.*, 2009). Kelp gulls (*Larus dominicanus*) eat the living skin and blubber of southern right whales and the whales spend less time resting and more time in high-energy behaviour to avoid gull attacks (Rowntree *et al.*, 1998; Thomas, 1988).

Gull attacks were first reported by Cummings *et al.* (1972) and the impacts on right whale mothers and calves were described and quantified in Golfo San José by Thomas

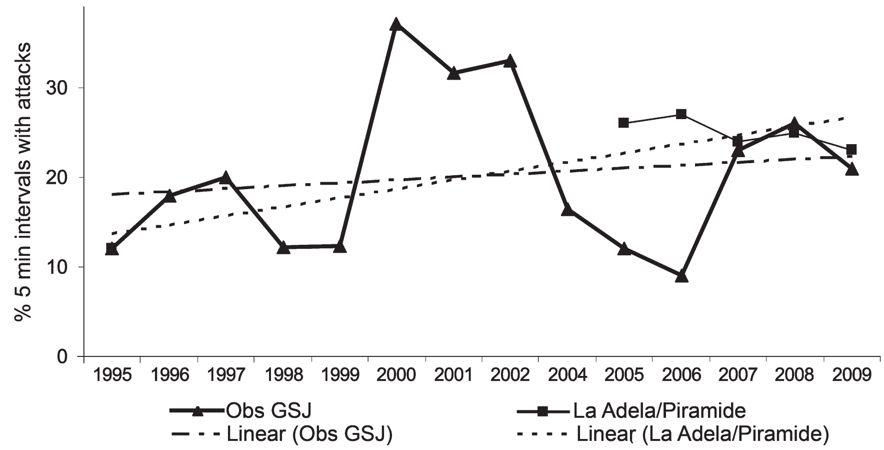

Fig. 1. Frequency of gull attacks observed at Observatorio (Golfo San José) and Playa La Adela/Punta Pirámides (Golfo Nuevo) (Sironi *et al*., unpublished data).

(1988) in 1984. Sironi reported a 5-fold increase in the number of gull attacks recorded between 1984 and 1995, and he stated that the overall increase has continued to the present. The trend in gull attack frequency in Golfo San José and Golfo Nuevo between 1995 and 2009 is shown in Fig.1. At both sites, attack frequency was 12% in 1995 and doubled to an average of 23.3% in Golfo San José and 24% in Golfo Nuevo for 2007, 2008, and 2009, the years with the highest observed right whale mortality.

Between 1999 and 2001, during continuous focal animal behaviour observations of 154 juvenile whales (approx. 1 to 4 years of age), 187 gull attacks were recorded (Sironi, 2004). In addition, during hourly scans, 652 gull attacks were recorded on whales of all age classes. The majority of attacks (81%) were aimed at mother-calf pairs, 9% were aimed at juveniles and 8.4 % were aimed at adults. The attack rate per hour on mother-calf pairs (2.7) was 5× higher than for juveniles (0.5) and for juveniles the attack rate was highest (5.2) when they were interacting with mother-calf pairs and lowest (0.7) when they were in groups containing adults only. A small proportion of the gulls that were visible to the observer at any one time were involved in attacks. Gulls aimed 90.4% of their attacks at existing skin lesions and the remaining 9.6% at apparently smooth skin. Analysis of aerial photographs (Rowntree *et al*., 2008; and see Sironi and WCI/ICB, unpublished data) showed that the percentage of whales with gull-induced lesions increased from 1% in 1974 to 37.8% in 1990, 67.6% in 2000 and 76.8% in 2008 (Fig. 2).

The behavioural response of whales to gull attacks has changed as the attacks have become more widespread over the years. In 1984 about 25% of mothers attacked by gulls temporarily adopted resting postures (‘crocodiling’, or lying on the back or side) that put their dorsal region, from the blowholes to the caudal peduncle, under water (Thomas and Taber, 1984). Since 1995 mothers spend the majority of their time, whether resting or travelling, in this ‘crocodiling’ or ‘galleon’ posture to keep their vulnerable backs submerged (Rowntree *et al*., 1998; and Sironi and Rowntree, unpublished data). A significant consequence of the success of this maternal gull avoidance behaviour is that gulls now target calves much more frequently than they did in the past. In 1995, attacks on mother-calf pairs were directed at the calves almost as often as at the mothers (44% of 1,184 attacks; Rowntree *et al*., 1998). In contrast, in 2009, 76% of the attacks on mother-calf pairs were aimed at the calves and the remaining 24% were aimed at the mothers (based on 934 attacks observed; Sironi *et al*., unpublished data).

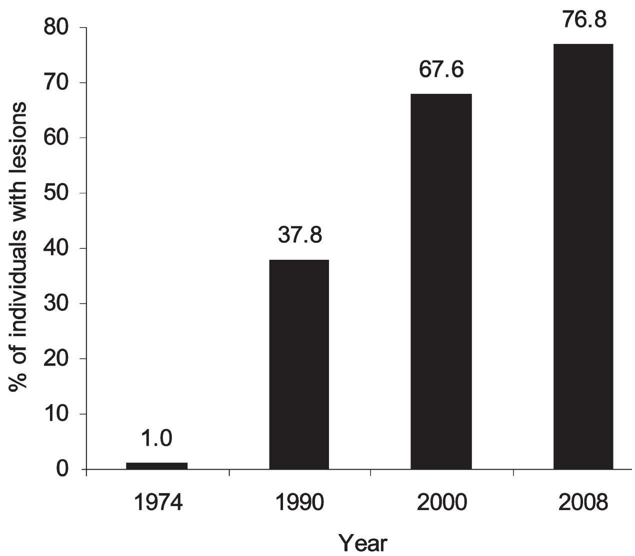

Fig. 2. Percentage of individual whales with visible gull-peck lesions on their backs (1974–2008) (Sironi and WCI/ICB, unpublished data).

Gull attacks interrupt resting and nursing bouts and social interactions, and they may affect the behavioural development of calves and juveniles. Rowntree *et al.* (1998) suggested that intense gull harassment could compromise calf survivorship in this population, although a cause-effect relationship would be difficult to prove. The percentage of whales with gull marks and the attack frequency have continued to increase with time. This may be a consequence of the population growth of some gull colonies due to the increased availability of garbage and fishery refuse at landfills and offshore. Also, the fact that juvenile gulls attack whales indicates that gulls are able to imitate and quickly learn this ‘new’ behaviour so it is spreading within the local gull population. It is possible that all whales at Península Valdés will have gull-caused lesions in the near future.

Fazio and Bertellotti described various features of gull attacks based on their observations from whalewatching boats and cliff observatories along the edge of Golfo Nuevo. The kelp gull is a generalist and opportunistic species that feeds mainly on invertebrates and fish, but it also consumes garbage and fishery discards. Around Península Valdés, kelp gulls feed on pieces of skin and blubber ripped from the whales’ backs, producing severe injuries because once a wound is opened gulls continue to enlarge it. This behaviour has increased since the first records in the early 1970s, along with the increase in the gull population.

During the whale reproductive seasons from 2005 to 2009, observers aboard whalewatching boats embarking from Puerto Pirámides (in eastern Golfo Nuevo) recorded gull attacks during 1,559 trips. The attack rate for 5,703 whale sightings was similar across years, with an overall mean of 4.50 attacks per hour (SD = 17.91) but the rate was consistently higher in July, August and September than in other parts of the season. Observations were made from a cliff in Punta Flecha (60km from Puerto Pirámides) in September and October 2009. There, the mean attack rate was 8.61 attacks/h (SD = 14.781, $n = 150$). There were no significant differences in values from the previous years (ANOVA: P = 0.3). Analysing the four years together, attack rates are higher within 200m of shore (Kruskal-Wallis: $X^2_3 = 67.85$, P<0.001; T3-Dunnet: P<0.001) and for mother-calf pairs.

Fazio and Bertellotti also provided information to the Workshop on attempts by researchers at CENPAT to ascertain if gull-transmitted disease has played a role in the recent mortality events. Kelp gull attacks not only cause stress to the whales but also may transmit infections to them. Two groups of diseases might be transmitted: infections carried by and infecting the gulls themselves and whale-specific diseases transmitted by the gulls from one individual whale to another. A third potential risk category is the introduction of opportunistic pathogens into the whale via gull-damaged skin. In order to monitor disease in both gulls and whales, different sampling protocols were implemented. Whale health was assessed by taking skin and blubber biopsy samples from both healthy skin and lesions on live animals using a crossbow from a boat. Health monitoring of kelp gulls consisted of taking blood and swab samples. Analysis protocols include histopathology for the detection of viruses, bacteria and fungi. In addition, blood samples were collected intermittently between 2005 and 2009 from kelp gulls at nesting colonies. The sampling protocol included live capture and syringe blood extraction as well as swabbing from the mouth and cloaca. Analysis protocols include the detection of viruses, bacteria and fungi. From 2006 to date, 55 samples have been collected. These had been sent out for analysis but no results were made available to the Workshop.

Much interest was expressed by Workshop participants in the possible relationship between widespread and increasing kelp gull parasitism and the recent high mortality of right whales at Península Valdés. Discussion indicated that up to 80% of living calves have gull-peck lesions on their backs; this is not reflected in stranding data since either stranding position (often ventral side up) or extent of decomposition prevents examination of the backs of a large percentage of dead whales. It was also noted that some live calves have gull-peck lesions over their entire back. Lesions can heal with time, as the lesion fills in with epidermis around the edges and the exposed blubber is eventually covered, albeit leaving a depressed area.

The risk of disease transmission by gulls was discussed. During the time of year when they are feeding regularly on whales, the gulls often fly from breeding areas, to local dumps, to whales, in relatively short periods of time. Local dumps contain both human refuse and fish offal from the large fishing industry centred in Puerto Madryn. Moore emphasised the importance of continuing to investigate the possible role of gull parasitism in calf mortality. This should include consideration of the possibility that the gulls serve as disease vectors as well as the fact that behavioural changes by right whale mother-calf pairs during the calving/nursery period are energetically costly and possibly also stressful.

3.3 Whalewatching

Information was provided on three subjects of study in collaboration with whalewatching operations: (1) demographic analyses from photo-identification; (2) analyses of whale responses to disturbance by the tour boats; and (3) observations of wounds and scars on whales caused by vessel strikes.

Lindner, on behalf of a group of co-authors (Alejandro Carribero, Romina Espinosa, Luisina Bossio and Nadia Geremias), presented information on photo-identification and resightings of individual right whales from whalewatching boats in Golfo Nuevo. Although right whales are observed in the two large gulfs at Península Valdés every year from May to December, changes in their distribution have been observed over time. The working hypothesis of this study was that the pattern of return by individual whales subject to the influence of whalewatching would differ from that of the rest of the population. The objective of one element of the study was to determine the proportion of identified animals exposed to whalewatching that returned to the area in subsequent seasons.

Starting in 1995, a trained observer worked aboard the whalewatching boats in the waters adjacent to Puerto Pirámides. Photo-identification, based on photographs of callosity patterns organised in a digital catalogue, was used to construct encounter histories for use in mark-recapture models. The study identified a total of 931 individuals, of which 56 were seen and photo-identified on more than one occasion. Using multi-state mark-recapture models, the probability of return to the study area was estimated at one, two and three years after initial photo-capture.

The models indicated that 43% of the whales had a probability of returning to the study area every three years, 20% every two years and 36% every year. Furthermore, 15% of the photo-identified individuals were documented in the area off Puerto Pirámides only once during the study period. The authors concluded that some proportion of the whales that visit the area do not return in subsequent seasons, and that the population of whales present in this area each year therefore consists of both ‘new’ individuals and ‘returning’ individuals. They also surmised that the whales do not move as cohorts or seasonally stable groups but rather as individuals.

Lindner summarised her team’s findings with regard to right whale responses to whalewatching boats. Golfo Nuevo is the centre of whalewatching tourism directed at right whales, which has expanded from a total of about 4,500 tourists embarked in 1987 to 119,000 in 2006. The objective of this study was to describe the behavioural responses of right whales to the proximity of whalewatching boats. In general, the whales moved away from the boats, the interaction of whales with the boats caused short-term behavioural changes, and different approach speeds elicited different reactions from the whales.

Between 2004 and 2009, trained observers on whalewatching vessels recorded the interactions between whales and tourboats. Only a small proportion of the whales (15.25%) approached the boats. When the boats approached rapidly, the whales tended to move away (54.1% of the time), but if the boat approached at slow speeds, the whales generally appeared undisturbed (47.37%). Approximately 35% of the observations were made at the instant of first sighting, and 30%, 21% and 14% corresponded to behaviour observed 5, 10 and >10 minutes after initial sighting, respectively. The months of September and October had the greatest proportion of sightings (27.0% and 26.7% respectively), coinciding with the peak of tourist demand but not the peak abundance of whales in the area.

These results were interpreted by the authors as suggesting that only a small proportion of the whales interact with tour boats, and with no apparent adverse effects. Also, they interpreted their results as indicating that the speed of approach influences short-term whale responses. The authors presented their conclusion that whalewatching activities at the peninsula have developed and are currently governed more by efforts to meet tourist demand than by precautionary conservation measures designed to minimise disturbance effects on whales.

Lindner also presented analyses of scars and wounds observed on living right whales that she attributed to vessel strikes. In the catalogue of identified whales in the area, some have wounds or marks clearly caused by collisions with boats. An analysis of photographs of whales identified during the seasons of 2007, 2008 and 2009 found that 6% of them had evidence of vessel strikes. The Workshop **recommended** that Lindner and colleagues prepare and publish a report on their findings on the return patterns of individual whales and responses to and impacts of whale watching activities.

3.4 Right whale feeding and potential food sources at Península Valdés

Although right whales generally fast at Península Valdés, feeding is occasionally observed (Payne, 1995; Sironi, 2004). Hoffmeyer *et al.* (2010) analysed the composition and biomass of zooplankton collected in the vicinity of foraging right whales at Península Valdés. Monthly plankton sampling and observations of whale behaviour and ocean features were conducted from whalewatching boats in Bahía Pirámides (Golfo Nuevo) between July and November 2005. During this study period, whales were seen feeding for five days between 19 and 23 October. Data and samples collected on 10 October provided a baseline for ocean and food conditions and whale behaviour when the whales were not feeding.

On 19 October 2005, at least 17 whales were seen feeding as the whalewatching boat approached and they continued to feed, with no observed change in behaviour, from 0800 until 1800 hours. During this feeding episode, zooplankton biomasses in the vicinity of the whales ranged between 0.09 and 0.21g wet weight m^{-3}. These values were 2–3 times higher than those observed on 10 October when whales were not feeding. The zooplankton biomass values recorded around feeding whales at Península Valdés were lower than, or similar to, the low end of the ranges reported elsewhere on the Argentinian and Patagonian continental shelf. Nonetheless, these zooplankton densities apparently were sufficient to be used by right whales.

Floating faecal samples from right whales around Península Valdés were analysed (Menéndez *et al.*, unpublished data). Right whales go there after a long migration from feeding areas at high latitudes and it is generally believed that they do not feed regularly in this calving/nursery area. However, feeding behaviour of whales has been observed occasionally in both Golfo Nuevo and Golfo San José, especially during the springtime (Sironi, 2004; Thomas and Taber, 1984). Also, faeces of whales have been detected from whalewatching boats operating in northeastern Golfo Nuevo. Faeces collected in October 2004 were analysed qualitatively as part of a large project to evaluate plankton availability relative to right whale feeding behaviour. Some material was identified as mandibles and coxae of *Calanus australis* and/or *Calanoides carinatus,* large copepods typically found in the local area. Pieces of crustacean segments and antennae were also observed, some of which probably corresponded to euphausiids. In terms of relative abundance, copepod mandibles were the most abundant remains (>70%), non-identified tegument parts were abundant (30–70%) and copepod coxae and prosomes were scarce (<30%). These findings, the first of their kind from Argentina, provide clear evidence that right whales forage to some extent either at the calving/nursery area or on the Patagonian shelf immediately prior to arrival. The consumption of large copepods by southern right whales is consistent with the well-documented central role of *Calanus finmarchicus* in the diet of North Atlantic right whales (*Eubalaena glacialis*). Tormosov *et al.* (1998) found that whales killed north of 40°S had stomachs filled with copepods, between 40° and 50°S they ate a mix of krill and copepods and south of 50°S they had stomachs filled with krill.

4. BACKGROUND ON SOUTHERN RIGHT WHALES ELSEWHERE IN THE WESTERN SOUTH ATLANTIC

4.1 Information related to summer foraging areas and prey

Information was presented from a number of studies on aspects of southern right whale reproductive and foraging behaviour away from the calving and nursery area at Península Valdés. These studies considered: (1) linkages between reproductive success and changes in krill abundance: (2) possible maternally directed site fidelity to feeding locations; and (3) identification of foraging locations from right whale baleen and blubber characteristics.

Rowntree reviewed the results of a study that linked reproduction in southern right whales with changes in sea surface temperatures (SST) and therefore krill abundance. In that study, Leaper *et al.* (2006) found that the reproductive success of the Península Valdés right whales, as measured from photo-identification data, was significantly correlated with SST off South Georgia in the sub-Antarctic, a likely feeding area. The authors reported that while southern right whales generally display a three year calving interval, when they deviate from this it is more often to a five rather than a four year interval. This suggests that reproductive failure comes late in pregnancy or early in lactation (Knowlton *et al.*, 1994; Leaper *et al.*, 2006). The whales had fewer calves than expected when the SSTs off South Georgia were higher than normal with a six year lag between the El Niño events in the Pacific and the observed impact on right whale reproductive output. The chick and pup productivity at South Georgia of gentoo penguins (*Pygoscelis papua*) and Antarctic fur seals (*Arctocephalus gazella*) respectively, also showed significant negative relationships with SSTs during the same years. Time lags of 11 months between SST impacts on krill abundance and changes in chick or pup production were consistent with the life-history patterns of these populations (Boyd *et al.*, 2006, p.28–45).

It was pointed out that the Leaper *et al.* (2006) study antedated the recent 'die-off' years at Península Valdés as it was based on a data time series from 1983–2000. The Workshop **recommended** that this study be updated as soon as possible.

Southern right whales show strong maternally directed site fidelity to their near-shore calving/nursery grounds where they congregate in winter, but little is known about their summer feeding ranges and whether choices of feeding locations are also maternally directed. Valenzuela *et al.* (2009) described maternally directed site fidelity to feeding grounds by combining genetic and stable-isotope analyses of skin samples collected from live whales at Península Valdés. They found that isotopic values were more similar than expected among individuals sharing the same mitochondrial haplotype, indicating that calves learn their feeding locations (represented by an extremely broad isotopic range: –23.1 to –17.2‰ δ^{13}C, 6.0 to 13.8‰ δ^{15}N) from their mothers and teach them to their offspring. These findings suggest that the timescale of culturally inherited site fidelity to feeding grounds is long (at least several generations). According to Valenzuela *et al.* (2009), such 'cultural conservatism' may affect the species' flexibility to find and exploit new feeding opportunities and could help explain why reproductive success declines following ENSO-driven sea-surface temperature anomalies in an important feeding ground near South Georgia.

Rowntree reported on efforts to use stable isotope analyses of baleen and fatty acid analyses of blubber to identify right whale foraging locations and prey types. Baleen from an adult right whale contains a six or a seven year history of the whale's foraging pattern (Rowntree *et al.*, 2008). Stable carbon isotope analyses of five baleen plates of adult right whales that died at Península Valdés showed a range of foraging strategies. All of the plates contained annual peaks that were consistent with foraging on plankton on the Patagonian Shelf shortly after leaving Península Valdés. Stable carbon isotopic signatures consistent with feeding off South Georgia or south of the Polar Front, probably on krill, indicated that most of the whales (four of them) travelled to higher latitudes after initially foraging on the Patagonian Shelf. One whale had fed only at lower latitudes and thus had probably remained on the shelf to feed on copepods. Future analyses of the baleen and blubber of stranded calves could indicate the presence of krill and possibly the proportions of krill and copepods in the diet of their mothers while pregnant. The Workshop **recommended** that this work be completed as soon as possible.

4.2 Southern right whales in Brazil

Groch reported that southern right whales were historically abundant off the Brazilian coast, from the border with Uruguay to the Northeast region. This population was severely depleted by commercial whaling in the 19th and early 20th centuries and was subject to intensive coastal whaling until 1973. By that time, the whale population appeared to have been extirpated from the region (Palazzo and Carter, 1983). In the early 1980s, right whales were 'rediscovered' in southern Brazil, and they have been studied since then. Since 1986, the species has been protected by national legislation in addition to the protection afforded under the IWC. Groups of right whales are sighted from July to November, especially along the southern Brazil coast, with peak abundance in September (Groch, 2005). Groups consist mostly of females with calves, but juveniles and adults without calves have also been sighted. The main area of concentration, located in Santa Catarina State, is a Right Whale Environmental Protection Area (130km of coastline) established in 2000.

Between 1936 and 2009, 55 right whale strandings were recorded along the Brazilian coast (Gomes, 2005; Greig *et al.*, 2001; Groch, unpublished data). Most of these records occurred in Rio Grande do Sul State, south of the main seasonal area of concentration. Of the total, 74% (n = 41) occurred between 1990 and 2009, resulting in a rate of ~2 strandings/year. About 61% (n = 34) were calves. The cause of 10 strandings was determined: 4 were attributed to entanglements and 6 to ship strikes.

Right whales wintering in Brazil have also been sighted off Península Valdés. In a comparison between 335 whales identified in Brazil and 1,884 whales identified in Argentina (comparison of data until 2004), 38 matches were found, representing 11.7% of the whales identified in Brazil (Groch *et al.*, 2004).

Groch further reported that of the individual right whales identified in Brazil, 10%, mostly females, have been resighted from photo-ids, with a modal calving interval of 3 yr. The number of right whales encountered off Brazil appears to be increasing at a rate of about 14%/yr (Groch *et al.*, 2004). The abundance of this population has been estimated to be as high as 555 whales in 2002 (Groch, 2005). To date, there has been no comprehensive assessment of the interchange/overlap between individuals photo-identified in different areas along the east coast of South America, and no regional population assessment has been carried out. The Workshop **recommended** that this work be undertaken as soon as possible and at least by the time of the southern right whale assessment meeting to be held in 2011.

5. GLOBAL TRENDS IN DISEASE AND TOXIC ALGAL BLOOMS AND OTHER BALEEN WHALE 'DIE-OFFS'

5.1 Disease

Gulland noted that there are increasing reports of disease outbreaks and mortality events in marine mammals worldwide (Gulland and Hall, 2007). This increase is partially explained by increased surveillance and improved technology for pathogen and toxin detection, but it also reflects the increasing frequency and distribution of factors such as harmful algal blooms that produce biotoxins that impact marine mammal health. Over the past 20 years, the majority of marine mammal unusual mortality events in the US with identified causes resulted from exposure to biotoxins such as domoic acid, brevetoxin and saxitoxin. Although increased numbers of dead marine mammals on beaches are relatively easily observed, such increases are not always a consequence of disease epidemics, but can result from changes in the prevalence of endemic disease, changes in nutritional status, direct anthropogenic impacts and changes in environmental conditions altering carcass distribution. Mortality events are typically a result of changes in multiple factors altering the animal's resistance to disease or exposure to a lethal factor, thus investigation of mortality events requires identification of potential predisposing factors as well as proximate factors causing death of an individual. For example, during the 1999–2000 mortality of eastern gray whales, examination of stranded animals revealed encephalitis, parasitism, domoic acid exposure and ship strikes as proximate causes of mortality, whereas photographic assessment of body condition of live animals revealed a severe change in nutritional status of the population as an underlying factor in causing increased mortality (Gulland *et al.*, 2005). Limitations to investigations of unusual mortality events to date include difficulties in establishing nutritional status of individuals and distinguishing fatal starvation from seasonal fasting, lack of knowledge on the range of endemic pathogens in marine mammals, and paucity of data on lethal doses of biotoxins.

As cumulative stressors can be fatal, it is important to not only identify proximate causes of mortality, but also to examine the entire life cycle of marine mammals impacted by unusual mortality events to understand the reasons for die-offs.

5.2 Toxic algal blooms

Rowles reported there are numerous harmful algal blooms (HABs) in marine waters globally but only a few of them have been associated with marine mammal morbidity and mortality through toxin effects on the animals. Some biotoxins affect prey species and indirectly affect marine mammals through prey depletion or prey shifts. Similar to other toxicant exposure routes, potential exposure pathways for HAB associated biotoxicosis include: (1) absorption (dermal); (2) inhalation (respiratory); (3) ingestion through prey or lactation; and (4) transplacental. For known biotoxicosis in marine mammals, ingestion is the more common route of exposure, with inhalation and transplacental exposures only occurring with a few toxins. Certain dinoflagellates, diatoms and cyanobacteria are known to produce biotoxins under certain conditions and for some of those toxins diagnostic tests are available. Those HAB associated biotoxins that have been evaluated for toxicity in marine mammals include ciguatoxins, brevetoxins, saxitoxins, okadaic acid and domoic acid (see Table 2). Of these toxins, the three most commonly associated with morbidity or mortality in marine mammals are domoic acid, brevetoxins and saxitoxins. The reported prevalence of *Pseudonitzschia* blooms with domoic acid in marine environments as well as in prey species or marine mammal tissues is increasing in geographic extent and frequency. Of population concern for marine mammals are the frequency of exposures to this toxin in many marine ecosystems, the permanent long term effects of a single exposure, the acute reproductive and neurological effects and the documented transplacental exposures and impacts on the developing foetus. Brevetoxins are more limited in geographic scope but can be equally as significant for acute mortality events and the potential for secondary effects such as prey depletion and immune suppression. Saxitoxins also have wide geographic distribution in ecosystems and may have acute mortality at certain doses and in certain species. Data on North Atlantic right whales show that these animals annually graze on prey containing saxitoxin and periodically containing domoic acid without detection of any apparent biological effects on the animals. Given that most marine mammal exposures to biotoxins are through ingestion, many biotoxicosis cases in marine mammals may not occur coincident with the actual blooms but at a specific time lag after the bloom as the toxin moves through the food web. In some cases there is evidence of effects in marine mammals in the absence of an identified bloom in the area even when remote sensing is being used for monitoring. In most cases there are no easily identifiable lesions (except in domoic acid biotoxicosis) and in some cases exposure occurs days to weeks prior to the development of pathological lesions, therefore diagnosis in the absence of toxins in tissues, fluids, or gut contents (or prey) is extremely difficult. There are many HAB-associated biotoxins in marine waters and foodwebs for which there are no validated tests and for which the mechanisms of action and toxicity are not yet known.

5.3 'Die-offs' in other baleen whale populations

Brownell summarised information on the few reported 'die-offs' of baleen whales. The first known report of such a 'multiple-death event' (other than incidents involving ice entrapment) occurred in 1987 when 14 humpback whales died in Cape Cod Bay (Massachusetts, USA) after consuming saxitoxin-contaminated mackerel (*Scomber scombrus*; Geraci *et al.*, 1989). In early 1995, at least 425 marine mammals, including individuals from three species of baleen whales, and 200 seabirds were found dead in the upper Gulf of California, Mexico (Vidal and Gallo-Reynoso,

Table 2

Common significant biological toxins in the marine environment (compiled by T. Rowles).

Toxins	Organism	Exposure route	Symptoms	Gross/histologic lesions	Reported in	Life stage	References
Algal toxins							
Domoic acid	*Pseudonitzschia australis*	Ingestion (prey, milk) Transplacental	Seizures; abortion; cardiac failure	Hippocampal necrosis and atrophy; cardiac necrosis	Pinnipeds; cetaceans	Feeding animals; suckling animals; foetuses; delayed effects in young animals following *in utero* exposure	Scholin *et al.* (2000); Brodie *et al.* (2006)
Saxitoxin	*Alexandrium, Gymnodinium, Pyrodinium* spp.	Ingestion	Acute mortality; incoordination; drowsiness; paralysis	None	Cetaceans; pinnipeds	Feeding animals	Geraci *et al.* (1989); Hernandez *et al.* (1998)
Brevetoxin	*Karenia brevis*	Ingestion (prey/milk); inhalation	Acute mortality; respiratory distress; neurological signs	Respiratory tract inflammation	Cetaceans; manatees	All nursing animals	Watkins *et al.* (2008)
Ciguatoxin	*Gambierdiscus toxicus*	Ingestion of reef fish	Diarrhoea; weight loss; itching; seizure; respiratory paralysis; temperature sensation reversal; fatigue	None	Suspected in Hawaiian monk seals	Feeding animals	Gilmartin *et al.* (1980)
Okadaic acid		Ingestion	Unknown	Unknown	Cetaceans		
Microcystins	Cyanobacteria	Ingestion; inhalation; dermal	Liver failure	Hepatic necrosis	Sea otters	Feeding animals	Miller (pers. comm.)
Bacterial toxins							
Botulinum	*Clostridium botulinum*	Ingestion	Paralysis	None	Beluga whale	All life stages	CDC, 2003; Miller, 1975
Tetanus	*Clostridrium tetani*	Ingestion; injection	Paralysis	None		All life stages	

1996). Four Bryde's whales were found dead in the Persian Gulf in 2007 (Braulik *et al.*, 2010) but no details were available regarding the cause(s) of those deaths. Another 'die-off' may have occurred in the upper Gulf of California as the remains of 10 dead baleen whales were found there in April 2009 (J. Urbán-Ramírez, pers. comm. to Brownell). Also, about 50 humpback whales were found dead along the coast of Western Australia during the latter half of 2009 (Doug Coughran, pers. comm. to Brownell).

The largest reported 'die-off' of baleen whales prior to the recent right whale mortality in Argentina involved gray whales in the eastern North Pacific. In 1999 and 2000, respectively, 283 and 368 gray whale deaths were documented. However, in 2001 the documented number of dead gray whales was only 21, which is around what is considered the background level for that population (Brownell *et al.*, 2007; Gulland *et al.*, 2005).

6. SOUTHERN RIGHT WHALE HEALTH MONITORING PROGRAM

6.1 Stranding response protocols 2003–09

Chirife described systematic efforts to monitor right whale mortality at Península Valdés that began in 2003, with the establishment of the Southern Right Whale Health Monitoring Program (SRWHMP). This programme is operated by a group of NGOs (Whale Conservation Institute, Wildlife Conservation Society, Instituto de Conservación de Ballenas, Fundación Patagonia Natural and Fundación Ecocentro).

6.1.1 Locating stranded whales

The SRWHMP field team is active during the six months that right whales are present at Península Valdés (mid-June to mid-December). The team locates strandings through: (1) bi-monthly surveys of the beaches where the whales concentrate; (2) aerial surveys of the coast; and (3) reports from members of a local stranding network. The network's 70-plus members live and work along the coast of the peninsula and include wildlife officers, fishermen, local inhabitants, whalewatching boat captains, dive boat operators, tour guides, boat captains, airplane pilots, scallop fishermen, researchers, non-governmental organisations and local authorities such as the Coast Guard. The land-based survey effort has varied with vehicle availability and the number of strandings to be investigated. When the team is busy visiting multiple strandings in a given week, the survey for that week is cancelled or postponed. Aerial survey effort also varies. Strandings are recorded during at least one aerial survey a year covering the perimeter of the peninsula at the time of peak whale abundance. This survey is conducted collaboratively by the Whale Conservation Institute and Instituto de Conservación de Ballenas and is dedicated to photo-identification of individual whales. The stranding network consistently reports most of the strandings (above 70%) recorded in the area in a year. This highlights the importance of developing and maintaining such networks.

6.1.2 Necropsy protocol

Stranded animals are investigated following a right whale necropsy protocol developed for the programme by M. Uhart, L. La Sala and L. Pozzi. The protocol is based on protocols developed by McLellan *et al.* (2004), F. Gulland (pers. comm.), A. Carribero (pers. comm.) and Geraci and Lounsbury (1993). When a stranded whale is reported, SRWHMP researchers travel as soon as possible to the stranding site. Once it is confirmed that the animal is dead, the geographical location is recorded and photographs are taken. Depending on the physical conditions and the state of decomposition of each animal, body measurements are taken and an external examination is carried out in search of scars, wounds and any other evidence of the cause of death or of human interaction. Depending on the physical condition, an internal examination or necropsy is conducted (partially or completely). In all cases the animals' tails are tagged and notched to avoid recording repetitions. Detailed protocols and sample collection lists currently used for the beached whales are available upon request.

7. REVIEW OF RIGHT WHALE DEATHS AROUND PENÍNSULA VALDÉS AND FINDINGS TO DATE FROM THE DIE-OFFS

Uhart and Rowntree reviewed the history of strandings at Península Valdés and presented detailed information on the recent high mortality. The recent series of 'die-offs' began in 2003 and has continued until the present (see Table 3). In 2003, 31 right whales stranded at Península Valdés, 29 of them calves. This was followed by very low mortality in 2004, when only 13 dead whales were recorded. In 2005, 7 adult right whales died at Península Valdés, more than had been recorded in a single year since some level of monitoring began in the area in the early 1970s. Six of these dead whales were found in Golfo San José within a six week period. In the same year 36 calves and 4 juveniles died. In 2006 only 18 whales (16 calves, one juvenile and one adult) stranded and in 2007, 83 whales died, 77 of them calves. Of these, at least 61 (60 of them calves) died over a span of 72 days. Only three of these carcasses were found in Golfo San José and the rest in Golfo Nuevo. In 2008, 95 dead right whales were found at Península Valdés, 81 of them in a period of 10 weeks: 57 (52 of them calves) of these in Golfo Nuevo and 24 (all calves) in Golfo San José. Finally, in 2009, 79 dead right whales were documented at Península Valdés: 38 (of which 35 were calves) beached in a three week period. Again, the majority of the whales died in Golfo Nuevo.

With respect to the recent right whale die-offs, Uhart summarised the numbers, age and sex composition, and seasonal timing of strandings, including data presented previously to the IWC Scientific Committee (Uhart *et al.*, 2008; 2009).

7.1 Strandings: long-term dataset

The number of strandings of individuals of all ages recorded from 1971 through 2001 grew at almost the same rate as the population (6.7%/yr compared to 6.8%/yr respectively; see Fig. 3). Survey effort increased from 1994–2002 (see Item 2.4, above) and again from 2003 with the initiation of the Southern Right Whale Health Monitoring Program

Table 3

The number and age categories of dead whales recorded at Península Valdés since 2003, when the SRWHMP began. Ninety-one percent of the dead whales have been calves. Years with higher numbers of strandings are highlighted. (Source: SRWHMP, unpublished data).

	2003	2004	2005	2006	2007	2008	2009	Total	%
Calves	29	13	36	16	77	89	73	333	91
Juveniles	1	0	4	1	1	0	0	7	2
Adults	1	0	7	1	5	3	5	22	6
Unknown	0	0	0	0	0	3	1	4	1
Total PV	31	13	47	18	83	95	79	366	100

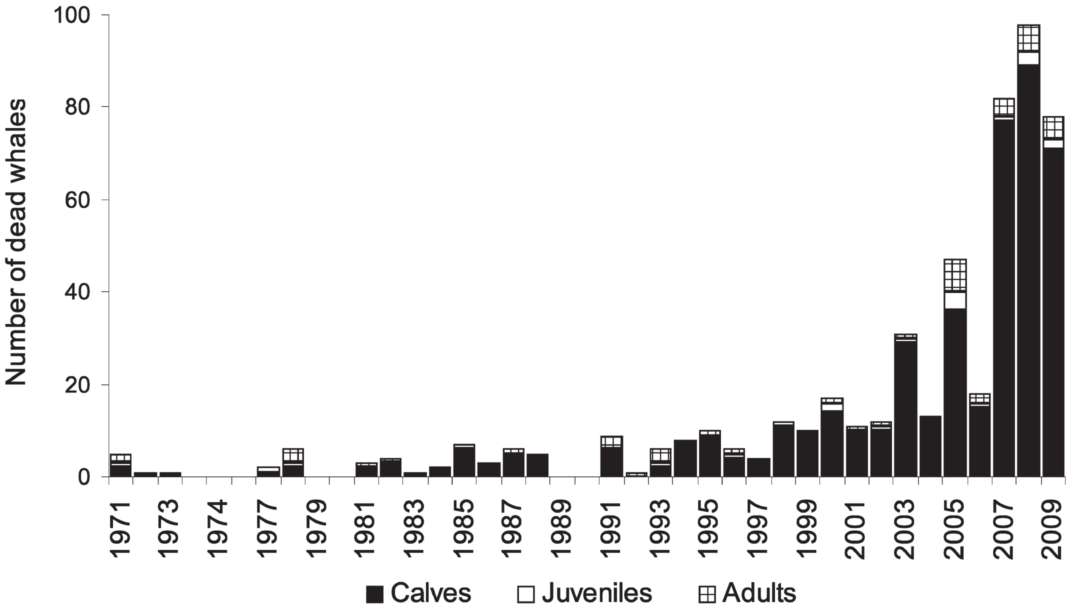

Fig. 3. Number and age category of dead whales recorded at Península Valdés since 1971 (Source: SRWHMP, unpublished data). (Note: post 2003 data are not equal in search/reporting effort to pre-2003 data, see Annex C.)

(SRWHMP). Since 2003, the number of whales stranded has increased dramatically: 366 right whale deaths were recorded and investigated at Península Valdés through 2009, with peaks in 2005 (47 strandings), 2007 (83), 2008 (95) and 2009 (79). Of the 366 documented deaths, 333 (91%) were calves less than four months old.

An analysis of numbers of strandings detected and reported, in relation to search effort and reporting efficiency, was provided by Jon Seger after the Workshop, and is included in this report as Annex C.

7.2 Proportions of different age categories and sexes among stranded whales from 1971–2009

Uhart reported that the number of stranded calves in the period from 2003–2009 was disproportionate to the increase in number of live calves observed in surveys. From 2003–09, the observed rate of increase in living calves from aerial counts was 0.11/yr, whereas the number of stranded calves increased at 0.25/yr (Fig. 4), indicating that the number of strandings documented was increasing at more than twice the rate of the number of living calves counted per year.

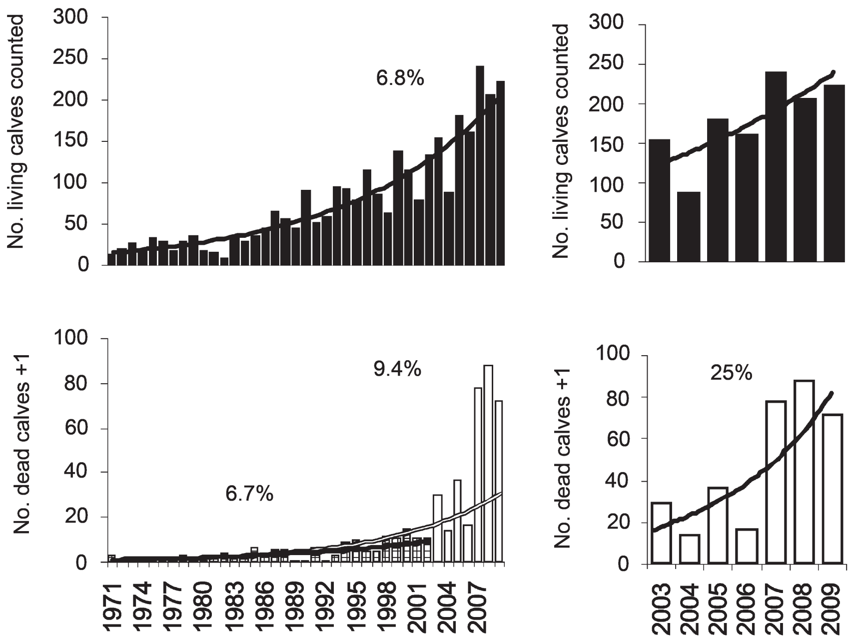

Fig. 4. Rate of increase in the number of living and dead calves counted each year. The graphs on the left show the similarity in the rate of increase from 1971–2002 in the number of dead (bottom left, 6.7%) and living calves counted each year (top left, 6.8%). The graphs on the right are enlargements of the years with high mortality, 2003–09. In these years, dead calves increased at more than twice the rate (25%) of living calves counted (11%). (Source: SRWHMP, unpublished data).

Table 4

Sex composition and sex ratio (males/total) of stranded right whales by age category (2003-09) (SRWHMP, unpubl. data).

	Neonates	Calves	Juveniles	Adults	Unknown	Total
Males	0	116	1	1	0	118
Females	2	139	4	19	0	164
Unknown	0	76	2	2	4	84
Sex ratio	–	0.45	0.80	0.95	–	–
Total	2	331	7	22	4	366

Considering all age categories in all years with data, a slightly higher number of females than males have been found dead at Península Valdés (see Table 4). This sex bias applies particularly to adults and juveniles; the sex ratio of calves is not significantly different from parity.

7.3 Seasonal timing of strandings

Since 2003, the timing of stranding peaks and the total numbers of dead animals have changed from year to year (Fig. 5). In 2005 and 2007, strandings peaked in October and through mid-November. In contrast, the peaks in 2008 and 2009 occurred from mid-August through mid-September. Secondary peaks in strandings occurred during the first two weeks of October in 2007, 2008 and 2009. In years with low mortality, strandings were fairly consistently distributed between September and October.

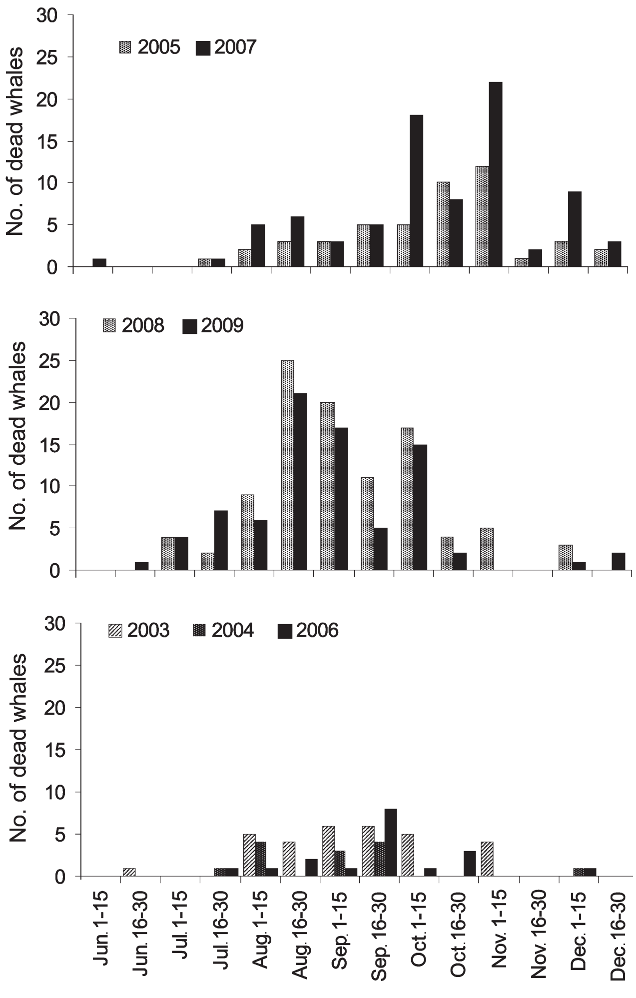

Fig. 5. Annual number of dead whales documented by half-monthly blocks, 2003–2009. The top two graphs are grouped into years when peaks in mortalities occurred late (top graph) or early (middle graph) in the nursery season. Bottom graph shows the distribution of strandings in years with low mortalities. (Source: SRWHMP, unpublished data).

7.4 Locations of strandings (Golfo San José vs. Golfo Nuevo)

According to Uhart, of the 373 beached whales recorded by the programme since it began in 2003, only 7 were located in areas outside of Península Valdés.

Over the years of the SRWHMP (2003 to 2009), live calves counted during the annual aerial photo-identification surveys conducted by WCI/ICB at the time of peak whale abundance were almost equally distributed between Golfo Nuevo and Golfo San José (Fig. 6). However, the percentage of dead whales has consistently been greater in Golfo Nuevo, except in 2006 (Fig. 6).

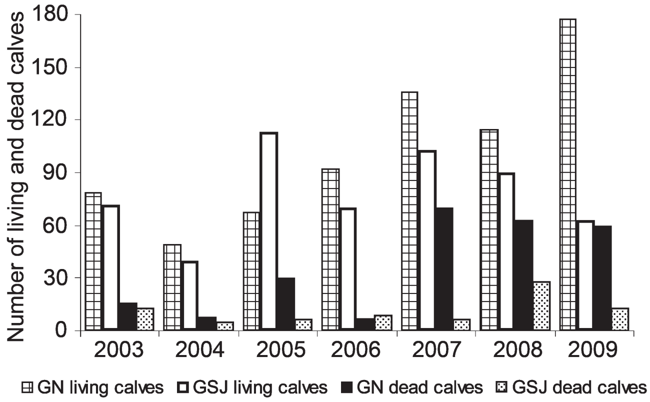

Fig. 6. Numbers of living and dead calves counted in each gulf from 2003 through 2009. GN = Golfo Nuevo, GSJ = Golfo San José. Living calves counted in aerial surveys, dead calves as tallied by the stranding network. Living calves had similar distributions between gulfs. With the exception of 2006, more calves died in Golfo Nuevo, particularly in years with high calf mortality. (Source: SRWHMP, unpublished data).

7.5 Calf body length vs. stranding date

Best and Rüther (1992) conducted aerial photogrammetry on mother-calf pairs of southern right whales on the South African coast. The smallest calf measured was 4.53m and on 1 August young calves recorded ranged from 5.41m for primiparous mothers to 5.93m for other females. Smaller and apparently primiparous females frequently had smaller calves, and they tended to give birth later in the season, than multiparous females. Best and Rüther measured some calves more than once within a season and found that they grew at an average rate of about 2.8cm/day, with no significant difference between the growth rates of first calves (primiparous mothers) and later calves (multiparous mothers).

Rowntree presented data on the relation between calf length and date of stranding as a way of gauging annual differences in nutritional state. It was suggested that calves growing at the expected rate up until their deaths were probably not suffering nutritional stress. According to Rowntree, differences in time of birth and calf size could explain the broad range of calf sizes observed at any one time off South Africa and among the dead calves stranded at Península Valdés (Fig. 7), particularly early in the calving/nursing season.

Stranded calves at Península Valdés are measured only once, so no direct comparison with the growth-rate estimates of Best and Rüther is possible. However, calves that strand late in the season tend to be larger than those that strand early, as expected, on the assumption that the mean age will be greater. The linear regression of measured lengths of stranded calves against the day they were discovered at Península Valdés from 2003 to 2009 has a slope of 1.7cm/day (Fig. 7; upper panel). This slope would be expected to be lower than the actual growth rate because later samples include mixtures of older (early-born) and younger (later-born) calves.

An interesting and potentially informative pattern emerges when this sample of calf lengths and stranding dates is subdivided into years with high mortality late in the season (2005 and 2007) and years with high mortality early in the season (2008 and 2009). In the late-in-season years, average stranded calf length increased at a rate of 2.6cm/day (Fig. 7; lower panel), which is remarkably close to the direct growth-rate estimate of Best and Rüther (1992). The majority of the calves died after 30 September, and these were 7.3m long on average, which is 1.2m longer than the average of 6.1m for mean length at birth estimated by Best (1994). Thus, it can be inferred that the calves had grown for some time, at apparently normal rates, before they died. In the early-in-season years, by contrast, the average length of stranded calves increased only slightly over the season (0.3 cm/day), and calves that died after 30 September were only 5.8m long, on average ($n = 114$, $t = 6.3$, $p<0.0001$ for the difference in mean lengths of late-season [post-30 September] strandings between the two sets of years).

Rowntree suggested from these data that in contrast to 2005 and 2007, when many calves grew for weeks or months before dying, most of the calves that stranded in 2008 and 2009 died fairly soon after birth, regardless of when they were born. This pattern would appear to be consistent with the hypothesis that nutritional stress (on the mothers and/or calves) or some lingering problem that made calves unviable

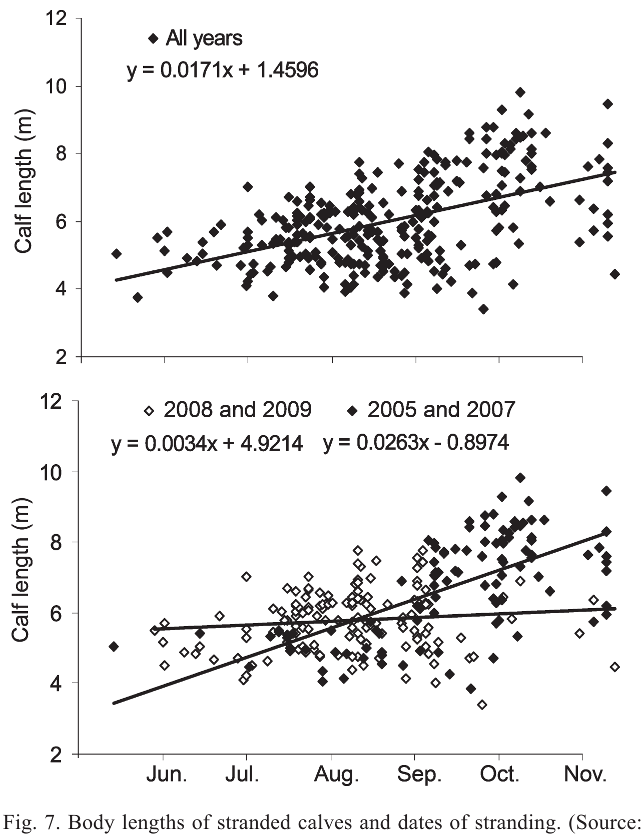

Fig. 7. Body lengths of stranded calves and dates of stranding. (Source: SRWHMP, unpublished data).

was more of a factor in 2008 and 2009 (the early-in-season stranding years) than it was in 2005 and 2007 (the late-in-season stranding years).

Rowntree further noted that calves that died early in 2008 and 2009 tended to be longer than those that died early in 2005 and 2007 (mean of 5.8m *vs.* 5.1m, $n = 132$, $t = 4.3$, $p < 0.0001$). This difference might be expected if relatively more of the early deaths in 2008 and 2009 were calves of older, larger, multiparous females, which tend to have larger calves and give birth earlier in the season than primiparous females (Best and Rüther, 1992).

7.6 Pathology from gross examinations and serology

Uhart summarised the outstanding findings to date from gross pathology examinations. Rough-surf injury, boat strikes, a hard blow from another whale, and other sources of blunt-force trauma remain potential diagnoses for a calf that died in 2003 with extensive renal and spleen hemorrhages, and for a calf that died in 2009 and was found with a large skull fracture. In 2004 the skeleton of an adult male that had stranded the year before was recovered and it was found to have chronic degenerative lesions in most vertebrae of the spine, with multiple fused blocks of vertebrae consistent with ankylosing spondylitis. Polymerase chain reaction (PCR) testing for *Brucella* sp. was negative although this result was questioned due to poor carcass condition and environmental exposure. Three episodes of possible dystocia were recorded, as follows.

(1) In 2005 an adult female died with a nearly full-term calf (female size 15.35m, calf size 4.46m not including the head) in her uterus.
(2) In 2007 the death of a female and her calf apparently occurred during parturition (the calf was lodged in the birth canal). This female was very small (14.60m) and her female calf was very large (5.35m).
(3) In 2009 a dead male calf had an extensive bruise in the dorsal area behind the skull as well as injuries in neighbouring organs and tissues. Similar wounds have been observed in North Atlantic right whales after difficult births (W. McLellan and M. Moore, pers. comm.).

As discussed elsewhere in this report (Item 3.2), scars and wounds from gull attacks are commonly found on the backs of right whales at Península Valdés. The gulls target existing lesions and enlarge them over the season. The percentage of whales with gull lesions has increased markedly since the early 1970s. Gull attacks were initially confined to adults, but by the year 2000, calves had become preferred targets. Currently, a significant number of calves older than a month have at least one and usually a chain of gull attack lesions on their back (WCI/ICB, unpublished data).

According to Uhart, gull-inflicted lesions on dead whales' backs appeared more swollen in the first week of October 2007 than in previous years since 2003. There are also reports from those trying to obtain biopsies of gull-peck wounds that lesions on the backs of living calves looked more swollen during this period than earlier in the season. Necropsies in 2007 showed that bleeding under the lesions extended through the blubber layer. In previous years, one of these lesions was found to be contaminated with bacteria, indicating that they could have led to systemic infections (see Item 7.11). Of the 81 dead whales observed during the 2009 season, at least 24 (30%) had evidence of injuries caused by gulls prior to death. Importantly, however, not all dead whales could be examined for such evidence since many

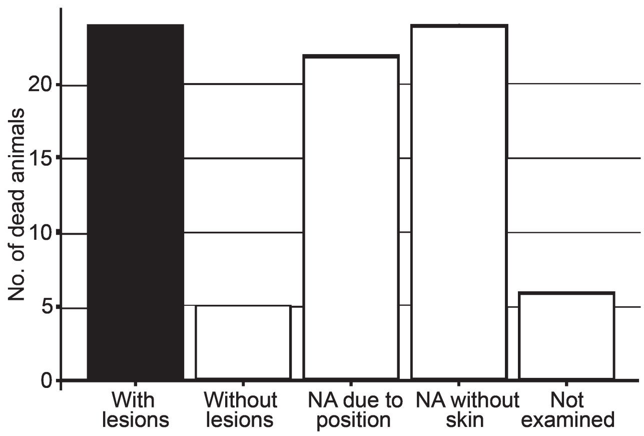

Fig. 8. Summary of information on presence or absence of gull attack lesions on dead right whales at Península Valdés in 2009 (Source: SRWHMP, unpublished data). NA = information not available.

stranded with the dorsal side down or had lost their skin (Fig. 8).

Uhart further summarised the findings from infectious disease serology. Infectious disease serology was conducted on 4 calves in very fresh condition sampled between 2004–09. Results were negative for brucellosis, leptospirosis (serovars, *L. pomona*, *L. harjo*, *L. ictero*, *L. grippo*, *L. canicola, L. australis, L. pyrogenes, L. bratislava, L. sejroe, ictero/icter, L. javanica, L. szwajizak, L. saxoebing, L. ballum, L. wolffi, L. atumnalis, L. bataviae, L. tarassovi*), influenza type A, morbillivirus panel (canine distemper, cetacean morbillivirus, phocine distemper), and seal herpesvirus (only tested on animals stranded in 2009). The two calves sampled in 2004 and 2005 were positive for canine herpesvirus. Mass tag was run on serum from two animals from 2009 (062909Pv-Ea01 and 072309PV-Ea07) with negative results. Pathogens included in the respiratory panel were: *Haemophilus influenzae*, *Chlamydophila pneumoniae*, *Neisseria meningitis*, *Streptococcus pneumoniae*, *Legionella pneumoniae* and *Mycoplasma pneumoniae*. Those included in the pan-viral panel were: Adenovirus Influenza A and B RSVA and B Coronavirus HPIV1 to 4 metapneumovirus enterovirus. PCR for *Brucella* sp. was run on 26 whales sampled between 2004–09 (samples included ovary, spleen, testicle, mesenteric lymph node). Results were negative. Bacteriological culture of swabs from skin, umbilicus, uterus, genitals and lungs was conducted on macroscopically visible lesions from six animals between 2003–09. Results were not significant, including *Streptococcus faecalis* (enterococcus), Gram– bacilli, *Candida* sp., *Escherichia coli* (not enterotoxigenic) and *Proteus mirabilis*.

7.7 Results of sampling for harmful algal blooms (HABs) and the timing of whale deaths

Whales are primarily fasting early in the nursing season but begin to feed occasionally at the end of September. This opens the possibility that at least some of the deaths in 2005 and 2007 were caused by or associated with the ingestion of biotoxins from algal blooms. However, in both years there were no reported die-offs of other marine mammals, marine birds or fish.

Both *Alexandrium* and *Pseudonitzschia* can produce toxins that have been linked to mass mortality of marine mammals (Gulland *et al.*, 2002; Scholin *et al.*, 2000). Uhart reported that Chlorophyll *a* concentrations were low at all times in 2005, but high in September and October in 2007 and 2008 in Golfo Nuevo (Fig. 9). Of the five peaks in mortality, three (1 in 2007 and 2 in 2008) occurred within a week of extremely high concentrations of Chlorophyll *a* (50–180 mg/m^3). Water samples from Golfo Nuevo in September 2007 and 2008 revealed high densities of the toxic dinoflagellate *Alexandrium tamarense*, and similar densities occurred in Golfo San José (GSJ) in 2008 (Fig. 10). However, these blooms were not temporally associated with the highest peaks in whale mortality in any year. Similarly, although high densities of the diatom *Pseudonitzschia* sp. were found in Golfo San José in December 2007 and November and December 2008, these blooms occurred well after the peaks in whale mortality. However, no signs of toxicity were observed in whales or any other marine species during those blooms, with a single reported exception: a two month old calf was observed dying after exhibiting respiratory distress and seemingly being unable to move (i.e. not avoiding repeated gull pecks and unable to float normally) on 29 September 2007 (A. Fazio, pers. comm.).

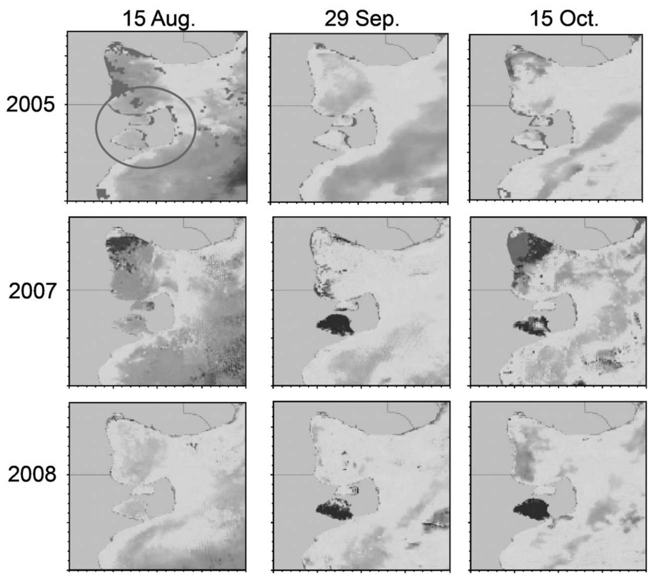

Fig. 9. Satellite maps showing changes in chlorophyll a levels in the waters surrounding Península Valdés as the seasons change from winter to spring. The land is grey and the peninsula and its northern (GSJ) and southern (GN) bays are indicated by an oval in the top left map. The dark-coloured filling in GN in the bottom right map indicates extremely high levels of chlorophyll a. (Source: MODIS-Aqua, Bloomwatch 180, *http://www.coastwatch.pfel.noaa.gov*).

Uhart also reported that traces of domoic acid had been found in the blood of one adult female right whale from Golfo San José and one calf in Golfo Nuevo, which died in October and November 2005, respectively. An additional 90 samples collected from 28 dead whales since 2007 tested negative for domoic acid and paralytic shellfish poison (G. Doucette, S. Fire and N. Montoya, pers. comm. to Uhart). Samples analysed have included stomach and intestinal contents, milk, urine, faeces, liver, brain, blood spot cards and others.

HABs have expanded in geographic range and increased in frequency in South America in recent years (Carreto *et al.*, 1998; Van Dolah *et al.*, 2003). They are regarded as a relatively new phenomenon at Península Valdés (Gayoso, 2001; V. Sastre, pers. comm. to Uhart). Nevertheless, key evidence relating the unusually high mortality of right whales in the area to HABs is lacking.

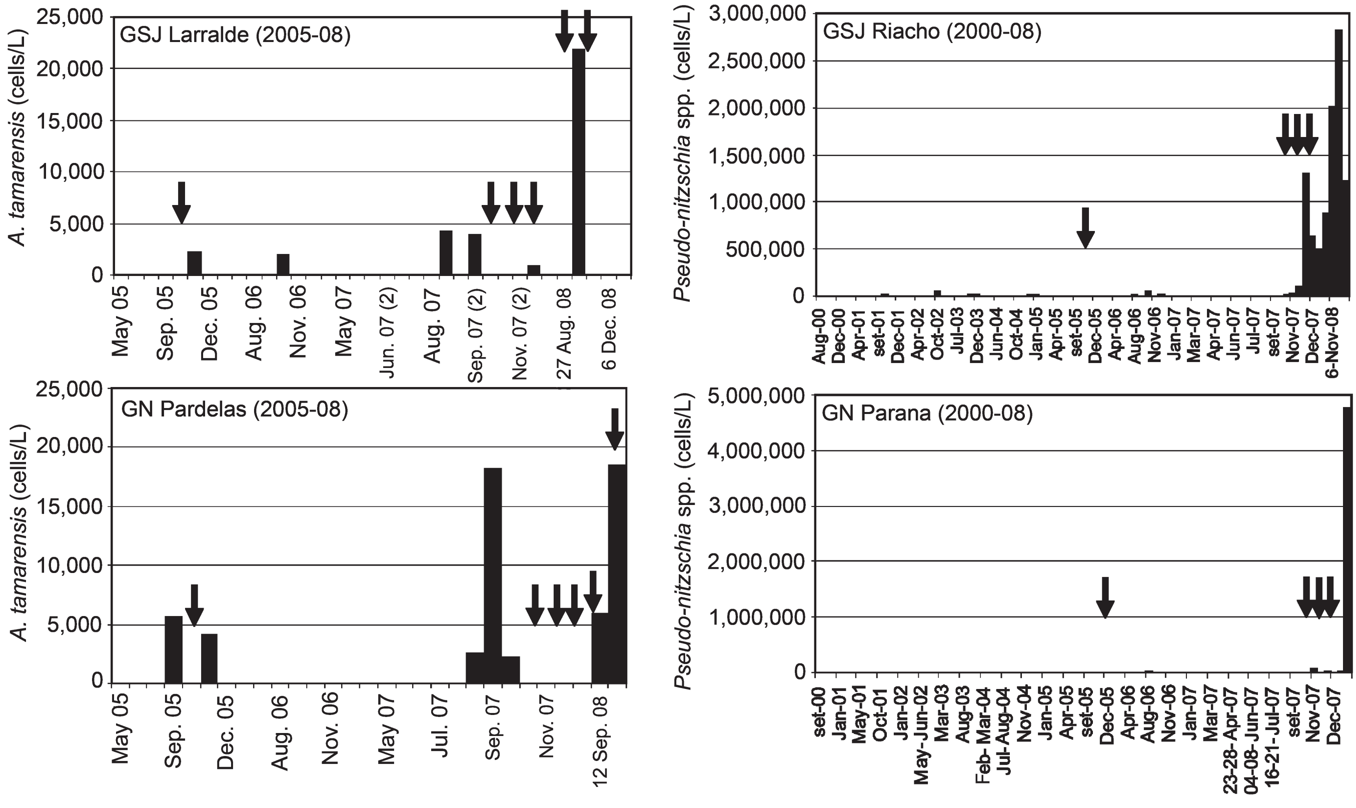

Fig. 10. Timing of algal blooms in Golfo San José (GSJ) and Golfo Nuevo (GN) since 2005. Graphs on the left represent peaks of *A. tamarensis*. Graphs on the right represent presence of *Pseudonitzchia* sp. Arrows mark times of peaks in whale mortality. (Source: Viviana Sastre and SRWHMP, unpublished data).

7.8 Changes in body condition of females with calves within season and between seasons – blow intervals

Rowntree presented preliminary results of a study using respiration characteristics (specifically blow intervals) as an index of maternal condition. Cliff-top observers recorded the time of each blow for mothers and their calves during focal animal follows lasting 30 minutes or longer. Data were collected over six years between 1997–2009. The initial objective of the study had been to see whether the mean time between blows (or blow interval) could be used as an indicator of a whale's breath-holding ability and thus its 'condition'. This objective was extended to include the obvious question of whether calf mortality rates correlated with this 'condition index'.

High calf mortality occurred late in the season in 2005 and 2007 and early in the season in 2008 and 2009. Length measurements of calves that died late in the season in 2005 and 2007 indicate that the calves were growing before they died while calves that died in the years with high mortality early in the season (2008 and 2009) were small throughout the season (see Item 7.5). One interpretation might be that mothers in 2005 and 2007 were in better body condition than mothers in 2008 and 2009.

All blow interval data presented here were for mothers and calves that were resting or travelling slowly. The mean blow intervals of mothers varied greatly within each year (Fig. 11) but the mean of the mean blow intervals of all mothers in 2008 and 2009 was significantly lower than that of mothers in 2005 (68s compared to 101s respectively, $t = 4.2$, $df = 74$, $p = 6.9 \times 10^{-5}$), suggesting that poor body condition of mothers could have led to early-season deaths of calves in 2008 and 2009.

The respiratory pattern for adult right whales that are resting or travelling slowly on the calving/nursery ground usually includes one large blow, as the whale first surfaces, followed by a series of 3–5 smaller blows before the whale submerges for a minute or longer. Fig. 12 is a graphic representation of the respiratory patterns observed in surfacing bouts. The cumulative frequencies of all blow intervals of mothers are grouped by years. The first third of the blow intervals are short and probably represent the short intervals after the initial surfacing blow. The divergence between years in lengths of blow intervals is largest at blow

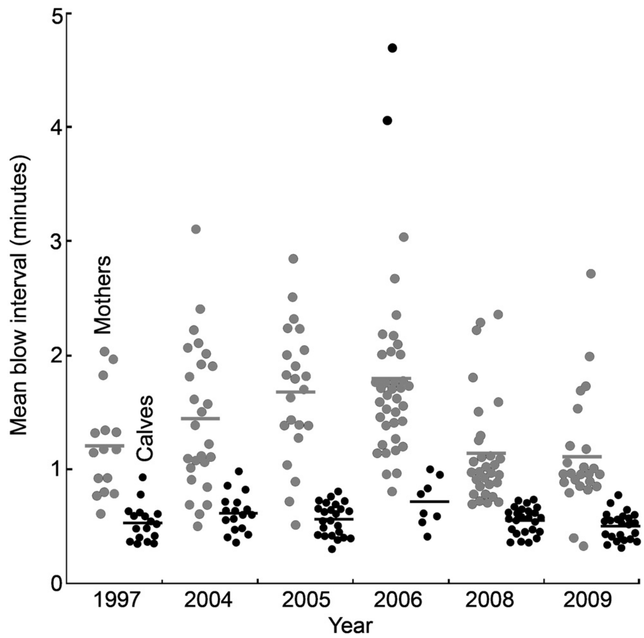

Fig. 11. Mean blow intervals of mothers (grey) and their calves (black) over six years of observations. Bars indicate the mean of the mean blow intervals for that year. Only data for whales that were resting or travelling slowly are presented here. (Rowntree, unpublished data).

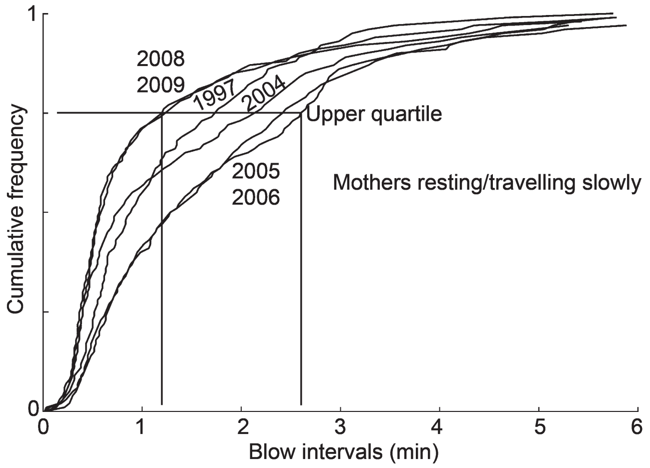

Fig. 12. Cumulative frequency of blow intervals of different durations for mothers that were resting or travelling slowly in different years of a 6-year study. The blow intervals for all mothers in a year were combined. The upper quartile of the data shows a clear differentiation between years with mothers breathing more frequently in 2008 and 2009 compared to mothers in 2005. (Rowntree, unpublished data).

intervals lasting 1 to 2.5 minutes and probably corresponds to the submergence times between blowing bouts. The graph shows that 75% of the blow intervals of mothers in 2008 and 2009 were less than 75sec compared to 260sec for mothers in 2005, indicating that mothers held their breath for much shorter periods of time in 2008 and 2009 than in 2005.

7.9 Distribution of haplotypes and clades among stranded vs. living whales

Rowntree summarised the results of a published paper (Valenzuela *et al.*, 2009) as well as an unpublished new analysis by Valenzuela and co-workers. Valenzuela *et al.* (2009) showed that southern right whales from similar mitochondrial lineages (haplotypes) consume isotopically similar food (based on carbon and nitrogen stable-isotope ratios for 131 adult females sampled between 2003–06) and concluded that different groups of potentially related whales from the Península Valdés region tend to feed in distinct areas of the southern South Atlantic and Southern Oceans. The new analysis used the previous data on population structure from Valenzuela *et al.* (2009) together with new mtDNA data on 88 additional live mothers and 43 dead stranded whales. The 37 haplotypes that appear in the combined sample of 219 live mothers from 2003–06 (Valenzuela *et al.*, 2009) and the available sample of stranded calves show similar overall frequencies (Fst = 0.001, P>0.1 by AMOVA on the haplotype frequencies). However, while the stranded calves showed significant genetic differentiation among years (Fst = 0.008, P = 0.03), the live mothers showed none (Fst = –0.001, P>0.1). The among-year differentiation of the calves is not merely an artefact of just one year being distinct from all others. Given the previous findings, this pattern of mitochondrial genetic differentiation among calves stranded in different years is intriguing and raises the question of whether it is related in some way to the modest levels of differentiation among females presumed to use different feeding grounds as maternal lineage may be linked to feeding ground site fidelity (see Item 4.1).

7.10 Trace metals in whale tissues

Rosas reported initial findings from trace metal analyses of tissues from whales sampled by the SWRHMP at Península Valdés during 2003–09. Non-essential metals, Cd and Pb, were not detected in the liver and kidney samples from 51 calves. Cu and Zn were detected and levels were significantly higher in liver than in kidney. A positive correlation was found between Cu and Zn for both organs, which suggests a common origin and/or that these metals 'behave' similarly in liver and kidney. Differences between sexes were not significant. Metal levels were higher in whales from Golfo Nuevo than in whales from Golfo San José, though the difference was not significant.

7.11 Results from histopathology

McAloose provided a summary of histopathology work carried out on tissue samples from 53 of the 366 (14%) right whales known to have died at Península Valdés between June 2003 and July 2009. The histological examinations were carried out in order to establish causes of death. All of this work was conducted by certified veterinary pathologists (American College of Veterinary Pathologists). All of the animals were reported in the gross necropsy records as being calves of the year, i.e. born in the year sampled.

Tissues were received from animals grossly categorised as being in condition code 2 (n = 10), 3 (n = 19) or 4 (n = 14); condition code was not listed in the gross necropsy reports for 10 animals. Twenty-two of the animals were male, 27 were female and the sex was undetermined on gross or histologic examination in four animals. One or more of the following tissues were received for examination for each animal: skin, skeletal muscle and/or diaphragm, lung, kidney, gastrointestinal tract, heart, connective tissue, liver, artery, baleen, spleen, ovary, adipose tissue, cartilage, bone, lymph node, testis, tongue, nerve, thymus, trachea, oesophagus, mucosa, penis, urinary bladder, uterus, brain, pancreas, urethra, bone marrow, eye, smooth muscle, tendon, adrenal gland, epididymis, spinal cord and thyroid gland. Post mortem autolysis was present in all cases and varied from mild to severe. Histologic assessment and interpretation depended on the ability to identify recognisable tissue and cellular architecture; establishing a cause of death was variably limited by tissue preservation and availability.

A variety of histologic lesions were identified in examined tissues. However, common significant lesions or pathologic processes (e.g. infectious disease) to explain the yearly or recurrent strandings were not identified in tissues examined histologically in these animals. Vessel strike was grossly established as the cause of death in one case. Bacterial sepsis, with hepatitis and concurrent inflamed gull-peck wounds, was present and considered the cause of death in one animal. Additional notable histologic lesions included the presence of squames (11/28), binucleated or multinucleated cells (5/28) or mild pneumonia (2/28) in the lungs, gull-peck wounds (n = 6) in the skin, poor body condition (n = 2) based on fat atrophy or hepatic lipidosis, colitis (n = 1) and renal tubular necrosis (n = 1). In vertebrate species, interpretation of the significance of intra-alveolar squames varies from incidental to a reflection of foetal distress and is dependent on additional factors including the number of squames, presence/absence of inflammation and/or other evidence of foetal distress such as intra-alveolar meconium. In examined lungs, the small number of squames and lack of additional findings was considered more likely to be an incidental finding than a reflection of foetal distress. Bi- and multinucleated cells in the lungs were rare to few in all animals in which they were seen. They were morphologically consistent with having a histiocytic origin, thought to be of pulmonary or tracheal origin, and this was considered an incidental finding; viral inclusions were not seen in any of these cells. A cause for the mild pneumonia in the two animals in which it was identified was not histologically apparent. Gull-peck lesions were found concurrently in one animal with systemic disease (sepsis, mentioned above); local inflammation (characterised by one or more of the following: dermatitis, thrombosis, vasculitis or cellulitis) in the absence of a systemic process was seen in 2 of 5 additional animals. Terminal aspiration or passive inflow of water after death (based on intra-alveolar bacteria, protozoa or foreign material in the absence of inflammation or other tissue pathology) was seen in 11 of 28 animals in which lung tissue was submitted and examined. Incidental age-related findings included extramedullary hematopoiesis ($n = 2$) and lymph node germinal centre formation ($n = 1$).

Ongoing monitoring for independent, multifactorial/ interrelated or concurrent disease processes, including infectious, toxic or nutritional disease, genetic or environmental factors including food availability, and maternal and calf fitness are critical for establishing the cause(s) of the recent recurrent, significant mortality of young right whales at Península Valdés.

The Workshop participants asked a number of questions on the material presented and a number of points were clarified. Most of the animals reported through the SRWHMN were dead when reported, there was only one case, referred to in Item 7.7 above of a calf reported live which subsequently died. Other than that incident there is very little observational data of the behaviour of calves or other stranding animals prior to stranding. For this reason the Workshop **recommended** that an alert network to detect and report such behaviour be established. Participants asked what percentage of stranded calves were neonates, with evidence of recent birth. The response was that only a small percentage of the strandings have been neonates. It was noted that while 80% of calves are gull pecked, samples of gull peck lesions have only been available for six stranded calves. Of those six samples, three showed inflammation and sepsis was noted in one of these. The point was made that this is a small sample of what appears to be a broad condition.

8. HEALTH (STATUS) OF SOUTH ATLANTIC OCEAN ECOSYSTEM

8.1 Offshore feeding areas

Forcada described recent trends in certain characteristics of the South Atlantic Ocean ecosystem and discussed the possible consequences of changing ocean conditions in the region. The offshore waters of the northern Scotia Sea in the southwestern Atlantic, and particularly north of South Georgia, are likely an important feeding area for southern right whales (Hedley *et al.*, 2001; British Antarctic Survey, unpublished data courtesy of Forcada). The Scotia Sea is one of the most productive regions of the Southern Ocean and has the highest estimated density of Antarctic krill (Atkinson *et al.*, 2004). Krill is the major link between primary production and millions of vertebrate predators (Croxall *et al.*, 1988) and thus is a keystone species that provides structure and function to the marine ecosystem (Murphy *et al.*, 2007). However, the krill in the Scotia Sea is not self-sustained. Predation on larvae and advective export of various age classes during winter are likely the main causes of local recruitment failure in krill (Tarling *et al.*, 2007). Because of this, successful krill reproduction and recruitment in the West Antarctic Peninsula (WAP) are essential to support a high krill biomass in the Scotia Sea, to which krill is transported by the Antarctic Circumpolar Current, the main eastward ocean circulation that occurs within a restricted latitudinal range and is topographically constrained through the Drake Passage, between South America and the Antarctic Peninsula.

The lack of either retentive oceanic structures or the formation of new ones can affect the advection and dispersal of young krill from the Antarctic Peninsula to the Scotia Sea. Sea ice cycles and climate–ocean variability are essential for the successful reproduction, recruitment and advection of krill. Successful recruitment is episodic and cycles tend to vary between 4 and 6 years in the Antarctic Peninsula (Quetin and Ross, 2003); recruitment indices are correlated with krill density indices across the Scotia Sea. Krill cycles are associated with ENSO (El Niño Southern Oscillation) and the Southern Annular Mode (SAM) variability (Ducklow *et al.*, 2007; Murphy *et al.*, 2007; Quetin and Ross, 2003). These are the dominant modes of large scale climate variability in the Southern Hemisphere and induce much of the physical forcing in the Southern Ocean. The SAM is the most important mode in high latitudes and results from internal atmospheric dynamics in middle latitudes; it is associated with a meridional shift in the position and intensity of the westerly winds. Both of the climate variability modes are linked to variations in temperatures over Antarctica, sea surface temperature throughout the Southern Ocean, and the distribution of sea-ice around the Antarctic continent. Shifts in the periodicity of sea ice cycles and derived recurring processes cause mismatches between earlier phytoplankton blooms, krill development and recruitment, and krill availability for predators. During the breeding seasons of seals and penguins, the cascading consequences for their populations are increases in distance and time of foraging trips, reduced breeding performance, lowered return of breeders and higher adult mortality (Forcada and Trathan, 2009; Forcada *et al.*, 2008; Forcada *et al.*, 2005; Forcada *et al.*, 2006; Fraser and Hofmann, 2003; Hinke *et al.*, 2007).

The rapid increase in ecosystem fluctuation associated with increasing climate variability observed since 1990 at South Georgia (Forcada *et al.*, 2008) has limited, and rendered less predictable, the main food supply for Antarctic fur seals and several penguin species and albatrosses. This food supply is predominantly Antarctic krill, and alternative prey species are unlikely to satisfy predator demands. This has increased the fitness costs of breeding for females, notably in Antarctic fur seals, causing significant short term changes in demographic structure through mortality and low pup production. These changes now occur with a frequency higher than the mean female fur seal generation time, thereby increasing population fluctuation. This loss of life history buffering against increasing climate variation is indicative of an unprecedented ecosystem change, which is likely to also have repercussions for southern right whales and other major krill predators.

Werner gave a brief presentation on key aspects of Antarctic krill biology and the Convention for the Conservation of Antarctic Marine Living Organisms (CCAMLR), the body responsible for the management of krill fishing operations in the Southern Ocean. For many marine animals in Antarctica, krill is the most abundant food source. These species depend on krill being within reach of their colonies in order to feed and rear their offspring during the summer. The recent and ongoing temperature increases in the Antarctic Peninsula area are resulting in a massive reduction of sea ice, followed by a reduction of ice algae, with a consequent local reduction of krill abundance. Concentrated krill fishing also contributes to local reductions in the availability of krill. Krill fishing operations occur in the Scotia Sea region, mostly in coastal areas, in total overlap with the foraging ranges of predators tied to land sites for colonial breeding or resting. Interest in krill fishing is growing and expansion of the fishery seems imminent. Werner stated that in spite of existing conservation measures established by CCAMLR, there is a pressing need to take further action to protect krill, and in turn the land-based predators that depend on this food source, from the effects of climate change and concentrated krill fishing in Antarctica.

8.2 Coastal areas in the Península Valdés region

Dans (on behalf of co-authors G.V. Garaffo, M. Degrati, G. Svendsen, A. Gagliardini and E. Crespo) provided a description of physical and trophic conditions in the gulfs bordering Península Valdés based on both published and unpublished data. Golfo San José is a small (814km^2), semi-enclosed bay connected to Golfo San Matías by a 9km wide mouth. It is approximately elliptical (minor and major axes *ca.* 38 and 56km long). The mean and maximum depths are 30m and 120m and there is a narrow depression in the middle of the gulf's mouth. The coastline is irregular, with several prominent points. The tidal regime is semidiurnal and average amplitude varies between 8.7 and 2.96m. Winds blow predominantly from the SW quadrant at a mean velocity of 15km h^{-1}. No permanent watercourses flow into Golfo San José. Oceanographic data suggest the existence of two distinct, broad regimes (the western and eastern portions of the gulf) based on the analysis of chemical and physical variables. At flood tide, a water jet funnels out through the western side of the mouth of Golfo San José into Golfo San Matías, while water flows in from the eastern side. Turbulence and eddies are only present in the western side of Golfo San José. A thermal front extends from south to north. The east/west zone is warmer/colder in summer but colder/warmer in winter.

Golfo Nuevo is 2,500km^2 and its maximum depth is 184m (Mouzo *et al.*, 1978). It is a semi-enclosed basin approximately 70km long and 60km wide, connected to the Atlantic Ocean by a shallow (mean depth 44m), 16km-wide entrance (Mouzo *et al.*, 1978). The temperature of the superficial layer of Golfo Nuevo is homogeneous from May to November, the cold season. However, it is spatially variable between December and April (warm season), with lower temperatures along the southern coast. Low temperatures also can occur along the northern coast. The highest temperatures occur in the central part of the gulf. In the summer a cyclonal movement of the water can be observed in satellite images.

Golfo San Matías also has a NE-SW front, mainly during the summer, with two distinct water masses, the northern one having warmer, more saline conditions than the southern one. Adult right whales and mother-calf pairs were observed in the northern area of this gulf during aerial surveys.

There have been several recent mid-summer sightings of right whales apparently engaged in feeding behaviour to the east of Peninsula Valdes, far from the coast and near the shelf break (Dans, unpublished data).

9. POSSIBLE EXPLANATIONS FOR RECENT SOUTHERN RIGHT WHALE DIE-OFFS

Before identifying and ranking possible explanations (hypotheses) for the die-offs, a series of predisposing factors/pertinent observations/propositions were identified. The factor numbers (see Item 9.1) are listed after each hypothesis (see Item 9.2) to show possible relevance.

9.1 List of predisposing factors/pertinent observations/propositions

1. Valenzuela *et al.* (2009) showed through isotopic and genetic studies that different groups (as defined by genetic maternal lineage) of southern right whales biopsied at Península Valdés fed in different regions.
2. There is some evidence for differential mortality of calves among maternal lineages in the population.
3. There is evidence of a long-term decline of right whale food availability in the feeding grounds (e.g. a documented decline in krill availability in the Scotia Sea and prey-related reduction in reproductive success of Antarctic fur seals and gentoo penguins breeding at South Georgia) and that the Península Valdés right whales have fewer calves than expected in years of low krill abundance (Leaper *et al.*, 2006).
4. There have been both local and global increases in harmful algal blooms (including at Península Valdés and the Falkland Islands/Islas Malvinas).
5. Some biotoxins can cross the placenta, resulting in delayed effects on neonatal survival (e.g. in pinnipeds, harbour porpoises, bottlenose dolphins).
6. There is a high prevalence of gull-peck lesions on southern right whales at Península Valdés.
   a. The incidence of gull attacks has increased dramatically since first quantified in 1984 and now almost all mothers and calves are affected.
   b. Mothers have changed their behaviour to prevent gulls from landing on their backs, and, as a consequence, the direct impacts of gull pecking have increasingly shifted to the calves.
   c. Gulls can transmit bacterial toxins (e.g. tetanus).
   d. Gull-peck lesions provide a potential portal for infection (e.g. directly from water or from avian agents).
   e. Gulls are one possible vector for transmission of infectious diseases from terrestrial or other sources.
   f. Gull evasion may increase right whale stress (e.g. possibly leading to immunosuppression) and energy costs.
7. Infectious diseases cause mortality in cetaceans and there is potential for these to cause differential mortality of neonates ('vertical transmission' from the mother) or other age classes (acquired).
8. A whale's energy budget may be significantly affected by whether it is feeding on krill or copepods, which differ in nutritional value.
9. Primiparous mothers in mammals are less successful than experienced mothers in raising calves to weaning.
10. Exposure to certain environmental contaminants may lead to immunosuppression, reproductive alterations or endocrine disruption, thus decreasing survival or reducing productivity. This has been observed in a number of marine mammal species, but not baleen whales.

9.2 Possible explanations or causation hypotheses for the southern right whale die-offs

The Workshop considered a number of possible explanations for the right whale die-offs at Península Valdés and generated a series of hypotheses. These were ranked according to their probability of being the most likely. Analyses of the four most likely hypotheses are presented first. Five other possible explanations, namely demographic factors, killer whale predation, whalewatching, fishery interactions and ship strikes, were also considered but ruled out. Discussion of these other possible explanations follows in a subsequent section.

Hypotheses with relatively high (but near equal) probability of being true (with alphanumeric codes of predisposing factors [in square brackets])

(A) The mortality of calves is a consequence of poor nutritional state of mothers. [1,2,3,6a,6d,6f,8]

(B) The mortality of calves is a consequence of exposure to HAB- and/or bacteria-associated biotoxins in: (a) the feeding ground resulting in *in utero* exposure of the calf; or (b) the calving/nursery ground. [1,2,4,5,6a,6c, 6d,6e]

(C) The mortality of calves is a consequence of infectious disease (viral, bacterial, protozoal, etc.). [1,2,6b,6c, 6d,6e,7]

Hypotheses with relatively low probability of being true

(D) The mortality of calves is a consequence of exposure to chemical pollutants (unlikely but cannot be ruled out; abandoned whaling stations at South Georgia, industries at Golfo Nuevo). [3,6d,10]

9.3 Elaboration of leading hypotheses

The increased mortality of southern right whale calves observed in the past few years constitutes an unusual event which may have one, or several, potentially interacting, causes. Based on the data and background information presented by local research groups and international experts, a series of hypotheses were proposed, evaluated and ranked according to their feasibility and likelihood as drivers of this particular mortality scenario. For each plausible hypothesis, key research questions were identified and a series of recommended actions were proposed. Ongoing routine population monitoring activities, which may include actions related to low-priority or discarded hypotheses, should not be stopped as they provide baseline information for understanding future population trends or diagnosing causes of future mortality events.

For each of the three leading hypotheses (A)–(C), above, a Working Group met to develop an outline and proposed approach to testing.

Hypothesis A: Food

Nutritional stress is a potential cause of breeding failure and high offspring mortality in mammals, when females cannot meet the appropriate energy requirements for gestation and lactation. Among pinnipeds, there is evidence of abortion or pup abandonment when food availability is very low, but the potential consequences for large whales are not so well understood. According to Brownell, female gray whales in poor body condition (judging by their 'thinness' when observed in the feeding area near Sakhalin Island, Russia) are likely to either wean their calves early or fail to become pregnant and thus extend their calving interval by a year (or more). North Atlantic right whales had calving intervals of close to six years when food resources were low in the late 1990s (Greene and Pershing, 2004), while in more recent years they have had a higher calving rate with a shorter calving interval of close to three years (Pettis, 2009). It is possible that under conditions of reduced food availability, the nutritive condition of pregnant females becomes insufficient to produce a viable calf or adequate lactation.

In the southwest Atlantic, right whales have several potential feeding grounds, based on historical catch records, with different prey species consumed at different latitudes and regions. Temperate-water prey such as copepods may be consumed on the Patagonian shelf and cold-water prey, mostly Antarctic krill, eaten south of the Polar Front (Tormosov *et al.*, 1998). Precise information on the location(s) of the main feeding grounds for this whale population is still unavailable but there is isotopic evidence suggesting that the krill and other pelagic crustaceans of the northern Scotia Sea and around South Georgia are among the major food sources of the adult female right whales that calve at Península Valdés (Leaper *et al.*, 2006).

Long term population and breeding performance records of several krill predators (fur seals and penguins) that feed and breed at South Georgia, in the same general areas where right whales feed, indicate a long-term ecosystem change in association with increasing climate variability (Boyd *et al.*, 2006; Forcada *et al.*, 2008; Forcada *et al.*, 2005). This has limited, and rendered less predictable, the main food supply of those other species and it may also have repercussions for the nutritive state of the right whales that breed at Península Valdés. This leads to the following hypothesis: *The high mortality of calves at Península Valdés is a consequence of the poor nutritional state of their mothers.*

OUTSTANDING QUESTIONS RELATED TO THIS HYPOTHESIS

(1) Valenzuela *et al.* (2009) showed through isotopic and genetic studies that different groups (as defined by genetic lineage) of right whales biopsied at Península Valdés fed in different regions.
- Where are the feeding grounds of right whales that calve at Península Valdés?
- What is the nature and degree of movement of individual right whales between feeding grounds?

(2) Evidence for differential mortality among maternal lineages in the population.
- Are there differences in haplotype frequencies between living whales and those found dead in the die-off events?
- If there are, does this correlate with isotopic signatures (i.e. particular feeding areas)?
- Are all the dead whales (represented by their haplotypes) showing similar isotopic signatures, indicating that they (or their mothers in the case of stranded calves) have fed in the same area(s)?

(3) Long-term decline of food supply in the feeding grounds (e.g. as documented for krill availability in the vicinity of South Georgia). Leaper *et al.* (2006) showed that declines in krill do affect right whales.
- Have there been significant changes in the distribution and abundance of the predominant copepod species on the Patagonian shelf?

(4) A whale's energy budget may be significantly affected by whether it is feeding on krill or copepods, which differ in nutritional value.
- Can diet signatures, measured either through fatty acid or stable isotope analysis, be indicative of whales' use of different feeding grounds and therefore of different prey availability and/or composition?

RECOMMENDED RESEARCH ACTIONS

(1) Complete the stable isotope signature analyses of available baleen from calves and adult females.

(2) Undertake analyses of a sub-sample (five exploratory, more if indicated) of the available blubber and milk samples, and of prey samples collected from feeding locations, for fatty acid distribution.

(3) Complete mtDNA sequencing for existing genetic samples, match these with photo-identification data, and

analyse for associations among maternal lineages, isotopes, years and deaths.
(4) Obtain and analyse repeat biopsies of the same individuals, recognizing that individuals do not visit the study area every year, and conduct analyses to relate isotopic signature indicative of prey switching to aspects of female life history (e.g. calving intervals, and implied loss of calves), and also to haplotypes.
(5) Develop a biopsy programme selectively targeting adult females (as many individuals as can be sampled per season) and their calves in order to assign maternities to dead calves.
(6) Develop a satellite tagging programme to determine linkages between the calving/nursery areas around Península Valdés and this population's feeding areas (target $n \approx 20$).
(7) Conduct photogrammetric surveys of mothers and calves to assess body condition.
(8) Determine whether the correlation between calf output at Península Valdés and sea surface temperature (SST) anomalies at South Georgia (Leaper *et al.*, 2006) has continued since 2000.
(9) Update Cooke's southern right whale population model with detailed parameterisation on adult female mortality, calf mortality and calving interval to assess whether there has been an increase in female or calf mortality.

Hypothesis B: Biotoxins

Biotoxins are naturally occurring compounds produced by bacteria, algae or other organisms that can cause a variety of diseases and/or death, depending on the toxin. In the marine environment, harmful algal bloom (HAB)-associated biotoxins have been responsible for disease and death in humans and marine mammals (for example saxitoxin causing paralytic shellfish poisoning or domoic acid causing amnesic shellfish poisoning). Some HAB-associated toxins can cross the placenta, resulting in foetal death, abortion, poor neonatal survival, expression of post-natal developmental abnormalities and abnormal behaviour. Bacteria such as *Clostridium tetani* or *C. botulinum*, which can be transmitted by animals or are present in the environment, also produce toxins that can cause disease and be fatal to marine mammals. HABs and bacterial biotoxin epizootics have been documented around Península Valdés and the Falkland Islands/Islas Malvinas where right whales calve and feed, respectively. Either of these mechanisms could have caused the seasonal deaths of right whale calves observed at Península Valdés in 2007–2009. This leads to the following hypothesis: *The high mortality of calves at Península Valdés is a consequence of exposure to HAB- and/or bacteria-associated biotoxins in: (a) the feeding ground resulting in* in utero *exposure of the calf; or (b) the calving/nursery ground.*

GENERAL COMMENTS

Mouse bioassays of routine samples are valuable even if a specific toxin is not suspected, thus they should be conducted.

Toxins (paralytic shelfish syndrome) have been implicated in mortality events affecting gentoo, rockhopper (*Eudyptes chrysocome*) and magellanic (*Speniscus magellanicus*) penguins as well as albatrosses, petrels and prions (*Procellaridae*) in the Malvinas/Falkland Islands (Uhart *et al.*, 2004).

Assessment of biotoxin exposure on the feeding grounds will always involve risk assessment (rather than direct measurement) because of the inaccessibility of these areas.

OUTSTANDING QUESTIONS RELATED TO THIS HYPOTHESIS

FEEDING GROUND:
(a) Where do these whales feed?
(b) Are there HABs on the feeding ground(s)?
(c) Is exposure occurring?
(d) If so, what biotoxins are involved?
(e) Are biotoxins present in the prey, especially krill? (Note: Such a finding for krill would be pertinent to the aquaculture industry using krill as feedstock.)
(f) Is there evidence of biotoxin impacts on neonatal survival of other mammalian predators feeding on krill and/or copepods on the same feeding grounds?
(g) Is there any new evidence that HABs are causing mortality events for penguins or pinnipeds at either South Georgia or the Falkland Islands/Islas Malvinas?

NURSERY/CALVING GROUND:
(h) Given that toxins such as domoic acid are known to have affected other marine mammal populations (Gulland *et al.*, 2002; Scholin *et al.*, 2000), is there post-partum exposure in right whales around Península Valdés?
(i) Are toxins present at stranding locations, areas of high whale concentration, or where whales are feeding, and how do levels relate to those documented in other right whale (and other marine mammal) habitat?
(j) Is a novel biotoxin present in the tissues or fluids of dead whales and is it pathogenic? Are bacterial toxins present?
(k) Are gulls acting as mechanical vectors of bacteria that form toxins such as tetanus?
(l) Are the suckling calves consuming water contaminated by bacteria such as *Clostridium botulinum*?

Research recommendations for this hypothesis overlap those for hypothesis C and are given in the next section.

Hypothesis C: Infectious disease

Infectious diseases are known to contribute to morbidity and mortality in marine mammals. Recent epizootics caused by morbillivirus have been reported in pinnipeds and cetaceans in the North Pacific and in the Mediterranean, Caspian and Baikal seas and by leptospira have been reported in eastern North Pacific pinnipeds. Endemic infectious diseases, such as *Brucella* spp., *Toxoplasma gondii* and *Chlamydia* spp., have caused abortions and weak and/or dead neonates and calves and all three of these have been reported from cetaceans. Infectious disease can be concurrent with or exacerbated by other factors including immunosuppression, poor nutritional state and other debilitators such as parasites and physical trauma. Differential expression of disease can manifest in different outcomes in various age classes, such as calf mortality in the absence of apparent disease in reproductive females. This leads to the following hypothesis: *The high mortality of calves at Península Valdés is a consequence of infectious disease (viral, bacterial, protozoal, etc.)* (see Table 5).

OUTSTANDING QUESTIONS RELATED TO THIS HYPOTHESIS

(m) Is transplacental transfer of disease significant in right whale calf survival?
(n) Is postnatal exposure to disease contributing to calf mortality?
(o) Is infectious disease the final cause of death following prior stressors (e.g. nutrition, gull pecks and disturbance, sewage, etc?
(p) Are gulls acting as mechanical vectors in the transmission of infectious disease (viral, bacterial, protozoal etc.) to right whale calves?
(q) What infectious diseases and toxins are evident in gulls?

Table 5

Pathogens with potential to cause death of southern right whale calves.

Agent	Lesions observed	Species affected	References
Herpesvirus	Inclusions, necrosis,	Cetaceans, pinnipeds, carnivora	Blanchard *et al.* (2001); Kennedy-Stoskopf (2001); Goldstein *et al.* (2005)
Morbillivirus	Inclusions, syncitia	Pinnipeds, cetaceans	Van Bressem *et al.* (1999; 2009)
Calicivirus	Vesicles, placentitis, pneumonia	Cetaceans, pinnipeds	Kennedy-Stoskopf (2001)
Parvovirus	Enteritis, myocarditis, cerebellar atrophy, abortion	Carnivora	Barker and Parrish (2001)
Chlamydia sp.	Placentitis	Pinnipeds	T. Spraker, Colorado State Univ., pers. comm.
Leptospira	Nephritis, hepatitis, placentitis	Pinnipeds, ungulates	Gulland (1998)
Brucella spp.	Placentitis, orchitis, meningoencephalitis	Cetaceans, pinnipeds	Bourg *et al.* (2007); Foster *et al.* (2007)
Coxiella burnetti		Pinnipeds	LaPointe *et al.* (1999)
Nonspecific (*Vibrio, Aeromonas, Pseudomonas* spp.)	Placentitis	All	Van Bressem *et al.* (2009)
Toxoplasma gondii	Placentitis, encephalitis, myocarditis, lymphadenitis, necrosis	Cetaceans, pinnipeds, otters	Dubey *et al.* (2003)
Neospora spp.		Pinnipeds	Dubey *et al.* (2003)
Candida albicans	Enteritis	Bovidae	

RECOMMENDED RESEARCH AND MANAGEMENT ACTIONS RELATED TO HYPOTHESES B AND C

Note: As stated later in the report, the Workshop concluded that the necropsy programme (SRWHMP) was working efficiently and that appropriate samples were being taken.

(1) Continue the Southern Right Whale Health Monitoring Program at Península Valdés and improve response time to examine dead whales.
(2) Continue to collect and analyse a broad suite of samples and collect more data on the presence of old and new gull-peck lesions.
(3) Link the stranding programme to broader environmental monitoring programmes designed to detect HABs.
(4) Establish a disease sampling programme for gulls that are observed to parasitise whales and for the broader gull population.
(5) Increase sustained capacity and long-term funding for the beach necropsy programme, sample archiving, database management, data analysis and publication.
(6) Regardless of whether gull-peck lesions are a contributing factor in whale mortality, they cannot be considered as anything other than harmful to the animals. Therefore, closure and/or improved management of dumps, better control of fish offal (on land and at sea) and direct gull control measures would be expected to lead to improved whale health. However, the details of any such program must be formulated at the local level with the input from all stakeholders.

ADDITIONAL SPECIFIC RECOMMENDATIONS OR RESEARCH TOPICS RELATED TO HYPOTHESES B AND C (LETTERS AFTER EACH RECOMMENDATION/TOPIC REFER TO QUESTIONS ABOVE)

(1) Tagging and satellite tracking to elucidate whale movements and locate feeding areas: (a), (b).
(2) Enhanced stranding response: (g), (h), (i), (j), (k), (l), (m), (n), (o).
(3) Biotoxin analysis of prey and necropsy samples: (a), (b), (c), (d), (e), (h), (i), (j), (k), (l).
(4) Literature review and further analyses of biotoxins, infectious diseases and pathobiology of other affected species such as seals or penguins: (a), (b), (c), (d), (e), (f), (h), (i), (j), (k).
(5) Unified analysis of related die-off events in the context of environmental change: (a), (b), (c), (d), (h), (m), (n), (o).
(6) Analyse archived (and newly collected), samples for increased suite of toxins and/or additional infectious disease pathogens. Testing for toxins to include (but not limited to, GCMS and/or MSMS on fresh-frozen tissue, serum and/or filter-paper dried blood or tissue (including faecal), spots). Testing for infectious diseases to include molecular diagnostic tests such as PCR, mass tag and high throughput sequencing on fresh-frozen tissue, formalin-fixed and paraffin-embedded tissue, serum and/or filter-paper dried blood or tissue (including faecal), spots: (d), (g), (h), (i), (k), (m), (n).
(7) Periodical and strategically collected water samples for HAB detection in GN and GSJ in winter and feeding ground in summer: (a), (b), (d), (e), (g), (h), (i), (l).
(8) Establish an abnormal behaviour alert system using whalewatching vessels and survey for past anecdotes of abnormal behaviour: (g), (n).
(9) Biopsy and culture gull-peck lesions and sample whale and gull faeces and gulls for bacteria, viruses, etc. (current studies to be concluded and published, and pending these results further studies to be undertaken): (h), (k), (n), (p), (q).
(10) Perform toxin bioassays using available fresh frozen tissue or blood samples: (h), (i), (j), (k).
(11) Analyse blood from future strandings for HABs, infectious disease and, where practical, heavy metals: (g), (i), (j), (k), (o).
(12) Analyse aqueous humour samples for infectious disease antibodies and toxins: (g?), (h), (i), (j), (k), (n).
(13) Collect blow samples for infectious agent culture and molecular diagnostics, metabolites such as ketones, and steroids: (j), (k), (n).
(14) Continue and expand methods for body condition assessment such as bone marrow fat content and photogrammetry: (o).
(15) Test faeces for HABs from carcasses and live animals. Test live animal faeces for cortisol. Increase efforts to collect floating faeces: (a), (g), (h), (i), (k).

ADDITIONAL LOGISTICAL RECOMMENDATIONS FOR THE SOUTHERN RIGHT WHALE HEALTH MONITORING PROGRAM

(1) Provide appropriate and adequate solutions for short- and long-term sample storage and facilitate logistics for shipment of time-sensitive samples to Buenos Aires and for export.

(2) Work to facilitate the permitting and export process for samples.
(3) Explore and invest in temperature-independent sampling and storage protocols.
(4) Explore in-country options for sample analysis. For PCR or other molecular diagnostics, consider performing DNA and RNA extractions locally in Puerto Madryn to generate room-temperature stable samples and eliminate the need for cold/frozen chain for sample storage, or transport.
(5) Improve ability of the SRWHMP to get access to fresher animals by securing another truck, a second necropsy team, ATV's, and 3 Iridium satellite phones.

9.4 Elaboration of less likely hypothesis

Hypothesis D: Exposure to chemical pollutants (trace elements, PCBs, PAHs, pesticides, EDCs, others)

Some persistent chemical pollutants can bio-accumulate in marine mammals and have the potential to cause toxic effects including reproductive impairment (Reijnders, 1986) and immune suppression (Ross *et al.*, 1996). Marine mammals can bio-accumulate very high levels of some persistent contaminants due to their life history and trophic level (Aguilar *et al.*, 2002). However, most baleen whales, including right whales, feed at a relatively low trophic level and therefore tend to be less prone to bio-accumulation than are many toothed cetaceans (O'Shea and Brownell, 1994). The Workshop considered the possibility that chemical pollutants have had a primary or contributory role in the recent right whale die-offs. This leads to the following hypothesis: The high mortality of calves at Península Valdés is a consequence of exposure to chemical pollutants (unlikely but cannot be ruled out; abandoned whaling stations at South Georgia, new industries at Golfo Nuevo).

Very low tissue concentrations of a range of persistent organochlorine pollutants have already been documented in South American sea lions, Commerson's dolphins and dusky dolphins (Raga *et al.*, 2008). Although only limited data are available on heavy metal concentrations in right whales in the Península Valdés region, levels of other pollutants like organochorines are also likely to be low given the low trophic level and predominantly offshore feeding habits of southern right whales (see also O'Shea and Brownell, 1994). The Workshop therefore concluded that chemical pollutants were unlikely to be a cause or significant contributory factor in the recent die-offs.

However, the Workshop **strongly recommends** that necropsies of stranded whales continue to be conducted as a priority along with the strategic sampling and storage of tissues for chemical pollutants and other analyses. Such research efforts are essential not just to maintain baseline data on whale health and contaminant exposure but also to facilitate investigations of any future die-offs.

OUTSTANDING QUESTIONS RELATED TO THIS HYPOTHESIS

(1) What contaminants are southern right whales exposed to?
(2) What are the biological effects of the detected contaminants (e.g. reproductive impairment due to PCBs, EDCs or trace elements (Reijnders, 1986); carcinogenesis and subclinical genetic toxicity due to PAHs (Martineau *et al.*, 2002); immunosuppression due to PCBs, trace elements and pesticides (Ross *et al.*, 1995))?
(3) Are levels of detected contaminants comparable to reported biological thresholds?
(4) Are levels of detected contaminants different between live and dead right whales?
(5) What evidence is there for pollutant-induced toxicity in right whales?

RECOMMENDED RESEARCH ACTIONS

(1) Sample tissues (blubber, kidney, brain, stomach contents, baleen, urine, blood, bile, vitreous, and liver) from dead right whales.
(2) Sample skin and blubber (biopsies) from live right whales.
(3) Process samples (analytical methodology) for above-mentioned contaminants according to internationally standardised methods.
(4) Compare levels with proposed toxicity thresholds (Hall *et al.*, 2005; Jepson *et al.*, 2005; Kannan *et al.*, 2000).
(5) Continue current necropsy protocols and pathology analyses.
(6) Explore subclinical biological effects (DNA damage, adduct formation): Comet Assays and P32 postlabelling.
(7) If funding is available, screen samples for a range of chemical contaminants (trace elements, PCBs, PAHs, pesticides, EDCs, others) using internationally standardised methods.
(8) If there is evidence of exposure, conduct a risk assessment to establish if any of the contaminants are at concentrations likely to induce toxic effects (based on experimental and empirical data).
(9) If any individual concentrations exceed the reported thresholds for biological effects, look for correlations between these levels of exposure and pathological, physiological or subclinical effects (Sonne *et al.*, 2008). For instance, if PAHs were detected in tissues, it would be necessary to correlate this information with pathological findings consistent with PAH-induced toxicity, such as tumours or proliferation of hepatocytes (Baird *et al.*, 2005), and also subclinical damage, such as formation of adducts or strand breakage (Valavanidis *et al.*, 2006).
(10) Toxicological risk assessment analyses can be used to infer population-level effects of the pollutant(s) in the exposed whale population (Schwacke *et al.*, 2002).

9.5 Further hypotheses considered but rejected

Demography

The Workshop considered how demographic phenomena might have caused or contributed to the die-offs. For example, the calf die-offs could have been the result of an increased proportion of primiparous females in the population (presuming calves of such females have lower survival) or they could reflect a change in the temporal pattern of calving through time. After considerable discussion, the group concluded that the available evidence did not support a demographic explanation. Nonetheless, it was agreed that analyses to rule out plausible demographic scenarios would be valuable. Three such scenarios are outlined below.

(1) The possibility that the calf die-offs are a result of an increased proportion of primiparous females in the expanding whale population can be evaluated by examining the Península Valdés aerial photo-id database to see if the proportion of primiparous females has increased from 2001 through 2009, in a manner that might account for a proportionate increase in calf mortality. Rowntree reported that Cooke's population

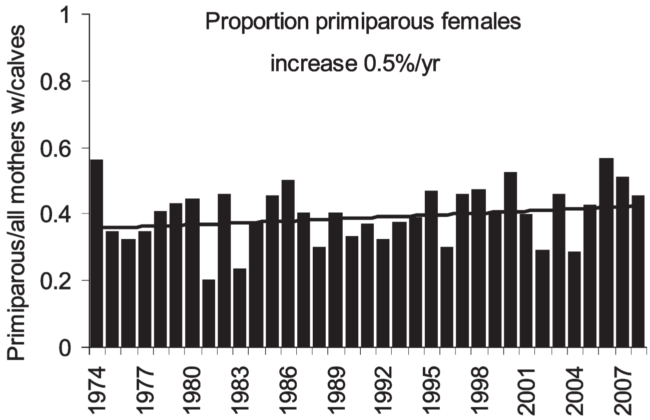

Fig. 13. Proportion of first-time (primiparous) mothers in the Península Valdés right whale population, 1974–2008. Note that no consideration was given to missed first-calvings. (Source: Rowntree, unpublished data).

modelling with data from 1971 through 2000 had shown no change in the rate at which new females entered the reproductive class (Cooke *et al.*, 2003; 2001). Rowntree presented data on the proportion of identified females seen for the first time with a calf for each year from 1974–2008 (Fig. 13), with no adjustments made for missed first calvings. The proportion of first-time calving females in this dataset showed little change over time. It was pointed out that additional effort to combine aerial- and boat-based photo-identification catalogues maintained by different research groups at Península Valdés would increase the number of individually identified calves and potentially allow comparison of the survival rates of calves born to primiparous females vs. multiparous females.

(2) It is possible that the temporal pattern of calving has changed through time, with some unspecified impact on the survival of young animals. For example, primiparous females give birth later in the season than multiparous females but how this could relate to the annual variability in calf death rates is unclear. Temporal comparisons of calving timing in the various datasets (e.g. the Península Valdés aerial photo-identification catalogue, the Península Valdés boat-based photo-identification catalogue, the Península Valdés aerial and shore-based counts, and the southern Brazil aerial photo-identification catalogue) might provide a basis for determining whether a change in pattern has occurred.

(3) A third scenario is that changes in the frequency and age structure of individual maternal lineages are linked to the die-offs. Such linkages have been examined in the North Atlantic humpback whale population (Rosenbaum *et al.*, 2002). This possibility could be investigated by testing (possibly in the current modelling efforts) for any effects of individual haplotype, clade level, year and age of females on individual life histories.

In summary, under this hypothesis (demography) it was recommended that the following analyses be conducted on existing datasets.

(1) Examine the Península Valdés aerial photo-identification database to see if the proportion of primiparous females increased from 2001 through 2009 (data from 1971 through 2000 were already analysed and no evidence of such an increase was found).

(2) Combine aerial- and boat-based photo-identification catalogues to increase the number of individually identified calves to allow comparison of the survival of calves born to primiparous females to that of calves born to multiparous females.

(3) Assess temporal changes in timing of calving and other parameters. This will necessitate an analysis of multiple long-term data sources, including: Argentina, Brazil and Uruguay aerial photo-identification catalogues, aerial counts and shore-based counts.

Predation by killer whales

Data presented by Sironi *et al.* (2008; see Item 3.1) showed that of 112 encounters between killer whales and right whales around Península Valdés (1972–2000), only 12 (11%) involved actual attacks, and it is likely that not all were fatal. Adult right whales were the main targets of the attacks; in fact, 80% of the attacked whales were adults, and calves were seen to be present in only two attacks (17%). The number of right whale-killer whale encounters per decade decreased with time, from 68 in the 1970s, to 26 in the 1980s, to 23 in the 1990s. Península Valdés has features that are advantageous for right whales to reduce predation risk. Mothers and calves aggregate in very shallow bays, which may be an effective anti-predator strategy for protecting the calves (Thomas and Taber, 1984). Only three dead calves out of 331 (1%) examined between 2003 and 2009 had wounds that could be attributed to killer whale bites, and these were judged to be relatively minor. Based on this evidence, the Workshop concluded that killer whale predation was not a contributing factor to the recent high mortality of right whales at Península Valdés.

Whalewatching

Lindner presented data on photo-identification of right whales from whalewatching boats based in Puerto Pirámides showing that 43% of the identified individuals returned to the area every three years, 20% every two years and 36% every year; 15% were photo-identified in the area only once (see Item 3.3). This suggests that the vast majority of whales returned to the area at least once. Behavioural observations indicated that a few whales interacted with whalewatching boats with no apparent 'adverse effects'. A small fraction (15.3%) approached the boats, 54.1% moved away from boats approaching at high speeds and 47.4% appeared to ignore boats approaching at slow speeds. Between 2007 and 2009, 6% of the whales photo-identified from whalewatching boats had marks attributed to collisions with vessels. Whalewatching is restricted to a small stretch of coast in Golfo Nuevo, and no whalewatching occurs in Golfo San José. The Workshop concluded that there was no evidence to suggest that disturbance or injury from whalewatching activity was a significant factor in the recent high mortality of right whales at Península Valdés.

Fishery interactions and vessel strikes

From a total of 366 right whale deaths (including 333 calves) recorded at Península Valdés between 2003 and 2009, none of the carcasses had ropes, nets or other visible evidence of entanglement in fishing gear. Blunt-force trauma (from a boat strike or other source) remains a potential diagnosis for a calf that died in 2003 with extensive renal and spleen haemorrhages and for a calf that died in 2009 and was found with a large skull fracture. In addition, a male calf bearing five linear, equally spaced cuts on the peduncle in 2003 is suspected of having been the victim of a vessel strike. Finally, an adult male was struck and killed by a large ship in the port of Puerto Madryn in July 2008.

The Workshop concluded that these two factors, entanglements and vessel strikes, are not having a significant population-level effect on right whale mortality at Península Valdés.

10. CURRENT SOUTHERN RIGHT WHALE HEALTH MONITORING PROGRAMME

Uhart provided the following summary of the health monitoring programme.

Growing out of the long-term right whale programme of the Whale Conservation Institute/Instituto de Conservación de Ballenas, systematic efforts to monitor right whale mortality at Península Valdés began in 2003 with the establishment of the Southern Right Whale Health Monitoring Program (SRWHMP) operated jointly by the Whale Conservation Institute, Wildlife Conservation Society, Instituto de Conservación de Ballenas, Fundacion Patagonia Natural and Fundacion Ecocentro.

The programme is co-directed by Marcela Uhart (Wildlife Conservation Society) and Victoria Rowntree (Whale Conservation Institute) with assistance from Mariano Sironi (Instituto de Conservación de Ballenas). The field staff consist of one fulltime veterinarian, Andrea Chirife, a part-time seasonal veterinarian or biologist, and a variety of volunteer field assistants. The field team carries out necropsies of carcasses reported by the stranding network or found by regular land surveys. The team also conducts one aerial survey each year at the time of peak whale abundance. Necropsy completeness depends on carcass quality, accessibility and caseload. Internationally recognised standard protocols are employed. Samples for histopathology, serology, nutritional status, contaminants, infectious disease and biotoxin diagnostics, genetics, stable isotopes and fatty acid composition analysis, are collected, archived and distributed to analytical laboratories. Since 2003, nearly 3,500 samples have been collected by the SRWHMP. The sample archiving capacity includes a –20ºC freezer and liquid nitrogen dewars. Sample analysis is undertaken on an ad hoc basis, primarily pro bono by various local and international laboratories. The SRWHMP maintains a database that includes complete information on stranded individuals, such as morphometrics, photographs, samples collected, necropsy reports and laboratory results.

The professionalism, complexity and relative completeness of this programme conceal the lack of a reliable financial base and hence programmatic security. For instance, without an emergency grant of US$5,000 in December 2009 from a US foundation, the one fulltime staff member, Dr. Chirife, would not be employed. The programme operated with no dedicated vehicle between 2003 and 2008. During that time, it operated on borrowed vehicles despite the huge road mileage involved in operating a stranding programme at Península Valdés (i.e. almost 13,000km were logged in 2009). Despite recent improvement in stranding network coordination by the provincial government, communication between the stranding reporters and necropsy crew is still hampered by the limited cellular phone coverage. The SRWHMP currently survives on time and resources invested by project leaders and their organisations, including salaries, equipment and supplies, office expenses, private vehicles, etc. As of June 2010 (the start of the upcoming stranding season) the SRWHMP had secured base funding from the US Marine Mammal Commission, but additional resources are needed. A minimum requirement for the programme's continuation is long-term sustained funding for a fulltime veterinarian and seasonal support staff, transportation, satellite telephone communication, better sample archiving facilities and sample and data analysis and reporting, and travel expenses to attend scientific meetings and provide community outreach.

11. CURRENT SOUTHERN RIGHT WHALE RESEARCH PROGRAMMES (OTHER THAN HEALTH AND MORTALITY MONITORING)

Those involved in right whale research at Península Valdés were asked to summarise their current programmes, including both the work directed specifically at the whales and that directed at relevant ecosystem characteristics and processes. Also, they were encouraged to include immediate plans for relevant future research.

11.1 Non-government programmes

Rowntree provided a summary of the work conducted by researchers from the Whale Conservation Institute (WCI)/ Ocean Alliance based in Massachusetts, USA, and the Instituto de Conservación de Ballenas (ICB) based in Argentina, with mostly foreign funding.

Annual aerial photographic survey of the WCI/ICB programme

An annual priority is to conduct at least one aerial photo-identification survey at the time of peak whale abundance (September) covering the 495km perimeter of Península Valdés. The survey plane flies along the coast at an altitude of 150m and circles over any whales encountered so researchers can photograph the callosity patterns on the whales' heads, record their locations and note the presence or absence of calves. Since 2003, the Argentine Armada has provided a Porter Pilatus prop-jet plane and crew for these surveys. Safety for those flying has been significantly improved by the use of this plane but the costs are high. Each survey, including fuel and food and housing for the survey crew, costs about US$15,000. Aerial photographs are analysed with a computer-assisted photo-identification system developed by Lex Hiby and Phil Lovell. Analysis and updating of the database after a single aerial survey takes about two months. The database spans 40 years and through 2008, the catalogue included more than 2,600 known individual whales. In recent years, the aerial surveys have been carried out by John Atkinson (photographer), Sironi (photographer, note taker, GPS recorder) and a volunteer assistant, with logistics coordinated by Diego Taboada of the ICB. Rowntree and Carina Maron, an Argentine graduate student at the University of Utah, have been responsible for the laboratory work and maintenance of the photo-identification catalogue.

Gull attack frequency

Gull attack frequency has been monitored annually since 1995 to assess the intensity of attacks and provide a baseline for interpreting the effects of management actions. Monitoring involves focal follows of mother/calf pairs from clifftops, each lasting for one hour. All gull attacks within a 5-minute interval are recorded. Between 60 and 100 focal follows are conducted each year at two sites, one in Golfo San José and one in Golfo Nuevo. This work has been directed by Sironi with the help of volunteer assistants from the Instituto de Conservacion de Ballenas. Costs are minimal (food and housing).

Biopsy sampling for genetic and isotope analyses

Biopsies are collected to link known individuals to matrilines (genetics) and to foraging locations (isotopes). On days with low wind conditions, researchers approach the whales in an inflatable 4.5m boat, photograph their callosity patterns for later individual identification, and collect a skin sample with a crossbow. Samples are divided and one is preserved in DMSO and the other is dried. Associated data include age, sex, GPS location, time, date and weather conditions. Analyses are conducted at the University of Utah using standard PCR and equipment in the university's stable isotope facility. Participating researchers include Luciano Valenzuela, Rowntree, Jon Seger and Sironi with assistance from volunteers from the ICB. This work has been supported by general operating funds and small grants from individual donors.

Blow intervals and focal animal follows to determine body condition and behavioral budgets

Data on blow intervals of mothers and calves have been collected since 1997 to determine the effect of gull harassment on the whales' body condition (breath-holding ability). At least 40 mother/calf pairs are followed each year for periods of 30–60 minutes. The time of every blow and the animal's behavioural state are recorded for as long as the blows can be seen clearly. Focal follows of different age groups are conducted periodically to estimate the percentage of time spent in different activity modes and thus assess whether activity patterns have changed over time in response to gull harassment. This work has been carried out by Rowntree, Sironi and volunteers and requires funding for international airfares, food and housing at Península Valdés.

Documenting right whale foraging locations on the Patagonian Shelf

Efforts are underway to collect and analyse zooplankton samples from the Patagonian Shelf, the western South Atlantic and the Southern Ocean to determine the signatures and values of different tracers (stable isotopes, trace metals and fatty acids) for matching with the same tracers in the skin of living whales (biopsies) and the skin and baleen of dead calves and adults. The goal is to accumulate zooplankton samples from different latitudes and distances from shore along the Patagonian Shelf. Samples from three distinct locations are in-hand but more are needed to broaden the coverage. Because this programme has no direct access to oceanographic vessels, it will be necessary to collaborate with researchers who work on such vessels and with holders of zooplankton collections (e.g. fisheries laboratories) to obtain more samples. In addition, information is being gathered from the literature and from other researchers to assess regional, seasonal and long-term changes in the distribution and abundance of the predominant zooplankton species on the shelf. This information will help determine which species the whales are likely to be consuming in particular regions and thus the species that should be analysed for tracer signatures. Results from analyses of krill and copepod samples from the Scotia Sea are available through the British Antarctic Survey and additional samples will be sought if required for additional analyses. This work is being carried out by PhD students (Maron, Valenzuela and Rowntree). Stable isotope analysis costs $8.50/sample ($800 per adult baleen plate) and fatty acid analysis $110/sample.

11.2 CENPAT programme of study on southern right whales

Crespo and colleagues at the Centro Nacional Patagónico (CENPAT) summarised their work on right whales. Personnel include: Crespo, Susana Pedraza, Dans, María Florencia Grandi, Rocío Loizaga de Castro, Mariana Degrati, Bertellotti, Fazio, José L. Esteves, Mónica Gil. University of Patagonia: Mariano A. Coscarella, Clara Rosas. Instituto de Biología Marina y Pesquera Alte. Storni: Raúl González, Guillermo M. Svendsen. Independent Consultant: Daniel Pérez.

Surveys of the living whale population

Since 1999 the CENPAT Marine Mammal Laboratory has developed a programme to monitor the southern right whale population. Its goals are to:

- Estimate and track the population rate of increase;
- Examine seasonal patterns of arrival and departure of different age classes; and
- Detect and investigate any changes in distribution.

The programme was supported from 1999 to 2008 by the Fundación Vida Silvestre Argentina (a national NGO), the Global Environmental Facility and the Fundación Banco de Bilbao Vizcaya Argentaria. In 2009 it was funded by the Provincial Government but this funding was cut in the middle of the season. There is no long-term government funding, either at the national or provincial level, and each year funds are requested of private partners. This makes it difficult to ensure the continuity of the monitoring effort.

Expansion of right whales into areas such as Golfo San Matías has been investigated although with only limited effort. Three aerial surveys were conducted from Puerto Lobos to Viedma in 2007 and 2008. Boat-based surveys targeting marine mammals, including right whales, were also carried out from 2006 to 2009. Financial support for this work came from the Fundación Vida Silvestre, Agencia Nacional de Promocíon Cientifica y Técnica, the Global Environment Facility and the Secretaria Medio Ambiente Nación. There is no existing commitment for future funding.

A recent survey onboard the oceanographic vessel *Puerto Deseado/CONICET* covered a broad area from the coast to the continental slope (1,500m isobath). It is expected that this survey will be repeated in 2010.

Interactions between kelp gulls and whales

Since 2005, the behavioural effects of gull attacks on right whales have been monitored from whalewatching boats and coastal observatories. Also, samples collected from right whale lesions and from kelp gulls have been analysed in order to assess whether gulls are vectors for disease transmission. Financial support for these efforts has come from Aluar, GEF/Secretaria Medio Ambiente Nación, Dirección de Conservación and Areas Protegidas Pcia. Chubut, and CONICET.

Interactions between vessels and whales

There are two additional lines of scientific research on the interactions between vessels and whales.

- Feasibility of using DAVs (suction cup devices) and other instruments on the whales to evaluate the effects of whalewatching at Puerto Pirámides. Particular attention is being given to the potential effects of the instrumentation process on whale behaviour.
- Analysis and mapping of ship strike risks around Puerto Madryn, and considering the use of sound recorders and sonic alarms for risk mitigation.

This work began in 2007 and continues with financial support from Aluar, Fundación Vida Silvestre and the whalewatching companies.

Other

ECOSYSTEM MONITORING

Available information on levels of chemical pollutants in Golfo San José (GSJ) and Golfo Nuevo (GN) is limited in time and space. The current programme includes the sampling of hydrocarbons, heavy metals and TBT, although in a non-systematic way. There is essentially no data from GSJ, and most of the data from GN comes from the sampling of molluscs and sediments near the coast. These samples are taken as part of different projects but they do not constitute a monitoring programme.

WHALE MONITORING

As described in Item 7.10, samples from calf carcasses from Golfo Nuevo and Golfo San José collected by the SRWHMP from 2003 to 2009 were analysed for essential and non-essential heavy metals (Cu, Pb, Zn, Cd). This work will be continued in coming years.

11.3 Photo-identification project on Southern right whales using whalewatching boats as research platforms (Fundación Ecocentro)

This conservation-focused research project has both scientific and educational aspects. Since 1995 trained observers onboard whalewatching boats have photographed right whales and studied aspects of the interaction between whales and tour boats. Around 1,200 different individual whales have been photo-identified to date. The intention is to continue developing re-sighting histories for known individuals, documenting return rates of the whales to the Puerto Pirámides area, and studying the reactions of whales to whalewatching boats. Also, the relationship between marine, commercial and tourist activity and the wounds observed on whales will be investigated in order to inform discussions concerning the need for traffic corridors (shipping lanes) to decrease the probability of encounters between ships and whales.

11.4 Future lines of work

Crespo and his group at CENPAT provided the following information on future work that they are considering.

- If funding can be secured, gull attacks can be recorded from aerial surveys on whales along the monitoring area in order to establish if this behaviour is spread throughout the whole area, complementing the observations performed by other research groups.
- With some additional funding, it may be possible to expand the monitoring effort to areas such as Golfo San Matías, where about a tenth of the right whale population was recorded in exploratory flights in 2007 and 2008 during the peak season.
- Taking advantage of the oceanographic research cruises, surveys of offshore areas in search of right whale feeding grounds can be undertaken at minimal cost.
- Design and implement sampling stations in Golfo Nuevo and Golfo San José for long-term pollution monitoring to assess 'ecosystem health.'
- Considering that biotoxins can alter the behaviour of whale calves, use available human resources in the area to survey for abnormal behaviours in calves. This work can be land- or boat-based.

11.5 Use of existing datasets in future investigations

McAloose summarised datasets that are known or thought to be available and that might be used for further investigations of the causes of right whale mortality at Península Valdés. Local and regional datasets collected independently of research on the recent unexplained right whale mortality events exist within the scientific community and may contain valuable and relevant information once analysed in this context. These include, for example: (1) periodic (though non-systematic) collection and evaluation of sediment and mollusc samples from Golfo Nuevo and Golfo San José for hydrocarbons, heavy metals and TBT by the Environmental Chemistry Laboratory (CENPAT); (2) local and regional health and mortality information for additional species of birds and marine mammals in locations such as Península Valdés and Punto Tombo collected by the Wildlife Conservation Society or other local governmental agencies or NGOs; (3) information from ongoing population monitoring of right whales in Brazil by the Right Whale Project there (Groch); and (4) information on prey availability, e.g. the British Antarctic Survey in the UK has made acoustic estimates of Antarctic krill biomass collected information on the diet composition of land-based predators breeding at South Georgia in areas with documented right whale feeding.

Retrospective evaluation of existing datasets in the appropriate context may reveal significant direct or indirect relationships between the calf die-offs and environmental, infectious, nutritional or other factors. Towards that end, efforts should be made to identify and gain access to such datasets and to develop the necessary collaborations with the data holders.

12. CONCLUSIONS AND RECOMMENDATIONS

The Workshop considered the evidence and concluded that there is reason for concern about the relatively high level of mortality, particularly of calves, experienced in recent years by the population of southern right whales that uses the Península Valdés region as a calving/nursery area. A total of 366 whales, including 333 calves, were found dead at Península Valdés between 2003 and 2009. For the vast majority of these, the cause of death is unknown. The Workshop further took note of the statement by the IWC Scientific Committee in 2009 that the long-term databases developed by research projects in Argentina and Brazil have great value for monitoring the population dynamics and health of southern right whales in the western South Atlantic. Participants in the Workshop **wished to express support** for the strong recommendation by the Scientific Committee that the monitoring work on the right whale population off the east coast of South America should continue without interruption. In addition, it was noted that a programme of right whale research had started in Uruguay and participants **agreed** that it should be expanded and integrated with the programmes in Brazil and Argentina.

Three leading hypotheses to explain the spikes in mortality of first-year whales (calves) in 2005, 2007, 2008 and 2009 were identified by the Workshop: a decline in food availability, biotoxin exposure and infectious disease. It was not possible to determine which of these is most likely, and it was acknowledged that some combination of factors may be involved. A fourth possible contributing factor, chemical contaminants, was considered less likely, and demographic factors, killer whale attacks, disturbance from whalewatching activities, vessel strikes and fishing gear entanglement were ruled out as significant causes of what appears to be a series of acute mortality events.

In light of the three leading hypotheses, several clear steps should be taken to build understanding of what has been killing these whales.

In addition to the specific recommendations and questions presented for each hypothesis elsewhere in this report, the following research strategy is proposed to investigate the hypotheses and to guide the allocation of research effort according to the strengths and capabilities of the different research groups.

(1) The work of detecting and investigating strandings and then analysing the patterns of mortality and the samples from necropsies to evaluate body condition and presence or absence of disease, toxins or other possible causes of mortality, **should continue as a top priority**. Specifically, researchers need to:
- find and examine as many stranded whales as possible through a strong, well-funded stranding network;
- continue to implement robust necropsy protocols, with both targeted and broad-scale bio-sampling and a priority on analysis of tissue samples; and
- document the age and sex of stranded animals and the timing and locations of deaths.

(2) Continued and expanded investigations of environmental factors that may be affecting the whales in the calving/nursery area **should also remain a priority**.
- Necropsy work (see above).
- Conduct broad environmental monitoring or collaborate with existing monitoring programmes to detect and identify biotoxins and diseases that could be implicated in the die-offs.
- Conduct detailed investigations of potential vectors of diseases or toxins, including detailed studies of kelp gulls as potential vectors.
- Behaviour work (see below).

(3) Besides the efforts to investigate dead whales, **it is important to continue and expand** the long-term research on live whales in the Península Valdés region to obtain demographic and behavioural information. A top priority should be the establishment of a reporting network to alert the research community whenever abnormal behaviour is observed that could be related to die-off causation.

Demography:
- Assess the body condition of mothers when they arrive in the area (e.g. fat rolls on neck, photogrammetry).
- Determine which mothers are losing their calves (e.g. primiparous vs. multiparous, haplotype group).
- Initiate a multi-year biopsy sampling programme in general, but especially targeted at assigning maternity to dead calves.

Behaviour:
- Seek to identify behaviour by whales on the calving/nursery ground that may indicate causes of mortality.
- Determine if whales are exhibiting unusual behaviour attributable to poor condition, toxins or disease.
- Using the available long-term data on behaviour as a reference, attempt to measure and assess the stress-related or energetic consequences of gull parasitism.
- Continue to monitor the frequency of gull attacks and their effects on whale behaviour at sites where long-term data (since 1995) are available.

(4) Identification of the feeding grounds of the Península Valdés right whales and investigation of environmental factors that affect these whales' survival and reproduction **should also be a priority**.
- Assess trends, both long-term and recent, in the quantity and quality of right whale prey, and attempt to link these to trends in right whale reproduction and calf survival at Península Valdés.
- Seek evidence of biotoxins and infectious disease on the feeding grounds and migratory routes and attempt to relate such evidence to right whale reproduction and calf survival at Península Valdés.
- Consider a satellite-tag tracking study designed to identify the main feeding grounds of this right whale population.

(5) The long-term aerial photo-identification programme (WCI/ICB) stands out, along with the stranding network (SRWHMP), as a **top priority**. The 40-year datasets on the population of right whales at Península Valdés should be maintained and data collection should continue. These data are critical for monitoring population trends, describing the significance of the recent die-offs and testing causation hypotheses. The recently initiated CENPAT aerial surveys to monitor trends in abundance and the boat-based photo-identification work are important complements to the long-term research and monitoring efforts.
- Estimate current population parameters by updating Cooke's assessment (using photo-identification data through the 2009 season) and by exploring other analytical approaches.
- Conduct an overall analysis of the population data, incorporating information on mortality (especially of adult females and calves), and search for indicators of causality.
- Consider how to increase aerial photo-identification survey coverage of the right whales at Península Valdés. For example, increasing the number of surveys to 3/year would provide better data on: (a) mother and calf condition on arrival; (b) which mothers lose their calves; and (c) calf survival through the nursery season. It would also likely improve the ability to re-identify juveniles in later years.

(6) Cooperation and collaboration between research groups are essential to building the knowledge needed to answer complex questions concerning die-offs such as those observed in recent years in Argentina. Therefore, efforts to improve such cooperation and collaboration **should be a high priority** for governments and NGOs.
- Explore mechanisms for establishing a South Atlantic right whale consortium similar to the North Atlantic Right Whale Consortium (including, at a minimum, researchers in Argentina, Uruguay and Brazil).
- Continue and strengthen the collaborations and networking that have already developed around the stranding programme and as a result of concern about the recent die-offs.
- Broaden collaborations to encompass such things as combining datasets (e.g. aerial and boat-based photo-identification catalogues) in order to achieve greater analytical power.

(7) The absence of conclusive information regarding the cause of exceptional right whale mortality should not preclude appropriate management measures. In particular, the Workshop stressed the need for kelp gull management and policy. Regardless of whether gull lesions are a contributing factor in whale mortality, they cannot be considered as anything other than harmful to the whales.
- Complete as soon as possible the ongoing studies to detect viruses, bacteria and fungi in the gulls already sampled.
- Efforts towards covering, closing or consolidating dumps, better management of fish offal (on land and at se(a), and direct gull control would be expected to lead to improved whale health.

The Workshop acknowledged the considerable efforts of the researchers in Argentina (and abroad) to investigate the die-offs and commended them on their accomplishments to date in the face of fiscal and logistical constraints and in view of the sheer numbers of dead whales. The SRWHMP in the Península Valdés region has developed efficient reporting and systematic surveillance systems for dead whales, and full necropsies are conducted whenever possible, using standard protocols adopted from the US large whale stranding networks that have long experience in large whale necropsies (McLellan *et al.*, 2004), particularly right whales. One of the major problems hampering identification of the cause or causes of the high southern right whale mortality is that the carcasses are considerably decomposed by the time they strand, are found by researchers or reported by network members. Nonetheless, researchers have collected a range of tissue samples that have either been analysed or are available for analysis. The investigation does not suffer from a lack of effort or expertise among scientists and volunteer right whale strandings responders in Argentina. The Workshop also noted that the scientists and volunteers, as in many areas of cetacean research in Patagonia, are operating with only minimal funding and this makes their achievements all the more impressive.

The Workshop further **recognised** the importance of having governmental commitment if there is to be long-term conservation of right whales in Argentina. Although there has been significant improvement over the last couple of years, an even stronger commitment by the provincial and national governments is required. The whalewatching industry must also continue and increase its investments in right whale research and monitoring, given that its own viability hinges on a large and healthy whale population in local waters. The Workshop stressed the importance of establishing links and sharing information on southern right whale health and life history trends in different parts of the range, especially Argentina, Brazil, Uruguay, South Africa, Australia and New Zealand.

Researchers working on right whales around Península Valdés met in 2009 to share findings and discuss plans. Building on that experience, the Workshop **recommended** that those researchers and others involved in right whale work elsewhere in the western South Atlantic (Argentina, Uruguay and Brazil) develop a consortium modelled at least in part on the North Atlantic Right Whale Consortium (NARWC, see *http://www.rightwhaleweb.org*). It should be possible to establish such a consortium with minimal funding (part-time salary for a secretary).[1]

[1]The NARWC began as a collective of field researchers combining their photo-identification catalogues to create a unified, species-wide catalogue, which is maintained by the New England Aquarium in Boston. Many US and Canadian agencies, laboratories and individuals contribute photographs on a routine basis. The consortium organises an annual scientific meeting where presentations are given on current research and management issues. Currently, about 180 people attend this 2-day event. The NARWC has a secretary who manages access to the databases according to clear rules agreed by consortium members. Under the data access application process, prospective data users describe their project and propose co-authors of planned publications to include major data providers. The databases maintained by various consortium member institutions include the photo-identification catalogue, a sightings database, a genetics database, and a necropsy database. Among other values of a consortium are that it facilitates syntheses of data over the entire range of the population, enables rapid and targeted dissemination of new information, helps prevent duplication of effort, encourages strong collaborative research and creates synergies by submerging individual aspirations to the overall goal of species conservation and welfare. The board of the consortium produces an annual 'report card' on the state of the population. The consortium can also provide an effective voice locally, nationally and internationally in terms of policy and funding.

REFERENCES

Aguilar, A., Borrell, A. and Reijnders, P.J.H. 2002. Geographical and temporal variation in levels of organochlorine contaminants in marine mammals. *Marine Environmental Research* 53: 425–52.

Atkinson, A., Siegel, V., Pakhomov, E. and Rothery, P. 2004. Long-term decline in krill stock and increase in salps within the Southern Ocean. *Nature* 432: 100–03.

Atkinson, A., Whitehouse, M.J., Priddle, J., Cripps, G.C., Ward, P. and Brandon, M.A. 2001. South Georgia, Antarctica: a productive, cold water, pelagic ecosystem. *Marine Ecology Progress Series* 216: 279–308.

Baird, W.M., Hooven, L.A. and Mahadevan, B. 2005. Carcinogenic polycyclic aromatic hydrocarbon-DNA adducts and mechanism of action. *Environ. Mol. Mutagen.* 45: 106–14.

Barker, I.K. and Parrish, C.R. 2001. Parvovirus infections. pp.131–46. *In*: Williams, E.S. and Barker, I.K. (eds). *Infectious Diseases of Wild Mammals*. Iowa State University Press, Ames, Iowa.

Best, P.B. 1994. Seasonality of reproduction and the length of gestation in southern right whales *Eubalaena australis*. *J. Zool.* 232: 175–89.

Best, P.B. and Rüther, H. 1992. Aerial photogrammetry of southern right whales, *Eubalaena australis*. *J. Zool. (London)* 228: 595–614.

Blanchard, T.W., Santiago, N.T., Lipscomb, T., Garber, R.L., McFee, W. and Knowles, S. 2001. Two novel alphaherpesviruses associated with fatal disseminated infections in Atlantic bottlenose dolphins. *Journal of Wildlife Diseases* 37: 297–305.

Bonner, W.N. 1987. Right whale sightings around South Georgia. *British Antarctic Survey Bulletin* 76: 99–103.

Bourg, G., O'Callaghan, D. and Boschiroli, M.L. 2007. The genomic structure of *Brucella* strains isolated from marine mammals give clues to evolutionary history within the genus. *Vet. Micro.* 125: 375–80.

Boyd, I.L., Wanless, S. and Camphuysen, C. 2006. *Top Predators in Marine Ecosystems: their role in monitoring and management*. Cambridge University Press, Cambridge, UK.

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.t* 11(1): 49–64.

Brodie, E.C., Gulland, F.M.D., Greig, D.J., Hunter, M., Jaakkola, J., St. Leger, J., Leighfield, T.A. and Van Dolah, F.M. 2006. Domoic acid causes reproductive failure in California sea lions (*Zalophus californianus*). *Marine Mammal Science* 22(3): 700–07.

Brownell, R.L., Makeyev, C.A.F. and Rowles, T.K. 2007. Stranding trends for eastern gray whales, *Eschrichtius robustus*: 1975–2006. Paper SC/59/BRG40 presented to the IWC Scientific Committee, May 2007, Anchorage, Alaska (unpublished). 11pp. [Paper available from the Office of this Journal].

Carreto, J.I., Montoya, D., Cucchi Colleoni, A.D. and Akselman, R. 1998. *Alexandrium tamarense* blooms and shellfish toxicity in the Argentine Sea: a retrospective view. pp.131–34. *In*: Reguera, B., Blanco, J.C., Fernandez, M. and Wyatt, T. (eds). *Harmful Algae*. Xunta de Galacia and Intergovernmental Commission of UNESCO.

Centers for Disease Control and Prevention (CDC). 2003. Outbreak of botulism type E associated with eating a beached whale – Western Alaska, July 2002. *MMWR Morb. Mortal. Wkly. Rep.* 52(2): 24–26.

Cooke, J., Rowntree, V. and Payne, R. 2003. Analysis of inter-annual variation in reproductive success of South Atlantic right whales (*Eubalaena australis*) from photo-identification of calving females observed off Peninsula Valdes, Argentina, during 1971–2000. Paper SC/55/O23 presented to the IWC Scientific Committee, May 2003, Berlin (unpublished). 16pp. [Paper available from the Office of this Journal].

Cooke, J.G., Rowntree, V.J. and Payne, R.S. 2001. Estimates of demographic parameters for southern right whales (*Eubalaena australis*) observed off Península Valdés, Argentina. *J. Cetacean Res. Manage. (special issue)* 2: 125–32.

Croxall, J.P., McCann, T.S., Prince, P.A. and Rothery, P. 1988. Reproductive performance of seabirds and seals at South Georgia and Signy Island, South Orkney Island, 1976–1987: Implication for southern ocean monitoring studies. pp.261–85. *In*: Sahrhauge, D. (eds). *Antarctic Ocean and Resources Variability*. Springer-Verlag, Berlin. 304pp.

Cummings, W.C., Fish, J.F. and Thompson, P.O. 1972. Sound production and other behavior of southern right whales, *Eubalaena glacialis*. *Transactions of the San Diego Society of Natural History* 17(1): 1–14.

Dubey, J.P., Zarnke, R., Thomas, N.J., Wong, S.K., van Bonn, W., Briggs, M., Davis, J.W., Ewing, R., Mense, M., Kwok, O.C.H., Romand, S. and Thulliez, P. 2003. *Toxoplasma gondii, Neospora caninum, Sarcocystis canis*-like infections in marine mammals. *Vet. Parasitol.* 116: 275–96.

Ducklow, H.W., Baker, K.S., Martinson, D.G., Quetin, L.B., Ross, R.M., Smith, R.C., Stammerjohn, S.E., Vernet, M. and Fraser, W. 2007. Marine pelagic ecosystems: the West Antarctic Peninsula. *Philosophical Transactions of the Royal Society of London B* 362: 67–94.

Forcada, J. and Trathan, P.N. 2009. Penguin responses to climate change in the Southern Ocean. *Global Change Biology* 15: 1618–30.

Forcada, J., Trathan, P.N. and Murphy, E.J. 2008. Life history buffering in Antarctic mammals and birds against changing patterns of climate and environmental variation. *Global Change Biology* 14: 2473–88.

Forcada, J., Trathan, P.N., Reid, K. and Murphy, E.J. 2005. The effects of global climate variability in pup production of Antarctic fur seals. *Ecology* 86: 2408–17.

Forcada, J., Trathan, P.N., Reid, K., Murphy, E.J. and Croxall, J. 2006. Contrasting population changes in sympatric penguin species in association with climate warming. *Global Change Biology* 12: 411–23.

Foster, G., Osterman, B.S., Godfroid, J., Jacques, I. and Cloeckaert, A. 2007. *Brucella ceti* sp.nov. and *Brucella pinnipedialis* sp.nov. for *Brucella* strains with cetaceans and seals as their preferred hosts. *Int. J. Syst. Evol. Microbiol.* 57: 2688–93.

Fraser, W.R. and Hofmann, E.E. 2003. A predator's perspective on causal links between climate change, physical forcing and ecosystem response. *Marine Ecology Progress Series* 265: 1–15.

Gayoso, A. 2001. Observations on *Alexandrium tamarense* (Lebour) Balech and other dinoflagellate populations in Golfo Nuevo, Patagonia (Argentina). *Journal of Plankton Research* 23(5): 463–68.

Geraci, J.R., Anderson, D.M., Timperi, R.J., St. Aubin, D.J., Early, G.A., Prescott, J.H. and Mayo, C.A. 1989. Humpback whales (*Megaptera novaeangliae*) fatally poisoned by dinoflagellate toxin. *Canadian Journal of Fisheries and Aquatic Sciences* 46(11): 1895–98.

Geraci, J.R. and Lounsbury, V.J. 1993. *Marine Mammals Ashore – A Field Guide For Strandings*. Texas A&M Sea Grant Publication, Galveston, Texas, USA. i–xi+305pp.

Gilmartin, W.G., DeLong, R.L., Smith, A.W., Griner, L. and Dailey, M.D. 1980. An investigation into unusual mortality in the Hawaiian monk seal, *Monachus schauinslandi*. pp.32–41. *In*: Grigg, R.W. and Pfund, R.T. (eds). *Proceedings of the Symposium on Status of Resource Investigation in the Northwestern Hawaiian Islands, April 24–25, 1980*. Sea Grant Reports UNIHI-SEAGRANT0MR-80-04, University of Hawaii.

Gilmore, R.M. 1969. Populations, distribution, and behavior of whales in the western South Atlantic: cruise 69–3 of R/V *Hero*. *Antarctic Journal of the United States* 4(6): 307–08.

Goldstein, T., Mazet, J.A.K., Lowenstine, L., Gulland, F.M.D., Rowles, T.K., King, D.P., Aldridge, B.M. and Stott, J.L. 2005. Tissue distribution of phocine herpesvirus-1 (PhHV-1) in infected harbour seals (*Phoca vitulina*) from the central Californian coast and a comparison of diagnostic methods. *Journal of Comparative Pathology* 133: 175–83.

Gomes. 2005. Encalhes de baleias-francas-do-sul *Eubalaena australis* (Desmoulins, 1822), na costa brasileira: sintese do conhecimento. PhD thesis, Faculdades Integradas Maria Thereza, Rio de Janeiro, Brazil. 42pp.

Greene, C.H. and Pershing, A.J. 2004. Climate and the conservation biology of North Altantic right whales: the right whale at the wrong time? *Frontiers in Ecology and the Environment* 2: 29–34.

Greig, A.B., Secchi, E.R., Zerbini, A.N. and Dalla Rosa, L. 2001. Stranding events of southern right whales, *Eubalaena australis*, in southern Brazil. *J. Cetacean Res.Manage.(special issue)* 2: 157–60.

Groch, K. 2005. Biologia populacional e ecologia comportamental de baleia franca austral, *Eubalaena australis* (Desmoulins, 1822), CETACEA, MYSTICETI, no litoral sul do Brasil. PhD thesis. Universidade Federal do Rio Grande do Sul, Porto Alegre, RS. 168pp.

Groch, K.R., Fabian, M.E., Adler, F.R., Palazzo, J.T. and Flores, P.A.C. 2004. Recent rapid increases in the right whale population off southern Brazil. *The Latin American Journal of Aquatic Mammals* 4(1): 41–48.

Gulland, F., Haulena, M., Fauquier, D.A., Langlois, G., Lander, M., Zabka, T. and Duerr, R. 2002. Domoic acid toxicity in Californian sea lions (*Zalophus californianus*): clinical signs, treatment and survival. *Veterinary Record* 150(15): 475–80.

Gulland, F.M.D. 1998. Leptospirosis in marine mammals. pp.469–71. *In*: Fowler, M. and Miller, R.E. (eds). *Zoo and Wild Animal Medicine*. W.B. Saunders.

Gulland, F.M.D. and Hall, A.J. 2007. Is marine mammal health deteriorating? Trends in the global reporting of marine mammal disease. *Ecohealth* 4: 135–50.

Gulland, F.M.D., Pérez-Cortés, H., Urbán, J.R., Rojas-Bracho, L., Ylitalo, G., Weir, J., Norman, S.A., Muto, M.M., Rugh, D.J., Kreuder, C. and Rowles, T. 2005. Eastern North Pacific gray whale (*Eschrichtius robustus*) unusual mortality event, 1999–2000. *NOAA Technical Memorandum NMFS-AFSC* 150: 34pp. [Available at: *www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-150.pdf*].

Hall, A.J., McConnell, B.J., Rowles, T.K., Aguilar, A., Borrell, A., Schwacke, L., Wells, R.S. and Reijnders, P.J.H. 2005. An individual based model framework to assess the population consequences of polychlorinated biphenyl exposure in bottlenose dolphins. *Environmental Health Perspectives* 114(3): 25pp.

Harris, G. and Garcia, C.O. 1990. Ballenas francas australes – el lento camino de la recuperacion. *Ciencia Hoy* 2(7): 37–43.

Hedley, S., Reilly, S., Borberg, J., Holland, R., Hewitt, R., Watkins, J., Naganobu, M. and Sushin, V. 2001. Modelling whale distribution: a preliminary analysis of data collected on the CCAMLR-IWC krill synoptic survey, 2000. Paper SC/53/E9 presented to the IWC Scientific Committee, July 2001, London (unpublished). 38pp. [Paper available from the Office of this Journal].

Hernandez, M., Robinson, I., Aguilar, A., Gonzalez, L.M., Lopez-Jurado, L.F., Reyero, M.I., Cacho, E., Franco, J., Lopez-Rodas, V. and Costas, E. 1998. Did algal toxins cause monk seal mortality? *Nature* 393: 28–29.

Hinke, J.T., Salwicka, M.S., Trivelpiece, S.G., Watters, G.M. and Trivelpiece, W.Z. 2007. Divergent responses of *Pygoscelis* penguins reveal a common environmental driver. *Oecologia* 153: 845–55.

Hoffmeyer, M.S., Lindner, M.S., Carribero, A., Fulco, V.K., Menendez, M.C., Fernandez Severini, M.D., Diodato, S.L., Berasategui, A.A., Biancalana, F. and Berrier, E. 2010. Planktonic food and foraging of *Eubalaena australis*, on Península Valdés (Argentina) nursery ground. *Revista de Biologa Marina y Oceanografia* 45: 131–39.

International Whaling Commission. 2001. Report of the Workshop on the Comprehensive Assessment of Right Whales: A worldwide comparison. *Journal of Cetacean Research and Management (special issue)* 2:1–60.

Jepson, P.D., Bennett, P.M., Deaville, R., Allchin, C.R., Baker, J.R. and Law, R.J. 2005. Relationships between polychlorinated biphenyls and health status in harbour porpoises (*Phocoena phocoena*) stranded in the United Kingdom. *Environmental Toxicology and Chemistry* 24(1): 238–48.

Kannan, K., Blankenship, A.L., Jones, P.D. and Giesy, J.P. 2000. Toxicity reference values for the toxic effects of polychlorinated biphenyls to aquatic mammals. *Human and Ecological Risk Assessment* 6(1): 181–201.

Kennedy-Stoskopf, S. 2001. Viral diseases. pp.285–307. *In*: Dierauf, L. and Gulland, F.M.D. (eds). *CRC Handbook of Marine Mammal Medicine, second edition*. CRC Press, Boca Raton, FL.

Knowlton, A.R., Kraus, S.D. and Kenney, R.D. 1994. Reproduction in North Atlantic right whales (*Eubalaena glacialis*). *Canadian Journal of Zoology – Revue Canadienne de Zoologie* 72(7): 1,297–305.

LaPointe, J.M., Gulland, F., Haines, D.M., Barr, B.C. and Duignan, P.J. 1999. Placentitis due to *Coxiella burnetti* in a Pacific harbour seal (*Phoca vitulina richardsi*). *Journal of Veterinary Diagnostic Investigation* 11: 541–43.

Leaper, R., Cooke, J., Trathan, P., Reid, K. and Rowntree, V. 2006. Global climate change drives southern right whales (*Eubalaena australis*) population dynamics. *Biology Letters* 2: 289–92.

Lysiak, N.S. 2009. Investigating the migration and foraging biology of North Atlantic right whales with stable isotope geochemistry of baleen and zooplankton. Doctoral thesis, Boston University.

Martineau, D., Lemberger, K., Dallaire, A., Labelle, P., Lipscomb, T.P., Michel, P. and Mikaelian, I. 2002. Cancer in wildlife, a case study: beluga from the St Lawrence estuary, Quebec, Canada. *Environmental Health Perspectives* 110(3): 285–92.

Matthews, L.H. 1932. Lobster-krill: Anomuran crustacea that are the food of whales. *Discovery Reports* 5(2): 467–84.

Matthews, L.H. 1938. Notes on the southern right whale, *Eubalaena australis*. *Discovery Reports* 17(2): 169–82.

McLellan, W., Rommel, S., Moore, M. and Pabst, D. 2004. Right whale necropsy protocol. Final report to NOAA Fisheries for contract #40AANF112525. 51pp.

Miller, L.G. 1975. Observations on the distribution and ecology of *Clostridium botulinum* type E in Alaska. *Canadian Journal of Microbiology* 21(6): 920–26.

Moore, M.J., Berrow, S.D., Jensen, B.A., Carr, P., Sears, R., Rowntree, V.J., Payne, R. and Hamilton, P.K. 1999. Relative abundance of large whales around South Georgia (1979–1998). *Mar. Mamm. Sci.* 15(4): 1,287–302.

Mouzo, F.G., Garza, M.L., Izquierdo, J.F. and Zibecchi, R.O. 1978. Rasgos de la geologia submarina del Golfo Nuevo (Chubut). *Acta Oceanografica Argentina* 2(1): 69–92.

Murphy, E.J., Trathan, P.N., Watkins, J.L., Reid, K., Meredith, M.P., Forcada, J., Thorpe, S.E., Johnston, N.M. and Rothery, P. 2007. Climatically driven fluctuations in Southern Ocean ecosystems. *Proceedings of the Royal Society B* 274: 3057–67.

O'Shea, T.J. and Brownell, R.L. 1994. Organochlorine and metal contaminants in baleen whales – a review and evaluation of conservation implications. *Science of the Total Environment* 154(2–3): 179–200.

Palazzo, J.T., Jr. and Carter, L.A. 1983. A caça de baleias no Brasil. Porto Alegre. Assoc. Gaúcha de Prot. Amb. Natural. 25pp. [In Portuguese].

Payne, R. 1986. Long term behavioral studies of the southern right whale (*Eubalaena australis*). *Reports of the International Whaling Commission (special issue)* 10: 161–67.

Payne, R. 1995. *Among Whales*. Scribner, New York. 431pp.

Payne, R., Brazier, O., Dorsey, E.M., Perkins, J.S., Rowntree, V.J. and Titus, A. 1983. External features in southern right whales (*Eubalaena australis*) and their use in identifying individuals. pp.371–445. *In*: Payne, R. (eds). *Communication and Behavior of Whales*. AAAS Selected Symposia Series 76. Westview Press, Colorado. xii+643pp.

Pettis, H. 2009. North Atlantic right whale consortium annual report card (01 November 2007 – 30 April 2009). Paper SC/61/BRG11 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 7pp. [Paper available from the Office of this Journal].

Quetin, L.B. and Ross, R.M. 2003. Episodic recruitment in Antarctic krill *Euphasusia superba* in the Palmer LTER study region. *Mar. Ecol. Prog. Ser.* 259: 185–200.

Raga, J.A., Aguilar, A. and Crespo, E.A. 2008. Memoria Cientifico Tecnica del proyecto Estudio de amenazas para la conservacion de mamiferos marinos de Patagonia, financiado por la Funadacion del Banco Bilbao Viscaya Argentaria.

Reijnders, P.J.H. 1986. Reproductive failure in common seals feeding on fish from polluted coastal waters. *Nature* 324: 456–57.

Richards, R. 2009. Past and present distribution of southern right whales. *NZ J. Zool.* 36: 447–59.

Rosenbaum, H., Weinrich, M., Stoleson, S.A., Gibbs, J.P., Baker, C.S. and DeSalle, R. 2002. Correlations of life history with matrilines in humpback whales of the Gulf of Maine. *Journal Of Heredity* 93: 389–99.

Ross, P.S., De Swart, R.L., Addison, R.F., Van Loveren, H., Vos, J.G. and Osterhaus, A.D.M.E. 1996. Contaminant-induced immunotoxicity in harbour seals: Wildlife at risk? *Toxicology* 112: 157–69.

Ross, P.S., De Swart, R.L., Reijnders, P.J.H., Van Loveren, H., Vos, J.G. and Osterhaus, A.D.M.E. 1995. Contaminant-related suppression of delayed-type hypersensitivity (DTH) and antibody responses in harbor seals fed herring from the Baltic Sea. *Environmental Health Perspectives* 103: 162–67.

Rowntree, V.J., McGuiness, P., Marshall, K., Payne, R., Sironi, M. and Sefer, J. 1998. Increased harassment of right whales (*Eubalaena australis*) by kelp gulls (*Larus dominicanus*) at Península Valdés, Argentina. *Mar. Mamm. Sci.* 14(1): 99–115.

Rowntree, V.J., Payne, R. and Schell, D.M. 2001. Changing patterns of habitat use by southern right whales (*Eubalaena australis*) on their nursery ground at Península Valdés, Argentina, and in their long-range movements. *Journal of Cetacean Research and Management (special issue)* 2: 133–43.

Rowntree, V.J., Valenzuela, L.O., Franco Fraguas, P. and Seger, J. 2008. Foraging behaviour of southern right whales (*Eubalaena australis*) inferred from variation of carbon stable isotope ratios in their baleen. Paper SC/60/BRG23 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 10pp. [Paper available from the Office of the IWC].

Scholin, C.A., Gulland, F., Doucette, G., Benson, S., Busman, M., Chavez, F.P., Cordaro, J., DeLong, R., De Vogelaere, A., Harvey, J., Haulena, M., Lefebvre, K., Lipscomb, T., Loscutoff, S., Lowenstine, L., Marin Iii, R., Miller, P.E., McLellan, W., Moeller, P.D.R., Powell, C.L., Rowles, T., Silvagni, P., Silver, M., Spraker, T., Trainer, V. and Van Dolah, F. 2000. Mortality of sea lions along the central California coast linked to a toxic diatom bloom. *Nature* 403: 80–84.

Schwacke, L.H., Voit, E.O., Hansen, L.J., Wells, R.S., Mitchum, G.B., Hohn, A.A. and Fair, P.A. 2002. Probabilistic risk assessment of reproductive effects of polychlorinated biphenyls on bottlenose dolphins (*Tursiops truncatus*) from the southeast United States coast. *Environmental Toxicology and Chemistry* 21(12): 2752–64.

Sironi, M. 2004. Behaviour and social development of juvenile southern right whales (*Eubalaena australis*) and interspecific interactions at Península Valdés, Argentina. PhD dissertation, University of Wisconsin, Madison. 198pp.

Sironi, M., López, J.C., Bubas, R., Carribero, A., Garcia, C., Harris, G., Intrieri, E., Iñiguez, M. and Payne, R. 2008. Predation by killer whales (*Orcinus orca*) on southern right whales (*Eubalaena australis*) off Patagonia, Argentina: effects on behaviour and habitat choice. Paper SC/60/BRG29 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 18pp. [Paper available from the Office of this Journal].

Sironi, M., Rowntree, V.J., Snowdon, C.T., Valenzuela, L. and Marón, C. 2009. Kelp gulls (*Larus dominicanus*) feeding on southern right whales (*Eubalaena australis*) at Península Valdés, Argentina: updated estimates and conservation implications. Paper SC/61/BRG19 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 12pp. [Paper available from the Office of this Journal].

Sonne, C., Wolkers, H., Leifsson, P.S., Jenssen, B.M., Fuglei, E., Ahlstrom, O., Dietz, R., Kirkegaard, M., Muir, D.C.G. and Jorgensen, E. 2008. Organochlorine-induced histopathology in kidney and liver tissue from Arctic fox (*Vulpes lagopus*). *Chemosphere* 71: 1214–24.

Tarling, G.A., Cuzin-Roudy, J., Thorpe, S.A., Shreeve, R.S., Ward, P. and Murphy, E.J. 2007. Recruitment of Antarctic krill *Euphausia superba* in the South Georgia region: adult fecundity and the fate of larvae. *Mar. Ecol. Prog. Ser.* 331: 161–70.

Thomas, P.O. 1988. Kelp gulls, *Larus dominicanus*, are parasites on flesh of the right whale, *Eubalaena australis*. *Ethology* 79(2): 89–103.

Thomas, P.O. and Taber, S.M. 1984. Mother-infant interaction and behavioral development in southern right whales, *Eubalaena australis*. *Behaviour* 88(1–2): 42–60.

Tormosov, D.D., Mikhalev, Y.A., Best, P.B., Zemsky, V.A., Sekiguchi, K. and Brownell Jr, R.L. 1998. Soviet catches of southern right whales, *Eubalaena australis*, 1951–1971; biological data and conservation implications. *Biological Conservation* 86(2): 185–97.

Townsend, C.H. 1935. The distribution of certain whales as shown by logbook records of American whaleships. *Zoologica: scientific contributions of the New York Zoological Society* 19(1–2): 1–50+6 maps.

Uhart, M., Karesh, W.B., Cook, R., Huin, N., Lawrence, K., Guzman, L., Pacheco, H., Pizarro, G., Mattsson, R. and Mörner, T. 2004. Paralytic shellfish poisoning in Gentoo penguins (*Pygoscelis papua*) from the Falklands (Malvinas) Islands. pp.481–86. *In:* 2004 Proceedings of the AAZV, AAWV, WDA joint conference.

Uhart, M., Rowntree, V.J., Mohamed, N., Pozzi, L., La Sala, L., Andrejuk, J., Musmeci, L., Franco, M., Sironi, M., Sala, J.E., McAloose, D., Moore, M., Tohuey, K., McLellan, W.A. and Rowles, T. 2008. Strandings of southern right whales (*Eubalaena australis*) at Peninsula Valdés, Argentina from 2003–2007. Paper SC/60/BRG15 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 9pp. [Paper available from the Office of this Journal].

Uhart, M.M., Rowntree, V., Sironi, M., Chirife, A., Mohamed, N., Pozzi, L.M., Musmeci, L., Franco, M., McAloose, D., Doucette, G., Sastre, V. and Rowles, T. 2009. Continuing southern right whale mortality events at Península Valdés, Argentina. Paper SC/61/BRG18 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 10pp. [Paper available from the Office of this Journal].

Valavanidis, A., Vlahogianni, T., Dassenakis, M. and Scoullos, M. 2006. Molecular biomarkers of oxidative stress in aquatic organisms in relation to toxic environmental pollutants. *Ecotoxicology and Environmental Safety* 64: 178–89.

Valenzuela, L.O., Sironi, M., Rowntree, V.J. and Seger, J. 2009. Isotopic and genetic evidence for culturally inherited site fidelity to feeding grounds in southern right whales (*Eubalaena australis*). *Mol. Ecol.* 18(5): 782–79.

Van Bressem, M.F., Raga, J.A., DiGuardo, G., Jepson, P.D. and Duignan, P.J. 2009. Emerging infectious diseases in cetaceans worldwide and the possible role of environmental stressors. *Diseases of Aquatic Organisms* 86: 14.

Van Bressem, M.F., van Waerebeek, K. and Raga, J.A. 1999. A review of virus infections of cetaceans and the potential impact of morbilliviruses, poxviruses and papillomaviruses on host population dynamics. *Diseases of Aquatic Organisms* 38: 53–65.

Van Dolah, F.M., Doucette, G.J., Gulland, F., Rowles, T. and Bossart, G. 2003. Impacts of algal toxins on marine mammals. pp.247–70. *In*: Vos, J.G., Bossart, G.D., Fournier, M. and O'Shea, T. (eds). *Toxicology of Marine Mammals*. Taylor and Francis, London.

Vidal, O. and Gallo-Reynoso, J.P. 1996. Die-offs of marine mammals and sea birds in the Gulf of California, Mexico. *Mar. Mamm. Sci.* 12(4): 627–35.

Watkins, S.M., Reich, A., Fleming, L.E. and Hammond, R. 2008. Neurotoxic shellfish poisoning. *Marine Drugs* 6(3): 431–55.

Whitehead, H.P. and Payne, R. 1981. New techniques for assessing populations of right whales without killing them. *FAO Fisheries Series No. 5 (Mammals in the Seas)*: 189–209.

Annex A

List of Workshop Participants

Antarctic Krill Conservation Project, Pew Charitable Trust
Rodolfo Werner

British Antarctic Survey
Jaume Forcada

Centro Nacional Patagónico
Marcelo Bertellotti
Enrique A. Crespo
Sylvana Dans
Yariana Degrati
Ana Fazio
Maria Florencia Grandi
Rocio Loizaga
Mariano Coscarello

Fundación Ecocentro
Luisina Bossio
Alejandro Carribero
Nadia Geremias
Maria Soledad Lindner
Espinosa Romina

Instituto de Conservación de Ballenas
Clara Luz Rosas
Mariano Sironi
Diego Taboada

The Marine Mammal Center
Frances Gulland

Okapi Wildlife Associates
Randall R. Reeves

Right Whale Project – Brazil
Karina Groch

Sea and Sky Project
Santiago Krapovickas

Secretaria de Turismo Provincial, Chubut
Diego Conchillo

Southern Right Whale Health Monitoring Program
Andrea Chirife

University of Utah
Victoria Rowntree

US Marine Mammal Commission
Peter O. Thomas

US National Marine Fisheries Service
Robert L. Brownell
Teri Rowles

Wildlife Conservation Society
Guillermo Harris
Denise McAloose
Marcela Uhart
Alejandro Vila
Howard Rosenbaum

Woods Hole Oceanographic Institution
Michael Moore

Zoological Society of London
Paul Jepson
Karina Acevedo-Whitehouse

Annex B

Agenda

1. Introduction
   a. Opening and welcome
   b. Arrangements – chair, rapporteurs, etc.
   c. Documents and document control
   d. Reporting – format, timing, assignments

2. Background on right whales around Peninsula Valdés
   a. History of the population
   b. Long-term studies by WCS and other NGOs
   c. Long-term studies by Argentina agencies
   d. Others

3. Review of recent mass die-offs (since 2004)]

4. Findings to date from the die-offs
   a. Numbers of dead whales recovered (including size, sex, genetics, etc.)
   b. Spatial and temporal aspects, with comparisons between the two gulfs and different years
   c. Pathology results

5. Causation hypotheses (not mutually exclusive)
   a. 'Natural' mortality of calves (e.g. in relation to nutritional state ['condition'] of mothers)
   b. Toxic algal blooms
   c. Disease(s)
   d. Predation (including 'harassment' by predators, gulls, adult male right whales)
   e. Disturbance by tourism, industrial activity, etc. (potentially mediated by underwater noise)
   f. Demographic adjustment (e.g. entry of first-time mothers into population)
   g. Population is near current environmental carrying capacity (mediated by 'condition' adult females

6. Health (status) of South Atlantic Ocean ecosystem
   a. Offshore feeding areas (including shifts in quantity and distribution of primary and secondary production, species interactions, etc.; relations to natural variability, regime shifts, climate change, etc.)
   b. Coastal areas in Peninsula Valdés region

7. Global trends in marine mammal diseases and HABs

8. Population consequences of the die-offs
   a. Population increase after depletion by commercial whaling
   b. Future population trends

9. Possible explanation(s) for recent SRW die-offs

10. Future SRW health and mortality monitoring program
    a. Current program
    b. Future needs

11. Future SRW research program
    a. Current program (other than health and mortality monitoring)
    b. Future needs

12. Conclusions and recommendations

Annex C

Testing the 'Effort' Hypothesis for UMEs at Península Valdés

Jon Seger[1]

Since 2003, the Southern Right Whale Health Monitoring Program (SRWHMP) would be expected to have recorded a larger fraction of the calves that died than were recorded on average during the previous 32 years (1971–2002). But there is no obvious way to estimate how much more efficient the detection process has become, because we cannot assume that the actual calf mortality rate has remained constant. The important but difficult question is how much of the post-2003 increase in detected deaths can be attributed to increased effort, and how much of it represents real increases in mortality?

One seemingly conservative approach to this question is to assume that the first four years of the stranding project saw typical (historic) rates of calf mortality. Then we can ask whether the seemingly very high calf mortality of 2007–2009 falls significantly outside the range to be expected, given the detection efficiency implied by the data for 2003–2006, under the assumption that those years were in fact 'normal'. Those years may not have been 'normal', but it seems unlikely that they had abnormally low mortality rates, so this approach should be biased against the conclusion that the years 2007–2009 were truly extreme.

It seems remarkable that exponential fits to the raw data

[1]Submitted post-Workshop. Current at 26 March 2010.

for calves detected (alive) in the aerial surveys, and calves detected (dead) on the beaches prior to 2003, both give growth rates very similar to those derived from Justin Cooke's sophisticated population model (6.7–6.8%/yr – see Fig. 1). This suggests that on average, strandings were detected in proportion to their actual numbers, though perhaps with low efficiency. Thus we can easily estimate the improvement in efficiency (under the assumption explained in the previous paragraph) by simply elevating the stranded-calves curve so that it fits the data for the first four years of the SRWHMP (2003–2006) (Fig. 1). The upper curve on the stranded-calves plot demonstrates this fit. The curve is drawn black during those four years, and gray everywhere else, to indicate that its elevation reflects a fit to those four years only (while retaining the standard 6.7% population growth rate). On these assumptions, the stranding project has roughly doubled the probability that a dead calf is detected. Alternatively, it is possible that the increase in detection is smaller than this, and that some of the high mortality years prior to 2007 were caused by smaller unusual mortality events.

But even with an assumed doubling of the detection efficiency, the three most recent years are clearly extraordinary. Table 1 shows 1- and 2-tailed Poisson probabilities of seeing as many (or as few) stranded calves as were actually seen in 2003–2009, on the assumption that the expected numbers are those implied by the upper curve.

Table 1

Poisson probabilities of seeing as many (or as few) stranded calves as were actually seen in 2003-09.

Year	Predicted	Observed	*P* (1-tailed)	*P* (2-tailed)
2003	20.52	29	0.045	0.09
2004	21.93	13	0.029	0.06
2005	23.44	36	0.0095	0.02
2006	25.05	16	0.037	0.07
2007	26.77	77	1.8e-15	3.6e-15
2008	28.61	87	0	0
2009	30.58	71	3.1e-10	6.2e-10

This is a very bad fit. A conventional contingency chi-square for stranded vs. live calves in these seven years ($\chi^2 = 149.4$, 6 d.f., $P \approx 0$) makes the same point. Clearly there has been a lot of heterogeneity in calf mortality rates among years. Even for the pre-2003 era, $\chi^2 = 105.9$, 31 d.f., $P < 1.0^{e-6}$. Some of this could be caused by variation in survey effort.

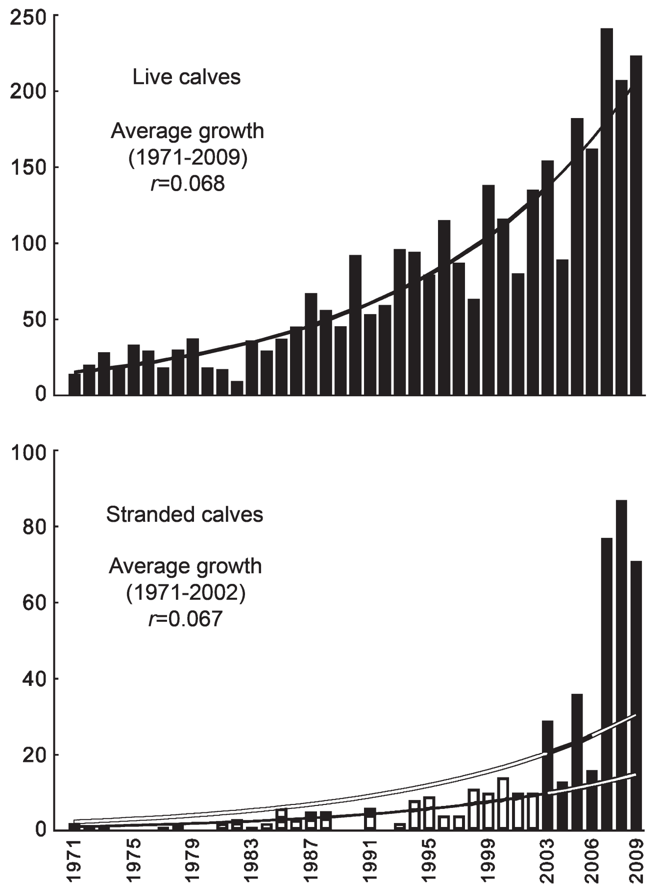

Fig. 1. Numbers of living calves counted in aerial photographic surveys (above), and numbers of stranded calves found on the shores of Golfo San Jose and Golfo Nuevo, 1971–2009. Curves are fits of the standard exponential population growth function to the raw data. In the lower panel (stranded calves), the lower curve is fit to the data for 1971–2002 only, and the upper curve is fit to the data for 2003–2006 (first four years of the SRWHMP) on the assumption that the average rate of growth is 0.067 (6.7%/yr) over all years. Each curve is not filled for the years that were not used in its fit. The upper curve supports the hypothesis that calf mortality was extraordinarily high in 2007–09 (i.e. far above the exponential prediction) even on the assumption that rates of calf mortality in 2003–2006 were typical of those seen in 1971–2002.

Report of the Third Intersessional Workshop on the Review of MSYR for Baleen Whales

Report of the Third Intersessional Workshop on the Review of MSYR for Baleen Whales

1. INTRODUCTORY ITEMS

The Workshop was held at the School of Aquatic and Fishery Sciences, University of Washington, Seattle (20–24 April 2010). The participants were Butterworth (Convenor), Brandon, Cooke (participating remotely), Donovan, Gabriele, Kitakado, Koski, Kraus, Punt, Ramp, Robbins, Straley and Wade.

1.1 Convenor's opening remarks
Butterworth welcomed the participants and advised that Cooke and Øien were unable to attend because their flights were cancelled as a result of the Icelandic volcanic eruption. He drew attention to the work plan for completion of the MSYR review (IWC, 2010a; 2010c), explaining the relationship of this review to the RMP, and the manner in which the issues considered during the Workshop would contribute to the review.

A critical aspect of the RMP review was reconsideration of the plausible range used for maximum sustainable yield rate (MSYR) in population models used for testing the *Catch Limit Algorithm* (*CLA*) of the RMP, which was currently 1% to 7% when expressed in terms of the mature component of the population. Information on observed population growth rates at low population sizes was being used to inform the review, but it had been pointed out that in circumstances where variability and/or temporal autocorrelation in the effects of environmental variability on population growth rates was high, use of these observed population growth rates could lead to mis-inference about the lower end of the range of plausible values for MSYR. The particular objective of discussions at the Workshop was to inform on whether the observed levels of variation in baleen whale reproduction and annual survival rate parameters were sufficiently large that biases of the nature identified from population models incorporating environmentally-induced variability might be of concern.

He thanked Cooke for his efforts to prepare potential data sets. He also thanked the data providers for making their information available.

1.2 Election of Chair
Donovan was elected as Chair.

1.3 Appointment of rapporteurs
Butterworth and Robbins acted as rapporteurs.

1.4 Adoption of Agenda
The adopted Agenda is given as Annex A.

1.5 Review of documents
New documents available to the meeting were SC/A10/MSYR1-3 (see Annex B).

2. ESTIMATION OF VARIABILITY FROM DATASETS FOR BALEEN WHALE SPECIES

2.1 General overview of time series data
Time series data from several species and populations were reviewed and assessed in preparation for the workshop, following on from previous work by the Committee and earlier workshops on this topic (IWC, 2009; 2010a). Based on this review, the following data types were identified as being the most common and potentially informative: calf counts, calving rates, calving intervals, abundance estimates and stranding data. A summary of the data received by the Workshop is provided in Table 1 and relevant population details are summarised below.

2.1.1 North Atlantic right whales
Kraus summarised photo-identification studies of North Atlantic right whales from the western North Atlantic, 1980 to the present. The data provided to the Workshop included calving rate and calving interval through 2009. A total of 581 animals have been catalogued since 1935 and an estimated 406 were alive in 2009. Survey effort was variable in the early 1980s but has been more consistent since 1986. Calving data were derived from a combination of breeding and feeding ground surveys, but results suggest that nearly 100% of all calving events are captured within three months. Issues with sighting heterogeneity meant that the population size has been calculated annually as the minimum number of whales known to be alive rather than through mark-recapture analyses. With respect to survivorship/mortality, although some carcasses are recovered, many are thought to go unobserved. Consequently, North Atlantic right whale abundance and stranding data were not considered useful time series for the purposes of the present Workshop.

2.1.2 South Atlantic right whales
South Atlantic right whales were photo-identified annually during aerial surveys around Península Valdés in Argentina since 1971 (Cooke *et al.*, 2003). Data from cow/calf pairs provide the most reliable inference for this breeding population and so the data submitted to the Workshop consisted primarily of calf counts, calving rates and calving intervals through 2008, although stranding data were also included. Prior modelling of reproduction suggested that the greatest inter-annual variation in reproduction occurred among females transitioning from 'ready to conceive' to 'resting' (Cooke *et al.,* 2003).

South Atlantic right whales were photo-identified during annual helicopter surveys of the southern coast of South Africa (Cape Town to Plettenberg Bay) since 1979 (Best, 2004; Best *et al.*, 2005; Best *et al.*, 2001). Photo-identification concentrated on cow-calf pairs along the same stretch of coastline at same time of year (mid-October). Earlier fixed-wing surveys had identified this stretch of coast as containing over 90% of cow-calf pairs on the South African coastline in spring, and the timing of the surveys was set to coincide with the end of the calving season but before the main exodus of whales from the coast. Matching (originally done only by eye) is now undertaken in conjunction with the Hiby-Lovell automated procedure (Hiby and Lovell, 2001). The catalogue (up to and including 2006) contained 954 adult females from which 1,959 calving intervals were recorded.

SC/A10/MSYR3 analysed the resightings data for female right whales with calves from aerial surveys conducted off South Africa from 1979 to 2006 for evidence of a change in

Table 1
Summary of potential data sets considered.

Area	Method	Total span (yrs)	Yrs missed/ gaps[1]	Potential data (and variance) types[2]	Data provider
Blue whale					
Gulf of California	Photo-ID	25	1/1	Calf count, calving propn	Sears/Ramp
Bowhead whale					
Bering-Chukchi-Beaufort Seas	Photo-ID	20	12/2	Calving propn (SE)	Koski
Fin whale					
Gulf of St. Lawrence	Photo-ID	19	0/0	Calf count	Sears/Ramp
Gray whale					
EN Pacific	Shore counts-southbound	40	17/7	Abundance-1+ (CV)	Laake, Perryman and Brownell Jr.
EN Pacific	Shore counts-northbound	16	0/0	Calf count (SE)	As above
EN Pacific	Reports	32	0/0	Strandings	As above
Humpback whale					
Gulf of Maine	Photo-ID	27	0/0	Calf count, calving interval[3] (SE), calving propn	Robbins
Gulf of St. Lawrence	Photo-ID	28	0/0	Calf count, calving interval[3] (SE), calving propn	Sears/Ramp
Southeast Alaska	Photo-ID	32	0/0	Calf count, calving interval[3] (SE), calving propn	Gabriele/Straley
West coast USA	Photo-ID	18	0/0	Abundance-total (CV)	Calambokidis
North Atlantic right whale					
WN Atlantic	Photo-ID	30	0/0	Calf count, calving interval[3] (SE), calving propn	Kraus
Southern right whale					
SE Atlantic	Photo-ID	28	0/0	Calf count, calving interval[4] (SE), calving propn	Best
SW Atlantic	Photo-ID	38	0/0	Calf count, calving interval[4] (SE), calving propn	Cooke
SW Atlantic	Reports	39	0/0	Strandings	Cooke

[1]The total number of years with no research effort versus the number of resulting gaps in the sequential data series. [2]For methods of estimation for modelling purposes see Item 2.2. Some estimates were limited to a subset of the study span, depending on the analysis. [3]Calving interval data available from complete or incomplete female sighting histories. [4]Calving interval data available from incomplete female sighting histories.

calving interval over this period. Statistically significant indications were found of a small decrease in the mean calving interval from 3.2 to 3.1 years somewhere between about 1985 and 1990.

2.1.3 Bowhead whales

Koski described the data set provided for the Bering-Chukchi-Beaufort (B-C-B) stock of bowhead whales. Several sources of information are available for estimates of year-to-year variation in calf production; these include either aerial or ice-based surveys, or both, during most years from 1978 to 2010 and aerial photographic surveys during spring, summer and early autumn of most years from 1981 to 2009. However, most of these data sets are biased due to segregation during migration or in the summering areas, and the biases cannot be properly accounted for. Therefore, the submitted data were restricted to eight years of photographic data collected near Barrow in spring from 1985 to 2004. The proportion of calves in the population was estimated and the data were fully corrected for all known biases, which include age-related timing of migration and the changes in the proportion of whales passing through the survey area throughout the spring migration period. Population estimates with confidence intervals are available for 12 years of ice-based surveys from 1978 to 2001 (George *et al.*, 2004; Zeh and Punt, 2005); an additional estimate, including confidence intervals, is available for 2004 from 2003–2004 photographic surveys (Koski *et al.*, 2004). Long-term rates of increase are available from the 12-year series of population estimates from ice-based surveys (Zeh and Punt, 2005). No reliable data are currently available for strandings or year-to-year mortality rates. On-going analyses show promise for quantifying first year mortality but results will not be available for another year or so.

2.1.4 Humpback whales

2.1.4.1 NORTH ATLANTIC

North Atlantic humpback whales were photo-identified during ship-based surveys in the Gulf of St. Lawrence since 1980 with an increase in spatial and temporal effort in the first years of the study. The Gulf is one of several summer feeding aggregations of the North Atlantic humpback whale population. Data provided to the Workshop were calving rates and calving intervals of individually identified mature females through 2009. Almost all females were sexed using skin sample biopsies before they started to reproduce, resulting in a rather high age at apparent first birth (12+ years). Mark-recapture estimates of sex-specific annual survival were available for adult whales, but not for calves/juveniles due to a low re-sighting rate (Ramp *et al.*, 2010). Abundance and stranding time series were not available.

Robbins described vessel-based photo-identification studies of North Atlantic humpback whales in the Gulf of Maine annually since the late 1970s. Sampling effort increased in both intensity and geographic coverage during the first decade and there continues to be considerable heterogeneity in individual sighting probabilities. Mark-recapture statistical analyses to date suggest annual variation in calf survival and calving probabilities, but not adult survival (Robbins, 2007; Rosenbaum *et al.*, 2002; Weinrich and Corbelli, 2009). There has been a significant increase in the age at first calving in the Gulf of Maine (Robbins, 2007), as well as significant differences in parameter values compared to other humpback whale populations (e.g. Gabriele *et al.*, 2007). Calf count, calving rate and calving interval data were provided to the Workshop for the period 1979–2005. Neither available abundance estimates nor carcass counts were considered reliable time series for this population.

2.1.4.2 NORTH PACIFIC

Humpback whale photo-identification vessel-based surveys have been conducted annually in Southeast Alaska (SEAK) since the 1970s. This North Pacific feeding aggregation ranges from northern Vancouver Island to Yakutat, Alaska. The data submitted to the Workshop came from the northern part of SEAK, and primarily from two research groups. They consisted of annual calf counts, 184 birth intervals and calving rate data for 361 females through 2008. SEAK humpback whales are also studied on their Hawaiian breeding ground, but individuals were not consistently encountered and so those data were not included. Effort in some areas has been inconsistent across years and there is a potential for variability in calving rates relative to feeding behaviour. There are also several population estimates (with CVs) based upon subsets of these data, the most recent one is bounded by the years 1994–2000 (Straley *et al.*, 2009). Stranding data were not available.

Data were also available from a population of North Pacific humpback whales that migrate between the US West Coast (California/Oregon/Washington) in summer and Mexico/Central America in winter. Mark-recapture estimates of abundance were available for near-shore California from photo-identification studies, 1991–2008 (Calambokidis, 2009).

2.1.5 Fin whales

Ship-based photo-identification data from North Atlantic fin whales from the Gulf of St. Lawrence were available from 1980 on. The data provided to the workshop included calf counts, calving rates and calving intervals through 2008. However, few calves have been observed in this population, especially prior to 2005. The Gulf of St. Lawrence is a summer feeding ground and females might have weaned their calves by their arrival. Due to a temporal shift in their distribution, more calving data was available since 2005. Due to the small time span of data with calving data, it was decided not to use the data set at the present time, but it was regarded as useful for future assessments. Neither abundance nor stranding data were available.

The North Atlantic Fin Whale Catalogue (Allied Whale, College of the Atlantic) is another potential source of time series data for this species that might be explored in the future.

2.1.6 Blue whales

Ramp described photo-identification data available for North Pacific blue whales from the Gulf of California since 1983. Sampling was performed in a nursery area where calves are thought to be 1–3 months in age. This work was undertaken during 4–6 weeks per year and annual sample sizes tended to be highly variable. The data provided to the workshop consisted of calving rates and intervals. The sample likely represents only a proportion of the reproductively active females of the Californian population. Population estimates are also available for this population using mark-recapture photo-identification and line transect surveys (Calambokidis, 2009; Calambokidis and Barlow, 2004). In recent years, the two survey methods yielded contradicting results. Analysis based on photo-identification studies showed an increase of less than 3% (Calambokidis, 2009).

2.1.7 Gray whales

Three time series of data were supplied for the eastern North Pacific stock of gray whales. These included: (i) abundance estimates; (ii) calf production estimates; and (iii) stranding counts. There are 23 annual abundance estimates (of the 1+ component) during 1967–2006, with associated covariances (Laake *et al.*, 2009). The abundance estimates are derived from the land-based survey of the southbound migration along the coast of central California. Calf production estimates are available annually during 1994–2009, from a land-based survey of the northbound migration along central California (e.g. Perryman *et al.*, 2002). Finally, the strandings data are annual gross counts during 1975–2006, from the states of California, Oregon and Washington, where stranding network effort has been consistent through time (Brownell *et al.*, 2007).

2.2 Summary of data to be used in further analyses

Cooke had prepared initial tabulations of the data provided to him on reproduction and survival rates. These data were checked and modified where necessary by participants at the Workshop. A subset of the available data ('calving proportion indices' and 'calving interval estimates') were selected for further analysis; few data were available to inform on survival rate variation. The calving proportion indices were developed by dividing calf counts by numbers of mature females, where both numerator and divisor might reflect only

Table 2

Basis of 'calving proportion indices' used in workshop analysis.

Area	Description of 'calving proportion index'
Blue whale	
Gulf of California	Number of calves produced by mature females (a subset of total calf count)/number of mature females.
Bowhead whale	
Bering-Chukchi-Beaufort Seas	Proportion of calves in the population, corrected for sampling biases.
Gray whale	
EN Pacific	Calf index/mature females.
Humpback whale	
Gulf of Maine	Number of calves produced by mature females (a subset of total calf count)/number of mature females.
Gulf of St. Lawrence	Number of calves produced by mature females (a subset of total calf count)/number of mature females.
SE Alaska	Number of calves produced by mature females (a subset of total calf count)/number of mature females. The first few years of the series were excluded from analysis due consistently low numbers of mature females.
North Atlantic right whale	
WN Atlantic	Number of calves produced by mature females (a subset of total calf count)/number of mature females.
Southern right whale	
SE Atlantic	Expected number of calves/estimated number of mature females (based on an exponential trend fitted to calf data).
SW Atlantic	Number of calves/estimated number of mature females (based on an exponential trend fitted to calf data).

a relative measure. For example, calf counts might constitute only a proportion of the number of calves born that year, while the number of mature females might be indexed by an exponential trend line fitted to a time series of some measure of population abundance. In the case of gray whales, the number of mature females was taken from output of the most recent stock assessment for this population (Punt and Wade, 2010). The basis of the 'calf proportion index' for each population is shown in Table 2.

Calving intervals were calculated for individually identified females, as the number of years elapsed since the prior calf. Analysis was restricted to intervals in which the female was seen in all intervening years; such data were available from four populations (see Table 1). Intervals ending in the same year were averaged to yield a single estimate for that year. The first six years of any series were excluded to avoid bias through underrepresentation of longer intervals.

Computations carried out under Item 2.3 below required values for demographic parameters of the populations modelled. The values used for this purpose and their sources are listed in Table 3.

2.3 Analysis

As an initial approach, the Workshop first applied the methodology set out in Annex C to estimate the coefficient of variation (CV) and temporal autocorrelation for the time series of calving proportion index and calving interval data discussed above. This methodology ignores observation error, so that the resultant estimates of CV listed in Table 4 are positively biased. The Workshop noted that the variability in annual calving proportion was always greater than that for calving interval. This probably arises from the negative correlation in calving proportion from one year to the next which arises because (apart from minke whales) baleen whales reproducing in one year do not generally also calve the following year.

Table 3

Parameters for use as input to the population models described under Item 2.3. Observed values in **bold** and inferred values in regular type.

Stock	Mean survivorship	Age at attainment of maturity	r_0
B-C-B bowhead whale	**0.99**	**22**	**0.04**
Survival: estimated using mark-recapture for 13 years 1981 to 1998 (Zeh *et al.*, 2002) and valid for marked whales only (primarily mature animals).			
Maturity: a 'blended' estimate from: (1) estimates of growth of individuals to age at sexual maturity from six years of photography data collected from 1982 to 1990 (Koski *et al.*, 1992; 1993); (2) baleen growth rates in small whales extrapolated to age at sexual maturity (Schell *et al.*, 1989); and (3) aspartic acid age estimates (George *et al.*, 1999).			
Increase: estimated from 12 years census data from 1978 to 2001 (Zeh and Punt, 2005) and incorporating harvest mortality (0.006).			
Eastern gray whale	**0.98**	**7**	**0.06**
Survival: The median non-calf survival rate estimated from most recent assessment (Punt and Wade, 2010).			
Maturity: The median of the posterior for this parameter from the most recent assessment (Punt and Wade, 2010).			
Increase: Information on changes in abundance is available from most recent assessment (Punt and Wade, 2010).			
Gulf of California blue whale	**0.975**	**10+**	0.07
Survival: 0.975 – adult survival (non-calf) from photo-id data (1979-2002) (Ramp *et al.*, 2006).			
Maturity: 10+ years. N = 2 females, 12 and 13 returned with their own calves to the Sea of Cortez (MICS unpublished data). Whaling data and earplug counts suggest earliest is age 10 (Laurie, 1937; Lockyer, 1984; Ruud *et al.*, 1950; Yochem and Leatherwood, 1985).			
Increase: under 3% (Calambokidis, 2009) [around 7-8%, modelled values for Antarctic blue whales – Branch *et al.* (2007; 2003)].			
Gulf of Maine humpback whale	**0.955**	**7**	**0.065**
Survival: 0.955 (an approximation based on available estimates). Survival has been estimated to range from 0.925 (2000–2005) (Robbins, 2007) to 0.964 (1979–1995) (Rosenbaum *et al.*, 2002), but most estimates are in the 0.95–0.96 range.			
Maturity: 7 years (range 5-13 years 1979–2000) (Robbins, 2007). This is based on individual females observed annually until their first calf.			
Increase: 0.065 Barlow and Clapham (1997) (more recent data suggest a lower present rate 0–4% (Clapham *et al.*, 2003).			
Gulf of St. Lawrence humpback whale	**0.982**	**12+**	0.065
Survival: Both sexes pooled (adult – males 0.971 and females 0.992) from photo-id data (years) – (Ramp *et al.*, 2010).			
Maturity: from photo-id data (years) 12+ years. (Ramp, 2008).			
Increase: 0.065 based on Barlow and Clapham (1997) for adjacent areas.			
SE Alaskan humpback whale	0.97+	**12**	**0.06**
Survival: Mizroch *et al.* (2004)'s judgement of best of several estimates using data from southeastern Alaska and Hawaii 1979–1996 was 0.957 (0.943–0.967). Here chose to use the high end of the 95% confidence interval, 0.967, because it seems more consistent with available data on observed population increases.			
Maturity: Age at Sexual Maturity: 11 Gabriele *et al.* (2007) used re-sighting histories of 10 individually identified female humpback whales of known age from southeastern Alaska to estimate ASM. The females were observed with their first observed calf at a mean of 11.8 years (range: 816 years; one whale was 8 yrs, most were 10–12 yrs old). Since publication, 7 additional known age females had their first calf at ages, although one female had her first calf at age 6. Using all of all the current data on females of known age resulted in a mean age at first calving of 11.0 years. (*n* = 16, range = 6–16).			
Increase: Average of available relevant estimates - Calambokidis *et al*. (2008) 5.5–6.0% for the main breeding area, Hawaii, using three methods to compare mark recapture population estimates from SPLASH (2004-2006) with estimates from 1991-1993 and Mobley *et al*. (2001) aerial surveys in 1994–2000 for Hawaii, 7%.			
WN Atlantic right whale	**0.96**	**9**	**0.01**
Survival: Fujiwara and Caswell (2001); Kraus *et al.* (2007) – photo-id and mark-recapture data 1980-2005, different analytical approaches.			
Maturity: Kraus *et al*. (2007) – Individual analysis mean of all calving events to known age females for the period 1980-2005.			
Increase: Kraus *et al.* (2007) – population viability analyses based on 1980-2005 photo-id data – re-sampling the estimated survival rates from the time varying models of survival rates and the observed calf numbers for the period.			
SE Atlantic southern right whale	**0.99**	**7.7**	**0.073**
Survival, *maturity* and *increase*: all from Best *et al.* (2005) from photo-id data of females and calves (years) and computer models.			
SW Atlantic southern right whale	**0.98**	**9.1**	**0.068**
Survival, *maturity* and *increase*: all from Cooke *et al.* (2003) from photo-id data of females and calves (years) and computer models.			

Annex D sets out methodology which relates variability in calving proportion to variability in the annual growth rate of a population by means of a population dynamics model. The values in Table 3 cannot be input directly into this model, because account has to be taken of the fact that there is an upper bound of 1 on the proportion of mature females that can calve in any one year, and further those females that have calved in one year cannot calve again in the next one or two years (depending on the species – minke whales are not under consideration here). The Annex D model builds in these constraints, and is tuned by adjusting the input CV and temporal autocorrelation estimates in Table 4 upwards until the corresponding model outputs for these quantities match those in Table 4, i.e. until the variability simulated by the model matches that observed in the field. The model then outputs the CV and temporal autocorrelation to be expected in the growth of the population from year to year (see example results in Tables 2 and 3 of Annex D).

Two further steps are needed before such results can be used to draw inferences about the plausible ranges for the CV and temporal autocorrelation parameters describing the effects of environmental variability on population dynamics in the model of Cooke (2007). The model of Annex C needs to be improved in the manner detailed towards the end of that Annex. The first stage of this process involves adjusting that model to allow estimates of observation error for each calving proportion index or calving interval to be taken into account so as to reduce the positive bias that arises from the existing model ignoring that effect. In the second stage, an approach that is technically more correct will be developed to formally integrate out what are random effects in the original model, and to use case-specific error models for each series rather than assume normal distributions throughout.

The second step is needed because the CV and temporal autocorrelation parameters input to the environmental variability model (Cooke, 2007) do not correspond exactly to the CV and temporal autocorrelation in the growth of the population from year to year output by the population model of Annex D. An appropriate selection, focusing on the higher value options for CV and temporal autocorrelation, from the standard set of scenarios for the environmental variability model (table 2 in IWC, 2010a) needs to be run to output corresponding statistics for the growth of the population from year to year, so that these can in turn be compared with such outputs from the population model of Annex D.

Most of the data available to the Workshop related to the reproduction process (calving). Environmentally induced variability in population abundance can arise also from variation in the annual survival rate, and the model of Annex D can also take this into account. However only two data series (from strandings) related to variations in survival rate were available to the Workshop, which noted that these seemed to indicate brief periods of heightened natural mortality for which the AR1 models used to represent variability in reproduction would probably not constitute the best form of statistical representation. The Workshop **agreed** that it was necessary that the impact of such survival rate variations also be considered as a component of this investigation, but that decisions on the specific form of representations of this effect to be included in further runs of the model of Annex D should be deferred to the 2010 Annual Meeting.

3. OTHER SOURCES OF INFORMATION

This section relates to progress made on other issues listed in the Work Plan for Completion of the MSYR Review (IWC, 2010c).

3.1 Other taxa

The work plan had suggested that a review of information on variability of population size and vital rates from other taxa, especially large mammals, would be useful, drawing attention to the literature cited in Inchausti and Halley (2001). Those authors had made use of the GPDD (Global Population

Table 4

Estimated parameters for the effects of environmental variability on reproductive success are shown for nine stocks of mysticetes, for which time series of calving data were available to the Workshop. The number of years with observations is given under '*n*'. 'Gaps' denotes how many times there were missing years (regardless of the number of missing years) between any two observations in a time series. The CV is equal to σ/μ, where σ is the standard deviation of the residual errors about the expected calving value μ. The standard deviations for each case are assumed to be correlated through time, given the corresponding coefficients under ρ. The standard errors of the three estimated parameters (ρ, μ and σ) are shown to the right of each, under 'SE'. The details of the modelling methods used to estimate these parameters are given in Annex C.

Stock	Calving data type	n	Gaps	CV	ρ	SE	μ	SE	σ	SE
Bowhead whale										
B-C-B	Proportion	8	2	0.581	0.075	0.521	0.060	0.013	0.035	0.009
Gray whale										
Eastern	Proportion	16	0	0.484	0.362	0.234	0.100	0.018	0.048	0.009
Blue whale										
Gulf of California	Proportion	18	4	0.915	–0.544	0.184	0.171	0.027	0.157	0.026
Humpback whale										
Gulf of Maine	Interval	22	0	0.161	0.197	0.210	2.457	0.104	0.395	0.060
Gulf of Maine	Proportion	27	0	0.454	–0.749	0.203	0.320	0.016	0.145	0.020
Gulf St. Lawrence	Interval	15	5	0.236	0.283	0.321	2.981	0.230	0.703	0.131
Gulf St. Lawrence	Proportion	25	1	0.859	–0.494	0.219	0.250	0.029	0.214	0.030
SE Alaska	Interval	23	0	0.179	0.410	0.192	2.674	0.164	0.479	0.071
SE Alaska	Proportion	25	0	0.224	0.121	0.202	0.219	0.011	0.049	0.007
North Atlantic right whale										
Western	Proportion	29	0	0.416	0.160	0.189	0.179	0.016	0.074	0.010
Western	Interval	25	0	0.150	0.609	0.155	4.124	0.300	0.617	0.087
Southern right whale										
SE Atlantic	Proportion	25	0	0.085	–0.336	0.188	0.990	0.013	0.084	0.012
SW Atlantic	Proportion	38	0	0.321	–0.151	0.160	1.248	0.057	0.401	0.046

Dynamics Database – *http://www.cpb.bio.ic.ac.uk*), which is said to be one of the largest collections of animal and plant population data in the world.

SC/A10/MSYR1 provided an initial summary of the contents of that database, and provided an extraction of those series that seemed most representative of larger mammals. However those constraints, coupled with a reliability factor of 3 or above in the range 1–5 assigned in the database, and a length of at least 11 years, resulted in the selection of only 35 data sets from the over 5,000 contained in the database. Only 8 of these 35 series are longer than 20 years.

Following inspection of the series so identified, the Workshop considered that they were very unlikely to contain information that would assist in the present Review. Workshop participants were aware of some other data series not included in the GPDD that might contain more information in the context of the objectives of this Review. However these series were not generally readily available, so that obtaining them and possible other further series not in the GPDD could prove a substantial task. The Workshop **agreed** that further discussion on this issue should be deferred to the 2010 Annual Meeting, when the Scientific Committee should be better placed to determine the need or otherwise for pursuing such an investigation further.

3.2 Genetic data

In the absence of participants with expertise in genetics at the Workshop, further consideration of this aspect was deferred to the 2010 Annual Meeting.

3.3 Variability – length of series relationship

Of the three items for attention on this issue (i.e. estimates of variance tending to increase with length of series) that are set out in the work plan, the compilation of data from other taxa had not proved helpful (see Item 3.1 above), whereas the inclusion of data series length as a factor in the meta-analysis of population growth rates had been accomplished (see Item 4 below).

Because of pressure of time to complete other computations needed urgently by the Commission, Allison had yet to complete the simulation study based on the environmental variability population model (Cooke, 2007) to determine the predicted relationship between the length of series and estimated level of variability for the standard scenarios (table 2 in IWC, 2010a). The Workshop **requested** that Allison attempt to complete this work to enable consideration of the results during the 2010 Annual Meeting.

4. REVISED META-ANALYSIS OF POPULATION GROWTH RATES

SC/A10/MSYR2 outlines an approach which could be used to construct a probability distribution for the rate of increase for an 'unknown' stock in the limit of zero population size, r_0, using data on observed rates of increase and their standard errors. This approach extends an approach presented to the 2009 Annual Meeting by being based on a beta distribution prior for the ratio of r_0 to the maximum demographically feasible rate of increase, r_{max}, and by accounting for environmental impacts on the population growth rate as well as uncertainty in the estimate of the realised growth rate. Estimation is based on Bayesian methods. Analyses based on simulation are conducted to evaluate the performance of this approach in data-rich and data-poor cases when estimates of r_0 are based on time-series of 20 years. As expected, performance is best when sample sizes are large and observation error is low.

The Workshop thanked Punt for this work. It suggested that further simulation runs be conducted with variance and temporal autocorrelation parameter values more typical of the higher ends of the ranges considered for the environmental variability model (Cooke, 2007), and observation error variance typical of those for the rates of increase in table 2 of IWC (2010b). It further **recommended** that the approach be recoded to be able to consider data sets of different lengths rather than all of the same length as at present. The Workshop **agreed** that the recoded approach would represent an improvement on that used last year to construct a probability distribution for the rate of increase for an 'unknown' stock in the limit of zero population size, r_0, and hence should be used for this purpose at the 2010 Annual Meeting.

5. WORK PLAN

The following schedule of further work was **agreed**, and would desirably be completed before or during the 2010 Annual Meeting.

(1) Further development of the methodology of Annex C to estimate series CVs and temporal autocorrelation to:
  (a) take account of observation error (Brandon); and
  (b) integrate out the random effects and make case-specific choices for error distributions (Brandon and Kitakado).

(2) Application of the model of Annex D to all the data sets listed in Table 3 to estimate the resultant CV and temporal autocorrelation predicted for the growth of the population from year to year (Punt).

(3) Implementation of the environmental variability population model (Cooke, 2007) to provide CVs and temporal autocorrelation estimates for the growth of the population from year to year for the higher value options for CV and temporal autocorrelation in the standard set of scenarios for that model (table 2 in IWC, 2010a) (Punt assisted by Allison).

(4) Implementation of the environmental variability population model (Cooke, 2007) to determine the predicted relationship between the length of series and estimated level of variability in the population rate of increase for the standard scenarios (table 2 in IWC, 2010a) (Allison).

(5) Reruns of the simulation testing of the meta-analysis approach of SC/A10/MSYR2 for the scenarios specified in Section 4 above, and extending the approach to be able to input data series of different lengths (Punt).

(6) Analysis of calving rate, calving interval and survival rate data using a Bayesian mixed effects model (Cooke).

In addition, the following issues were referred to the 2010 Annual Meeting for further consideration there:

(a) implementation of the model of Annex D including an appropriate representation of variation in annual survival rates based on information on strandings;

(b) application of a refined version of the approach in SC/A10/MSYR2 to provide an updated probability distribution for the rate of increase for an 'unknown' stock in the limit of zero population size, r_0, using data on observed rates of increase and their standard errors;

(c) consideration of whether further efforts should be expended to search for population-variability-related data series for other large mammalian taxa; and

(d) consideration of whether genetic data might be able to place bounds on the plausible range of values for variation and temporal autocorrelation parameters in the environmental variability population model (Cooke, 2007).

6. ADOPTION OF REPORT

The Chair thanked the rapporteurs, participants (both present and contributing from afar) for their contributions and Punt for the meeting arrangements. Although progress might not have been as great as had been anticipated, partly due to the 'volcanic disruption', the Workshop had been fruitful and good humoured. The participants thanked the Chair for handling the meeting with informality and tolerance!

The report was adopted by e-mail. The Chair expressed special thanks to Jooke Robbins.

REFERENCES

Barlow, J. and Clapham, P.J. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. *Ecology* 78(2): 535–46.

Best, P.B. 2004. Trends in the southern right whale population wintering in South African waters, 1971–2003. Paper SC/56/SH5 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 9pp. [Paper available from the Office of this Journal].

Best, P.B., Brandao, A. and Butterworth, D.S. 2005. Updated estimates of demographic parameters for southern right whales off South Africa. Paper SC/57/BRG2 presented to the IWC Scientific Committee, June 2005, Ulsan, Korea. 17pp. [Paper available from the Office of this Journal].

Best, P.B., Brandão, A. and Butterworth, D.S. 2001. Demographic parameters of southern right whales off South Africa. *J. Cetacean Res. Manage. (special issue)* 2: 161–69.

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., Matsuoka, K. and Miyashita, T. 2003. Antarctic blue whales are recovering. Paper SC/55/SH6 presented to the IWC Scientific Committee, May 2003, Berlin (unpublished). 21pp. [Paper available from the Office of this Journal]

Brownell, R.L., Makeyev, C.A.F. and Rowles, T.K. 2007. Stranding trends for eastern gray whales, *Eschrichtius robustus*: 1975–2006. Paper SC/59/BRG40 presented to the IWC Scientific Committee, May 2007, Anchorage, Alaska (unpublished). 11pp. [Paper available from the Office of this Journal].

Calambokidis, J. 2009. Abundance estimates of humpback and blue whales off the US West Coast based on mark-recapture of photo-identified individuals through 2008. Report No. PSRG-2009-7 presented to the NMFS Scientific Review Group, 3–5 November 2009, San Diego, CA. [Available from NMFS]

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., Urbán, J., Weller, D., Witteveen, B.H., Yamaguchi, M., Bendlin, A., Camacho, D., Flynn, K., Havron, A., Huggins, J., Maloney, N., Barlow, J. and Wade, P.R. 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*]

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. Mammal Sci.* 20(1): 63–85.

Clapham, P., Barlow, J., Bessinger, M., Cole, T., Mattila, R., Pace, R., Palka, D., Robbins, J. and Seton, R. 2003. Abundance and demographic parameters of humpback whales from the Gulf of Maine, and stock definition relative to the Scotian shelf. *J. Cetacean Res. Manage.* 5(1): 13–22.

Cooke, J., Rowntree, V. and Payne, R. 2003. Analysis of inter-annual variation in reproductive success of South Atlantic right whales (*Eubalaena australis*) from photo-identification of calving females observed off Peninsula Valdes, Argentina, during 1971–2000. Paper SC/55/O23 presented to the IWC Scientific Committee, May 2003, Berlin (unpublished). 16pp. [Paper available from the Office of this Journal].

Cooke, J.G. 2007. The influence of environmental variability on baleen whale sustainable yield curves. Paper SC/N07/MSYR1 presented to the MSYR Workshop, Seattle, USA, 16–19 November 2007 (unpublished). 19pp. [Paper available from the Office of this Journal].

Fujiwara, M. and Caswell, H. 2001. Demography of the endangered north Atlantic right whale. *Nature* 414(November 2001): 537–41.

Gabriele, C.M., Straley, J.M. and Neilson, J.L. 2007. Age at first calving of female humpback whales in southeastern Alaska. *Mar. Mammal Sci.* 23(1): 226–39.

George, J.C., Bada, J., Zeh, J., Scott, L., Brown, S.E., O'Hara, T. and Suydam, R. 1999. Age and growth estimates of bowhead whales (*Balaena mysticetus*) via aspartic acid racemization. *Can. J. Zool.* 77: 571–80.

George, J.C., Zeh, J., Suydam, R. and Clark, C. 2004. Abundance and population trend (1978–2001) of western arctic bowhead whales surveyed near Barrow, Alaska. *Mar. Mammal Sci.* 20(4): 755–73.

Hiby, L. and Lovell, P. 2001. A note on an automated system for matching the callosity patterns on aerial photographs of southern right whales. *J. Cetacean Res. Manage. (special issue)* 2: 291–95.

Inchausti, P. and Halley, J. 2001. Investigating long-term ecological variability using the Global Population Dynamics Database. *Science* 293: 655–57.

International Whaling Commission. 2009. Report of the MSYR Workshop, 16–19 November 2007, National Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA, USA. *J. Cetacean Res. Manage. (Suppl.)* 11:467–80.

International Whaling Commission. 2010a. Report of the Intersessional Workshop on MSYR for Baleen Whales, 6–8 February 2009, Seattle. *J. Cetacean Res. Manage. (Suppl.)* 11(2):493–508.

International Whaling Commission. 2010b. Report of the Scientific Committee. Annex D. Report of the Sub-committee on the Revised Management Procedure (RMP). *J. Cetacean Res. Manage (Suppl.)* 11(2):114–34.

International Whaling Commission. 2010c. Report of the Scientific Committee. Annex P. Work Plan for Completion of the MSYR Review. *J. Cetacean Res. Manage (Suppl.)* 11(2):399–400.

Koski, W.R., Davis, R.A., Miller, G.W. and Withrow, D.E. 1992. Growth rates of bowhead whales as determined from low-level aerial photogrammetry. *Rep. int. Whal. Commn* 42: 491–99.

Koski, W.R., Davis, R.A., Miller, G.W. and Withrow, D.E. 1993. Reproduction. pp.239–74. *In*: Burns, J.J., Montague, J.J. and Cowles, C.J. (eds). *The Bowhead Whale.* Special Publication No.2. The Society for Marine Mammalogy, Lawrence, Kansas. 787pp.

Koski, W.R., George, J.C., Suydam, R., Rugh, D.J. and Brandon, J. 2004. Aerial photography of bowhead whales at Barrow, Alaska, during the 2003 and 2004 spring migrations. Paper SC/56/BRG26 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 9pp. [Paper available from the Office of this Journal].

Kraus, S.D., Pace, R.M., III. and Frasier, T.R. 2007. High investment, low return: The strange case of reproduction in *Eubalaena glacialis*. pp.172–99. *In*: Kraus, S.D. and Rolland, R.M. (eds). *The Urban Whale: North Atlantic Right Whales at the Crossroads*. Harvard University Press, Cambridge, MA.

Laake, J., Punt, A., Hobbs, R., Ferguson, M., Rugh, D. and Breiwick, J. 2009. Re-analysis of gray whale southbound migration surveys 1967–2006. *NOAA Tech. Mem. NMFS-AFSC* 203. 55pp.

Laurie, A.H. 1937. The age of female blue whales and the effect of whaling on the stock. *Discovery Rep.* 15(2): 223–84.

Lockyer, C. 1984. Review of baleen whale (Mysticeti) reproduction and implications for management. *Rep. int. Whal. Commn (special issue)* 6: 27–50.

Mizroch, S.A., Herman, L.M., Straley, J.M., Glockner-Ferrari, D.A., Jurasz, C., Darling, J., Cerchio, S., Gabriele, C.M., Salden, D.R. and von Ziegesar, O. 2004. Estimating the adult survival rate of central north Pacific humpback whales (*Megaptera novaeangliae*). *J. Mammal.* 85(5): 963–72.

Mobley, J.M., Spitz, S., Grotenfeld, R., Forestell, P., Frankel, A.S. and Bauer, G.B. 2001. Abundance of humpback whales in Hawaiian waters: results of 1993–2000 aerial surveys. Report to the Hawaiian Islands Humpback Whale National Marine Sanctuary. 16pp.

Perryman, W.L., Donahue, M.A., Perkins, P.C. and Reilly, S.B. 2002. Gray whale calf production 1994–2000: Are observed fluctuations related to changes in seasonal ice cover? *Mar. Mammal Sci.* 18(1): 121–44.

Punt, A.E. and Wade, P.R. 2010. Population status of the eastern North Pacific stock of gray whales in 2009. US Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-207. 43pp.

Ramp, C. 2008. Population dynamics and social organisation of humpback whales (*Megaptera novaeangliae*) in the Gulf of St. Lawrence – a long-term study. PhD thesis, University of Bremen, Bremen, Germany. [Available at: *http://nbn-resolving.de/urn:nbn:de:gbv:46-diss000111355*]

Ramp, C., Bérubé, M., Hagen, W. and Sears, R. 2006. Survival of adult blue whales *Balaenoptera musculus* in the Gulf of St. Lawrence, Canada. *Mar. Ecol. Prog. Ser.* 319: 287–95.

Ramp, C., Berube, M., Palsboll, P., Hagen, W. and Sears, R. 2010. Sex-specific survival in the humpback whale (*Megaptera novaeangliae*) in the Gulf of St. Lawrence, Canada. *Mar. Ecol. Prog. Ser.* 400: 267–76.
Robbins, J. 2007. Structure and dynamics of the Gulf of Maine humpback whale population. PhD thesis, University of St Andrews, St Andrews, Scotland. [Available at: *http://hdl.handle.net/10023/328*]
Rosenbaum, H.C., Weinrich, M.T., Stoleson, S.A., Gibbs, J.P., Baker, C.S. and DeSalle, R. 2002. The effect of differential reproductive success on population genetic structure: Correlations of life history with matrilines in humpback whales of the Gulf of Maine. *J. Hered.* 93(6): 389–99.
Ruud, J.T., Jonsgard, A. and Ottestad, P. 1950. Age-studies on blue whales. *Hvalrråd. Skr.* 33: 5–63.
Schell, D.M., Saupe, S.M. and Haubenstock, N. 1989. Natural isotope abundances in bowhead whale (*Balaena mysticetus*) baleen: markers of ageing and habitat usage. *Ecol. Stud.* 68: 260–69.
Straley, J.M., Quinn, T.J. and Gabriele, C.M. 2009. Assessment of mark-recapture models to estimate the abundance of a humpback whale feeding aggregation in Southeast Alaska. *J. Biogeography* 36: 427–38.
Weinrich, M. and Corbelli, C. 2009. Does whale watching in Southern New England impact humpback whale (*Megaptera novaeangliae*) calf production or calf survival? *Biol. Conserv.* 142: 2931–40.
Yochem, P.K. and Leatherwood, S. 1985. Blue whale – *Balaenoptera musculus* (Linnaeus, 1758). pp.193–240. *In*: S.H. Ridgway and R. Harrison (eds). *The Sirenians and Baleen Whales*. Academic Press, London and Orlando. xviii+362pp.
Zeh, J., Poole, D., Miller, G., Koski, W., Baraff, L. and Rugh, D. 2002. Survival of bowhead whales, *Balaena mysticetus*, estimated from 1981–98 photo-identification data. *Biometrics* 58: 832–40.
Zeh, J.E. and Punt, A.E. 2005. Updated 1978–2001 abundance estimates and their correlations for the Bering-Chuckchi-Beaufort Seas stock of bowhead whales. *J. Cetacean Res. Manage.* 7(2): 169–75.

Annex A

Agenda

1. Introductory items
    - 1.1 Opening remarks
    - 1.2 Election of Chair
    - 1.3 Appointment of rapporteurs
    - 1.4 Adoption of agenda
    - 1.5 Review of documents
2. Estimation of variability from datasets for baleen whale species
    - 2.1 General overview of time series data
        - 2.1.1 North Atlantic right whale
        - 2.1.2 South Atlantic right whales
        - 2.1.3 Bowhead whales
        - 2.1.4 Humpback whales
            - 2.1.4.1 North Atlantic
            - 2.1.4.2 North Pacific
        - 2.1.5 Fin whales
        - 2.1.6 Blue whales
        - 2.1.7 Gray whales
    - 2.2 Summary of data to be used in further analyses
    - 2.3 Analysis
3. Other sources of information
4. Revised meta-analysis of population growth rates
5. Work plan
6. Adoption of Report

Annex B

List of Documents

SC/A10/MSYR
1. LURMAN, L. GPP: Initial summary.
2. PUNT, A.E. A revised Bayesian meta-analysis for estimating a posterior distribution for the rate of increase for an ‘Unknown’ stock.
3. BRANDÃO, A., BEST, P.B. and BUTTERWORTH, D.S. A note on possible change in the mean calving for Southern Right whales off South Africa.

Annex C

Preliminary Estimates of Calving Variability for Nine Stocks of Mysticetes

John R. Brandon and Toshihide Kitakado

Given a time series of observations (i.e. calving proportions or intervals) it is assumed that the i^{th} observation is related to the expected value, such that:

$$x_i = \mu + \varepsilon_i \qquad (1)$$

where:

x_i is the i^{th} value of interest (e.g., calving proportions in year i);

μ is the expectation of the value of interest;

ε_i is the deviation of the i^{th} value from the expectation, where:

$\varepsilon_i \sim N(0,\sigma^2)$, and σ^2 is the variance of the deviations.

Further, it is assumed that the deviations were correlated through time, such that:

$$\varepsilon_{i+1} = \rho\varepsilon_i + \eta_i \qquad (2)$$

where:

ρ is the correlation coefficient, and:

$\eta_i \sim N(0,(1-\rho^2)\sigma^2)$ *i.i.d.*

The likelihood of observing a time series of data incorporated the possibility that the time series in question may have missing years of observations. That is: let t be the span of years over which observations are available, such that $i = 1, \ldots, t$. Each time series of observations are available for n out of those t years, such that $j = 1, \ldots, n$. In order to allow for $n \leq t$, the negative log-likelihood of observing a given time series is:

$$-1\mathrm{n}(LL) = 1\mathrm{n}(\sigma_1) + \frac{(x_1-\mu)^2}{2\sigma_1^2} + \sum_{j=2}^{n}\left[1\mathrm{n}(\sigma_j) + \frac{1}{2\sigma_j^2}(\varepsilon_j - \rho^{r_j}\varepsilon_{j-1})^2\right] \qquad (3)$$

where:

$\sigma_1^2 = \sigma^2/(1-\rho^2)$;

r_j is the number of years between successive observations (i.e., if observations between the $j\!-\!1$ and j^{th} time-step are in successive years, then $r_j = 1$; if there is one missing year between observations $r_j = 2$, etc…), and;

σ_j^2 is the variance of the deviations taking into account the possibility of missing years, which leads to:

$$\sigma_j^2 = \sum_{s=1}^{r_j} \sigma^2\rho^{2(s-1)}$$

Three parameters were estimated: μ, σ and ρ. The estimates and their standard errors were calculated by using the mle function in the statistical software R (v. 2.9.1). In addition to the estimated parameters, the CV of the deviations (i.e. CV = σ/μ) was also derived for comparison. The CVs are approximately equal to the standard deviations in log-space, which is a typical parameterization of environmental variability in population dynamics models (here an initial log-transformation could not be used because of zeros in some series). Results are given in table 4 of the main report.

These preliminary estimates are based on empirical observations and provide a basis on which to consider the extent of the effect of environmental variability in reproductive success of mysticetes. However, there are certain limitations in this modeling approach which need to be addressed before any conclusions are drawn from these examples. Notably, there has been no attempt to account for observation (sampling) error in the time series. Hence, the estimated extent of environmental variability may be biased high because it is assumed here that the calving values are known exactly. In order to take observation error into account, it will be necessary to model error variance for each data point as the sum of the unknown process variance and the observation error. Where the latter are not available, some distributional assumption will need to be made. For example, the sampling error for calf count data can be modelled using a Poisson distribution.

Once observation error has been taken into account, alternative methods will be needed in order to account for the remaining deviations due to environmental variability. For example, the deviations may be treated as nuisance parameters and integrated out of the likelihood when fitting the model. It seems likely that this integration will be performed using numerical (in contrast to analytical) approaches for some, if not all of the data sets. For those situations, the random effects module for AD Model Builder may be used to implement these suggested improvements, which should provide a more accurate representation of the extent of environmental variability in these case studies.

Annex D

Population Model Projections Under Different Levels of Process Error

André E. Punt

The following population dynamics model forms the basis for the forecasts under different levels of variability in calving rate (and in principle survival):

$$N_{y,a} = \begin{cases} f_y\,(N_y^m - N_{y-1,0}S_{y-1}) & \text{if } a = 0 \\ N_{y-1,a-1}S_{y-1} & \text{if } 1 \le a < x \\ (N_{y-1,x} + N_{y-1,x-1})S_{y-1} & \text{if } a = x \end{cases} \qquad (1)$$

where $N_{y,a}$ is the number of animals of age a at the start of year y,

N_y^m is the number of 'mature' females at the start of year y:

$$N_y^m = 0.5 \sum_{a=a_m}^{x} N_{y,a}$$

f_y is the calving rate (number of calves per mature female which did not calf the previous year – this number of mature females is given by N_y^m) during year y:

$$f_y = f e^{\varepsilon_y^f - \sigma_f^2/2} \quad \varepsilon_y^f = \rho^f \varepsilon_{y-1}^f + \sqrt{1-(\rho^f)^2}\,\eta_y^f \quad \eta_y^f \sim N(0;\sigma_f^2)^1 \qquad (2)^1$$

f is the expected calving rate (in the absence of density-dependence),

ρ^f is the extent of auto-correlation in calving rate,

σ_f is the extent of variation in calving rate,

S_y is the survival rate during year y ($S_y = e^{-M_y}$):

$$M_y = \bar{M} + \varepsilon_y^M \quad \varepsilon_y^M = \rho^M \varepsilon_{y-1}^M + \sqrt{1-(\rho^M)^2}\,\eta_y^M \quad \eta_y^M \sim N(0;\sigma_M^2) \qquad (3)$$

ρ^M is the extent of auto-correlation in natural mortality, and

σ_M is the extent of variation in natural mortality (set equal to 0 for the analyses of this document).

Table 1 lists the values for the parameters of this model. Table 1 does not list a value for f. The value for this parameter (0.3644) is selected so that the deterministic rate of increase is equal to the pre-specified value for r_{max}. The population is projected ahead for 2,000 years, and the annual rate of increase, $\tilde{r}_y = \ell n(N_y^m / N_{y-1}^m)$ is computed. Table 2 lists the values for four output statistics (mean, standard deviation, CV and lag-1 autocorrelation over years 200–2000) for $\tilde{r}_y$ and the 'raw' calving rate[2] $N_{y,0} / N_y^m$. Results are shown in Table 2 for five runs of the model based on different sequences of random numbers. The CV and lag-1 autocorrelations in Table 2 are appreciably lower than the input values for σ_f and ρ^f in Table 1. Application of the model in which $\sigma_f = 0.6$ and $\rho^f = 0.9$ leads to much closer agreement between the outputs of the model and the values for the CV and lag-1 autocorrelation coefficient for the calving rate in Table 1 (Table 3). Fig. 1 shows the annual values for $\tilde{r}_y$ and the 'raw' calving rate (called 'calving proportion' elsewhere in this report) corresponding to the parameters in Table 3.

[1]Subject to the constraint that calving rate cannot exceed 1 (if a generated value for the calving rate exceeds 1, the value for η_y^f is generated again and this process repeated until the calving rate is less than 1).

[2]The raw calving rate was chosen for consistency with the approach used when analysing the data for the actual populations.

Table 1

Values for the parameters of the population dynamic model.

$\bar{M}$	X	a_m	r_{max}	σ_M	σ_f	ρ^M	ρ^f
$-\ell n0.9$	20	5	0.05	0	0.44	0	0.7

Table 2

Summary statistics for the application of the model based on the parameter values in Table 1. Auto is the temporal autocorrelation.

ROI				Calving rate			
Mean	SD	CV	Auto	Mean	SD	CV	Auto
0.0445	0.0278	0.6239	0.2276	0.2536	0.0915	0.3608	0.3457
0.0468	0.0283	0.6058	0.2393	0.2630	0.0947	0.3600	0.3625
0.0471	0.0290	0.6145	0.2636	0.2653	0.0993	0.3743	0.3855
0.0469	0.0287	0.6119	0.2771	0.2643	0.0976	0.3691	0.4087
0.0461	0.0286	0.6212	0.2598	0.2613	0.0978	0.3742	0.3943

Table 3

Summary statistics for the application of the model based on the parameter values in Table 1, except that $\sigma_f = 0.6$ and $\rho^f = 0.9$.

ROI				Calving rate			
Mean	SD	CV	Auto	Mean	SD	CV	Auto
0.0371	0.0280	0.7552	0.6247	0.2282	0.1006	0.4409	0.7291
0.0420	0.0283	0.675	0.5913	0.2474	0.1031	0.4166	0.7031
0.0424	0.0293	0.6922	0.6160	0.2500	0.1082	0.4328	0.7220
0.0421	0.0301	0.7150	0.6287	0.2493	0.1109	0.4447	0.7299
0.0401	0.0299	0.7463	0.6374	0.2412	0.1100	0.4562	0.7366

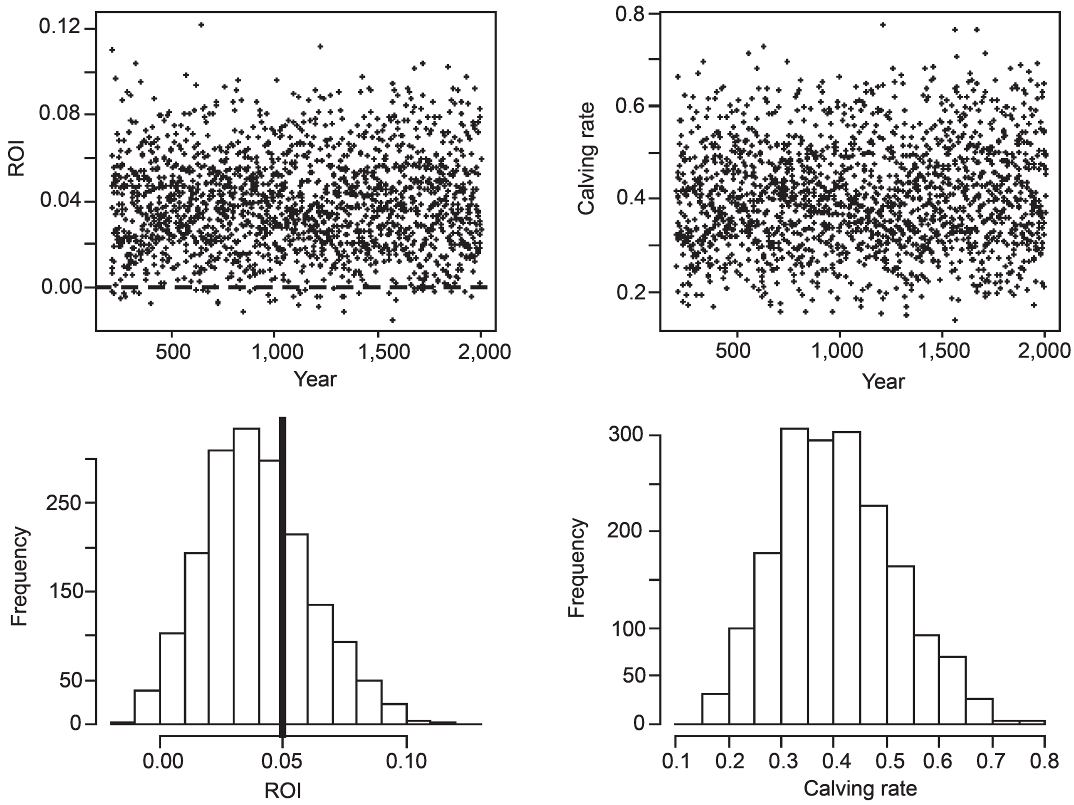

Fig. 1. Time-series of the annual rate of increase and the annual 'raw' calving rate based on $\sigma_f = 0.6$ and $\rho^f = 0.9$.

Report of the Intersessional Meeting on the North Pacific Survey Programme

Report of the Intersessional Meeting on the North Pacific Survey Programme

The meeting was held at Tokyo University of Marine Science and Technology, Japan from 27–28 September 2009. Meeting participants are listed in Annex A.

1. OPENING REMARKS AND WELCOMING ADDRESS

Kato, as Convenor, welcomed the participants. He noted that the meeting was being held in the context of the recently changed Japanese political situation, with a new government, whose funding priorities were not yet known. Currently, all budgets are frozen. It was important that detailed plans for a programme in the North Pacific were available as soon as possible, for presentation to government at the appropriate time.

On behalf of the Fisheries Agency of the Japanese Government, Uoya welcomed all participants, especially the visitors from overseas. He urged the meeting to give shape, as far as possible, to the proposed North Pacific sighting survey programme. He drew attention to the uncertainty of obtaining the necessary budget in the current situation, although he was hopeful that the same level of support would be available as for the most recent SOWER cruise. He looked forward to a fruitful and successful meeting.

2. APPOINTMENT OF CHAIR AND RAPPORTEURS

Kato was elected Chair. Bannister and Donovan acted as rapporteurs.

3. ADOPTION OF AGENDA

The agreed Agenda is given in Annex B.

4. ORGANISATION OF THE MEETING

The meeting **agreed** that a small technical sub-group under Donovan should undertake the in-depth consideration of the details of the priority items discussed at the SC/61 meeting (IWC, 2010b; 2010c). The report of that sub-group was accepted by the full meeting and is incorporated into this report under Items 8, 10 and 11.

5. REVIEW OF AVAILABLE DOCUMENTS

A list of documents available appears as Annex C.

6. REVIEW OF PREVIOUS DISCUSSIONS

The meeting reviewed discussions from the SC/61 meeting, held in Madeira in 2009 (IWC, 2010a, pp.48–49). There, a proposal for a mid- to long-term research programme involving sighting surveys to provide information for stock management in the North Pacific, sponsored by the Japanese Government, had been presented. The first research cruise was planned for July-August 2010, with planning for the cruise to be undertaken in conjunction with the 2009/10 SOWER planning meeting, i.e at this meeting.

The Committee had welcomed the initiative and strongly encouraged it in the context of international collaboration under IWC auspices. Attention was drawn to the similarity in the design process to that of the ACCOBAMS Mediterranean sighting surveys (Cañadas *et al.*, 2006; 2008) and the Southern Ocean Research Partnership (SORP, 2009). A number of points to be considered in planning the programme had been identified (IWC, 2010a, pp.48–49).

7. TERMS OF REFERENCE

The meeting noted the four terms of reference agreed at the SC/61 meeting, and the documentation available at this meeting. The terms of reference were:

(1) review the Committee's issues in the North Pacific and circulate a paper before the next (2010) Annual Meeting;
(2) review the past and ongoing survey activities and available data in range states from completed *pro formas*;
(3) consider possible line transect survey plans and additional data collection (e.g. photo-identification and biopsy) for the 2010 season; and
(4) prepare a proposal for an intersessional workshop (between SC/62 and SC/63) on future surveys beyond 2010.

These four terms of reference were discussed under Items 8–11 below.

8. REVIEW DOCUMENT OF THE COMMITTEE'S IDENTIFIED ISSUES FOR LARGE WHALES IN THE NORTH PACIFIC

The meeting was pleased to receive a first draft of some aspects of the document required for the next Annual Meeting by Matsuoka and Pastene. This had focused on sei, Bryde's and common minke whales (because these species have been under consideration by the Committee either via the RMP *Implementation* process and/or possible in-depth assessments) and the authors had noted that the final document must also include the other large whale species. It was **agreed** that the work on the document would be continued intersessionally by a group comprising of Matsuoka, Pastene, Kitakado, Donovan and Brownell; the final version will be made available in advance of IWC/62. After review by the Scientific Committee it will form a valuable background document for the proposed intersessional workshop (see Item 13).

9. REVIEW OF THE PAST AND ONGOING SURVEY ACTIVITIES AND AVAILABLE DATA

At IWC/61, Donovan had provided the *pro forma* developed to summarise the available information when planning for a similar programme for the Mediterranean and Black Seas. This had been used by Japanese and US scientists as the basis for a summary of their data. The meeting thanked them for their work and, after reviewing their submissions (NP/09/WP2) agreed to a modified final *pro forma*. In addition Pastene and Donovan agreed to develop an equivalent *pro forma* for information and data relevant to stock structure issues.

It was agreed that the revised *pro formas* should be completed in time for the proposed intersessional workshop and should include all major research programmes (governmental and other) dealing with large whales to the extent possible. Donovan agreed to circulate the revised *pro forma* to appropriate scientists in those range states that were not present at this meeting. The *pro forma* will also be made available on the IWC website. The completed forms will provide essential background information for the proposed intersessional workshop to develop a medium/long-term research programme (see Item 13).

10. INITIAL CONSIDERATION OF MEDIUM/ LONG-TERM OBJECTIVES

The meeting **agreed** that it was useful to have a brief consideration of possible medium- to long-term objectives for an international collaborative programme under the IWC for the North Pacific. In doing so it considered the report of the workshop to look at the 'future of SOWER' (NP/09/WP7; IWC, 2006). It **agreed** that the long-term objective developed there and subsequently adopted by the Committee provided a useful starting point. It thus **suggests** to the Committee the following draft broad objective within which sub-objectives and priorities will need to be developed (e.g. at the proposed intersessional workshop discussed under Item 13):

> The programme will provide information to allow determination of the status of populations (and thus stock structure is inherently important) of large whales that are found in North Pacific waters and provide the necessary scientific background for appropriate conservation and management actions. The programme will primarily contribute information on abundance and trends in abundance of populations of large whales and try to identify the causes of any trends should these occur. The programme will learn from both the successes and weaknesses of past national and international programmes and cruises, including the IDCR/SOWER programme.

11. PRIORITY AND CRUISE PLAN FOR 2010

11.1 Framework for the cruise

For the following reasons the meeting **agreed** that the cruise could be considered to be a joint IWC/Japan collaborative venture, although almost entirely funded by Japan:

(1) the positive discussions at IWC/61;
(2) at least one international researcher will be taking part (expected to be from the USA with US funding by the US Government);
(3) the contribution to the planning made by the international scientists present at this meeting (see below) was provided in the same way as for SOWER cruises;
(4) all guidelines for surveys under the RMP will be followed; and
(5) data will be freely available and biopsy samples will be split in the same manner as for the SOWER cruises.

11.2 Priorities

The meeting reviewed the information provided in NP/09/WP2 and NP/09/WP4 as well as drawing on the experience of the participants. It was **agreed** that the area between 170°E and 170°W was important for two main reasons:

(1) it has been poorly covered by previous surveys and not at all in recent decades thus representing an important information gap for several large whale species;
(2) for at least some species it spans proposed stock boundaries.

Thus the meeting **agreed** that a research cruise in this area in the summer of 2010, focusing on the collection of line transect data to estimate abundance[1] and biopsy/photo-identification data, would make a valuable contribution to the work of the Scientific Committee on the conservation and management of populations of large whales in the North Pacific in a number of ways, including:

(1) providing information for the proposed future in-depth assessment of sei whales in terms of both abundance and stock structure;
(2) providing information relevant to *Implementation Reviews* of whales in terms of both abundance and stock structure;
(3) providing baseline information on distribution and abundance for a poorly known area for several large whale species/populations, including those that were known to have been depleted in the past but whose status is unclear;
(4) providing biopsy samples and photo-identification photos to contribute to discussions of stock structure for several large whale species/populations, including those that were known to have been depleted in the past but whose status is unclear; and
(5) providing essential information for the intersessional workshop to plan for a medium/long-term international programme in the North Pacific (see Item 13).

11.3 Survey area and itinerary

A total cruise of about 60 days (i.e. including transit time) represents the maximum operation period of the vessel without refuelling/resupplying. Given this, the meeting **agreed** that in order to adequately cover the longitudinal range 170°E to 170°W, it would be necessary to restrict the latitudinal range. Based on past JSV data and catch data, it was **agreed** that a southern boundary at 40°N and a northern boundary at the Aleutian islands chain would incorporate the expected latitudinal range of sei whales at that time of the year and allow sufficient coverage.

The cruise will take place in July and August and will involve about 15 days transit to and from the research area and thus some 45 days of research. Based on experience elsewhere in the North Pacific, allowing for poor conditions and time for photo-identification and biopsy sampling work should enable an average of about 67 n.miles per day to be covered in primary searching effort. A proposed cruise track is given as Fig. 1.

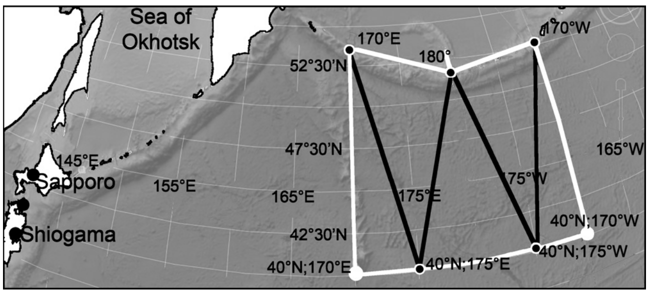

Fig. 1. Map showing research area and proposed cruise track. This will require a total of 60 days including some 15 days transit.

11.4 Research vessel

The actual vessel to be used has not yet been determined but it may be a vessel that has been used in the SOWER programme; it will certainly have suitable characteristics to

[1]The most appropriate way to try to estimate the abundance of sperm whales is using a towed acoustic array. Matsuoka, Donovan and Brownell will investigate the logistics/practicalities of this for 2010.

be able to undertake the plans outlined in this report and it will have space for four researchers. Searching will occur at the most comfortable cruising speed normally between 10.5 and 11.5 knots.

11.5 Details of the cruise

11.5.1 Survey modes and length of research days

Whilst recognising that the blows of common minke whales are less visible in the North Pacific, the meeting **agreed** that the vessel should alternate BT Option-II mode and SS-II mode (as in SOWER, no more than 100 n.miles shall be surveyed continuously in BT mode).

For survey in BT Option-II the duties of the TOP and IOP observers will be essentially the same as for normal IO mode. Therefore, with respect to the amount of time for continuous survey in this mode, normal IO mode guidelines will apply.

Research hours during the cruise will be the same as on recent SOWER cruises. As in the SOWER programme, for biopsy sampling/photo-identification work on priority species (North Pacific right, blue, sei, humpback[2], common minke, fin) 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 should again involve mutual agreement between the Captain and Cruise Leader and an allocation of equivalent time-off the following morning or evening.

The research day in transits will begin 30 minutes after sunrise and end 30 minutes before sunset, with a maximum of a 12-hour research day. Time-zone changes will be in 30 minute intervals, coming into effect at midnight.

11.5.2 Number of crew on effort

Two crewmembers will be in the barrel whenever full searching effort is conducted.

One crewmember will be at the helm on the Upper Bridge, regardless of the research mode. Also present on the Upper Bridge, whenever the sighting survey is conducted, will normally be the captain and chief engineer (or an alternate).

There will be four researchers on the vessel. During survey, the number of researchers searching from the Upper Bridge should be standardised at three.

During the BT option-II mode, there should be two observers in the IOP, one crew observer and one researcher.

11.5.3 Acceptable conditions

The usual guidelines for acceptable conditions should apply, i.e. visibility (to see a minke whale) is greater than 1.5n. miles and wind speed is <25 knots; the sea state should be <Beaufort 6.

11.5.4 Estimated angle and distance training and experiment

The meeting **agreed** that it was valuable to conduct the 'traditional' estimated distance and angle training and experiment undertaken during SOWER cruises. The experiment is designed to calibrate and identify any biases in individual observers' estimation of angle and distance. The experiment should be conducted during weather and sea conditions representative of the conditions encountered during the survey.

The detailed protocol can be found in the Guide for Researchers[3].

[2]Brownell will liaise with the organisers of the SPLASH programme to ascertain whether priority should be given to humpback whales.

[3]Available online at http://www.iwcoffice.org.

11.5.5 Data format

The survey will be conducted using the same data forms as on the SOWER cruise. Donovan and Matsuoka will ensure that standardised species codes are developed for all species that may be found in the area, basing their work on the existing codes for SOWER cruises.

11.5.6 Biopsy sampling/photo-id/videotaping studies

As appropriate and decided by the Cruise Leader, research time will be given for biopsy sampling and/or photo-identification of North Pacific right, blue, sei, humpback[4], common minke and fin whales (Bryde's whales are unlikely to be seen north of 40°N). As noted above, the estimated daily number of miles to be steamed in searching mode has a built in allowance for such work.

Videotaping of blue whales will occur in accordance with the protocol given in the Guide for Researchers, which also provides further information on biopsy sampling and photo-identification protocols.

Photographs will become the sole property of the IWC and are available under the standard IWC Guidelines.

11.5.7 Acoustic studies

This will depend on whether it is practical to use a towed array for sperm whales and whether it is possible to obtain suitable sonobuoys for blue whales.

11.5.8 Oceanographic studies

No specific oceanographic studies are planned for 2010.

11.5.9 Use of SCANS equipment

The meeting **agreed** that as last year, 'SCANS' equipment should be used (logistics permitting) to assist in measuring angles and distances and investigating search patterns.

11.6 International researchers

As noted above, Brownell **agreed** to identify an appropriate US scientist to participate in the 2010 survey at no cost.

11.7 Identification of home port organiser

It will be the responsibility of the Japanese scientists to organise matters in the home port.

11.8 Necessary permits

The proposed cruise track includes waters under US jurisdiction. The meeting **agreed** that every effort should be made to obtain permission for the vessel to operate fully in US waters, including photo-identification and biopsy sampling. Obtaining a permit will be the responsibility of Japan; Brownell **agreed** to assist in the process as far as possible. It was also noted that should biopsy samples be obtained within US waters, a special CITES permit would need to be obtained; samples obtained outside US waters would need an 'introduction from the sea' CITES permit. CITES permits will also be required to ship the IWC half of the biopsy samples to the SWFSC in La Jolla, as is the case for the SOWER samples.

11.9 Data holders and transportation of equipment

The meeting **agreed** that the rules for data availability, shipping and storage should be as for the present SOWER cruise. It also noted that existing IWC equipment used in the 2009/10 SOWER cruise could be used on the North Pacific

[4]Brownell will liaise with the organisers of the SPLASH programme to ascertain whether priority should be given to humpback whales.

cruise if required. Copies of data, photographs etc. should be sent to the IWC Secretariat upon completion of the cruise.

11.10 Meetings

Arrangements for the holding of pre- and post cruise meetings with crew and researchers will be the responsibility of the Japanese scientists.

11.11 Reports

The cruise will follow the requirements for reports and documentation developed for cruises that could provide information for use under the RMP (IWC, 2005). This will be the responsibility of the Japanese scientists.

12. REVIEW OF THE BUDGET

The plans given under Item 11 assume the same level of Japanese funding being available as for the 2009/2010 SOWER cruise. There are no direct funds available for 2010 within the present IWC budget; the IWC contribution is largely reflected in the contribution of Donovan, Bannister and Brownell to the planning process and loans of equipment where relevant. Brownell will investigate funding for the US researcher. Funding is thus primarily an internal matter for the Government of Japan.

13. PROPOSAL FOR AN INTERSESSIONAL WORKSHOP ON A MID- TO LONG-TERM PROGRAMME

The meeting **agreed** on the importance of holding a well-organised intersessional workshop to plan for a mid- to long-term programme within the North Pacific. It agreed that a proposal for such a workshop should be developed for presentation at IWC/62. The agenda and process developed for the ACCOBAMS Workshop (see Item 6) for the Mediterranean would provide a useful starting point. A working group was established to work intersessionally on a draft outline proposal for submission to IWC/62, with the following membership: Donovan (Convenor), An, Brownell, Kitakado, Matsuoka, Miyashita, Pastene.

14. OTHER MATTERS

Ohsumi asked that his view be recorded that while he applauds the new North Pacific initiative, he believes very strongly that given the importance to the IWC of the Southern Ocean, continued monitoring of whale stocks there is vital. Other members agreed with that view, pointing out that while the SORP initiative has the potential to contribute to that objective, the extent to which that will be possible under that partnership has yet to be demonstrated. There is a continuing need to obtain information on large whale abundance and distribution. Brownell noted that the US Government had been asked to provide $US1million for work in the Southern Ocean from October 2011.

15. CONCLUDING REMARKS

Donovan thanked all those who had taken part in the meeting, in particular the Chair, Kato, and the interpreters, who had performed their difficult task with their customary efficiency and cheerfulness. Kato thanked everyone for their cooperation and hard work.

The meeting concluded at approximately 17:45 on 28 September 2009.

REFERENCES

Cañadas, A., Fortuna, C., Birkun, A. and Donovan, G. 2006. Plans for surveying the Mediterranean and Black Seas (the ACCOBAMS region). Paper SC/58/O12 presented to the IWC Scientific Committee, May 2006, St. Kitts and Nevis, West Indies (unpublished). 11pp. [Paper available from the Office of this Journal].

Cañadas, A., Fortuna, C.M., Birkun, A., Donovan, G. and Hammond, P. 2008. Progress report on the plans for surveying the Mediterranean and Black Seas (the ACCOBAMS region). Paper SC/60/O16 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 3pp. [Paper available from the Office of this Journal].

International Whaling Commission. 2005. Report of the Scientific Committee. Annex D. Report of the sub-committee on the Revised Management Procedure. Appendix 3. Requirements and guidelines for conducting surveys and analysing data within the revised management scheme. *J. Cetacean Res. Manage. (Suppl.)*7: 92–101.

International Whaling Commission. 2006. Report of the IWC Workshop on Future SOWER Cruises, Tokyo, 1–4 October 2004. *J. Cetacean Res. Manage. (Suppl.)* 8: 303–12.

International Whaling Commission. 2010a. Report of the Scientific Committee. *J. Cetacean Res. Manage (Suppl.)* 11(2):1–98.

International Whaling Commission. 2010b. Report of the Scientific Committee. Annex G. Report of the Sub-Committee on In-Depth Assessments. *J. Cetacean Res. Manage (Suppl.)* 11(2):180–97.

International Whaling Commission. 2010c. Report of the Scientific Committee. Annex G. Report of the Sub-Committee on In-Depth Assessments. Appendix 2. Report of the small group planning the 2009/10 IWC/SOWER cruise. *J. Cetacean Res. Manage (Suppl.)* 11(2):192–94.

Southern Ocean Research Partnership. 2009. Report of the planning workshop of the Southern Ocean Research Partnership (SORP), Sydney, Australia, 23–26 March 2009. Paper SC/61/O16 presented to the IWC Scientific Committee, June 2009, Madeira, Portugal (unpublished). 63pp. [Paper available from the Office of this Journal].

Annex A

List of Participants

Republic of Korea
Yong Rock An

Western Australian Museum, Australia
John Bannister

Southwest Fisheries Science Center, USA
Robert Brownell

IWC Secretariat
Greg Donovan

Tokyo University of Marine Science and Technology, Japan
Hidehiro Kato
Toshihide Kitakado

Fisheries Agency of Japan, MAFF
Toshinori Uoya

National Research Institute of Far Seas Fisheries, Japan
Tomio Miyashita

Kyodo Senpaku Co., Ltd., Japan
Hirohisa Shigemune

The Institute of Cetacean Research, Japan
Yoshihiro Fujise
Seiji Ohsumi
Shigetoshi Nishiwaki
Luis Pastene
Koji Matsuoka
Hiroto Murase
Saeko Kumagai

Interpreters
Yoko Yamakage
Hiroko Yasokawa

Annex B

Agenda

1. Opening remarks and welcoming address
2. Appointment of chair and rapporteurs
3. Adoption of Agenda
4. Organisation of the meeting
5. Review of available documents
6. Review of discussions at IWC/61
7. Terms of reference at IWC/61
8. Review document of the committee's identified issues for large whales in the North Pacific
9. Review of the past and ongoing survey activities and available data
10. Initial consideration of medium/long-term objectives
11. Priority and cruise plan for 2010
    - 11.1 Framework for the cruise
    - 11.2 Priorities
    - 11.3 Survey area and itinerary
    - 11.4 Research vessel
    - 11.5 Details of the cruise
        - 11.5.1 Survey modes and length of research days
        - 11.5.2 Number of crew on effort
        - 11.5.3 Acceptable conditions
        - 11.5.4 Estimated angle and distance training and experiment
        - 11.5.5 Data format
        - 11.5.6 Biopsy sampling/photo-id/videotaping studies
        - 11.5.7 Acoustic studies
        - 11.5.8 Oceanographic studies
        - 11.5.9 Use of SCANS equipment
    - 11.6 International researchers
    - 11.7 Identification of home port organiser
    - 11.8 Necessary permits
    - 11.9 Data holders and transportation of equipment
    - 11.10 Meetings
    - 11.11 Reports
12. Review of the budget
13. Proposal for an intersessional Workshop on a mid- to long-term programme
14. Other matters
15. Concluding remarks

Annex C

List of Documents

NP/09/WP

1. Extract from SC/61 Scientific Committee report.
2. Review of the past and ongoing survey activities and available data (NOAA, NRIFSF, ICR).
3. Encounter rate of large whales in North Pacific (Miyashita).
4. Brief review of the Scientific Committee's issue in the North Pacific (Matsuoka and Pastene)
5. An idea of middle-long term research plan for the North Pacific cetacean sighting survey under international cooperations.
6. Report of the workshop on obtaining baseline cetacean abundance information for the ACCOBAMS area (Donovan *et al.*).
7. Report of the IWC Workshop on Future SOWER cruises, 1–4 October 2004, Tokyo (*J. Cetacean Res. Manage. (Suppl.)* 8: 303–312)
8. Review of the sighting survey for common minke whales conducted in Korean waters (subarea 5 and 6) from 2000 to 2009.
9. Proposed area and plan for 2010 survey (Matsuoka).

Report of the IWC POLLUTION 2000+ Phase II Workshop

Report of the IWC POLLUTION 2000+ Phase II Workshop

1. INTRODUCTORY ITEMS

The Workshop was held at the Marine Mammal Center, Sausalito, CA, USA from 22–24 February 2010.

1.1 Welcoming remarks
Jeff Boehm, Executive Director of the Marine Mammal Center, thanked the participants for coming and offered the services of the Center for the Workshop. Ylitalo (Convenor) welcomed the participants.

1.2 Introduction of participants
The Workshop participants introduced themselves and their areas of expertise with regard to pollutants and cetaceans. A list of Workshop participants and Steering Committee members are shown in Annex A.

1.3 Election of Chair
Ylitalo was elected Chair.

1.4 Appointment of rapporteur
Bolton was appointed rapporteur. All participants assisted in the preparation of the report.

1.5 Adoption of Agenda
The adopted Agenda is given in Annex B.

1.6 Available documents
Fossi *et al.* (2008), Fossi *et al.* (in press), Godard *et al.* (2004), Hall *et al.* (2006), Hall *et al.* (2005), Marsili *et al.* (2008), Muir and Howard (2006), Pierce *et al.* (2008), Spinsanti *et al.* (2006). Documents distributed during the meeting: IWC (2008), Pauly *et al.* (1998), Dorneles *et al.* (2007), Dorneles *et al.* (2008a), Dorneles *et al.* (2008b), Lailson-Brito *et al.* (2010), Dorneles *et al.* (2010).

2. BACKGROUND AND GOALS OF POLLUTION 2000+ PROGRAMME

2.1 POLLUTION 2000 Phase I
Rowles gave an overview presentation that summarised the origins, goals and findings of previous IWC-POLLUTION 2000+ workshops, namely the 1995 Bergen Workshop and the 2007 Barcelona Workshop. The IWC-POLLUTION 2000+ Programme was initiated to investigate pollutant cause-effect relationships in cetaceans. It arose from a major Workshop on chemical pollution and cetaceans held in Bergen in 1995 as part of the IWC's instruction to the Scientific Committee that it should: 'give priority to research on the effects of environmental changes on cetaceans in order to provide the best scientific advice for the Commission to determine appropriate response strategies to these new challenges'. Based on the findings of the Bergen Workshop there was the recommendation to move forward with planning a research strategy for evaluating impacts of pollutants on cetaceans. That plan was developed and finalised through several workshops: Texel 1997 developed a proposal for the follow up research programme, Barcelona 1999 further developed the programme and Texel 2000 finalised the specific protocols and biomarkers for the study. Interim progress reports as well as working documents on specific studies within the project have been regularly submitted to the IWC Scientific Committee. A fundamental concept behind the Phase I study was to attempt to examine a pollution 'gradient' for populations of the same species (i.e. a 'clean', moderately exposed and heavily exposed population). In an ideal world the objective would be to determine a predictive model linking tissue pollutant levels in individuals with effects at the population level. Even though this was clearly not a realistic short-term goal, it was proposed to be a potential long-term goal. Given the variety of factors influencing population dynamics, it was noted that eventually some level of probability of certain effects occurring at the population level could be assigned, given certain levels of specific pollutants in individuals. Polychlorinated biphenyls (PCBs) were identified as the chemicals of interest for this programme due to their widespread global distribution and the extensive information on the levels and effects of these compounds for a variety of mammals. One of the first important tasks (and indeed achievements) of the programme was to develop an integrated protocol for sampling, storage and shipping procedures for cetacean samples to ensure that tissue samples to be collected were adequate and would reach the designated laboratories in suitable condition for the analyses. This was developed at the Texel meeting in November 2000. It included protocols for collecting samples for pollutant analysis, indicators and biological variables and is published in the *Journal of Cetacean Research and Management* (Reijnders *et al.*, 2007).

In 2000, Phase 1 of the POLLUTION 2000+ was begun with two short-term objectives:

(1) to select and examine a number of biomarkers of exposure to and/or effects of PCBs and try to determine whether a predictive and quantifiable relationship with PCB levels in certain tissues exists with a focus on bottlenose dolphins; and
(2) to validate/calibrate sampling and analytical techniques utilising harbor porpoises to address such questions for cetaceans, specifically
    (a) determination of changes in concentrations of variables with post-mortem times;
    (b) examination of relationships between concentrations of variables obtained by biopsy sampling with those of concentrations in other tissues that can only be obtained from fresh carcasses.

The examination of these two objectives was considered to be Phase I of what necessarily would have to be a long-term programme. The results from Phase I would be used to determine what might be achieved under Phase II. The results of the two Phase I subprojects were as follows.

Bottlenose dolphin sub-project
(a) Blubber retinol levels were negatively correlated with tissue lipid content and PCB concentrations, however, it could not be ascertained which of the variables were responsible for the decrease in retinol.
(b) There was a positive correlation between dermal CYP1A1 expression and both total PCBs and toxic equivalent quotient concentrations. These concentrations appeared to be stronger determinants of dermal CYP1A1 expression than sex, reproductive status or age.
(c) While immune assays (*in vitro* leukocyte subpopulations, mitogen induced proliferation assays and interleukin 6

levels) were dependent on body length, they showed no correlation with PCB concentrations.
(d) PCB concentrations were not correlated to reproductive hormone (oestradiol and progesterone) levels.
(e) An approach using an integrated set of biomarkers to examine the relationship with PCBs failed.

In all cases: sample size (*n*) was insufficient to allow conclusive results, because potential cause-effect relationships, if existing, were weak.

In addition, an individual-based model was developed to set a framework for examining population level effects. That approach demonstrated how a potential link beween PCB levels and first calf survival could affect annual population growth rate, using the Sarasota bottlenose dolphin population data as an example. However, the framework also showed how sensitive this framework would be to the shape and uncertainty around the dose-response relationship used in the model.

Harbour porpoise subproject
In this post-mortem calibration project it was found that with a post-mortem period of up to 48 hours, and animals kept under 'natural' conditions there was no effect on:

(a) total PCB concentrations;
(b) total DDT concentrations;
(c) retinol levels;
(d) luciferase measures (indicator for dioxin-like exposure);
(e) histology of formalin-fixed, paraffin-embedded lymphoid organs; and
(f) levels of thyroid hormones (T3, T4 and fT4) in serum.

The histology results of snap-frozen pre-scapular lymph nodes were inconclusive as a result of autolytic changes. Tests for CYP1A1 expression using immunohistochemistry, enzymatic assays and western blots were also inconclusive.

2.2 Phase II – goals and objectives
A Phase II Planning Workshop was held in Barcelona in 2007. The Workshop recommended to the Scientific Committee that Phase II of POLLUTION 2000+ should focus initially on the following:

(1) developing a modelling framework;
(2) evaluating model populations that may be more promising for studies for Phase II. It is proposed that initial evaluation focuses on:
    (a) bottlenose dolphins, due to the large body of ecotoxicological information obtained during Phase I;
    (b) humpback whales, because of the significantly large number of biopsy samples from populations whose demography is well known; and
(3) developing a protocol for validating in model species the use of biopsy samples for the specific analyses needed in Phase II.

In subsequent meetings the Scientific Committee recommended that a new Steering Committee be formed and move forward to host an intersessional workshop with the following goals.

(1) Develop integrated modeling approaches and a risk assessment framework for evaluating the cause and effect relationships between pollutant exposure and cetacean populations:
    (a) further refine the conceptual model developed at the Workshop in Barcelona;
    (b) develop the draft models and risk assessment framework;
    (c) review and assess modelling approaches to meet the framework;
    (d) evaluate existing models that could be tested and develop a plan for testing these models with available datasets;
    (e) assess the model characteristics needed and a plan for developing new models if needed;
(2) Develop a prioritisation hazard identification framework to evaluate the broad number of environmental pollutants; and
(3) Identify data needs and available datasets or case studies that would be appropriate for the models that are exposure driven, source driven or effects driven.

The Sausalito Workshop discussed some of the species that were given for consideration at the Barcelona Workshop. Although a number of tissue samples from bowhead whales are available from subsistence activities, at this time it appears that there is an insufficient contaminant gradient among the samples to develop dose-response relationships. Limited chemical contaminant data are available for Southern right whales for dose-response assessments. For minke whales, while there is a gradient in contaminant exposure, it was noted that population dynamics data are lacking in order to elucidate model parameters. Humpback whales afforded the greatest opportunity to represent a mysticete species as many biopsy samples are available for humpback populations that are exposed to different pollutant levels, and for a few populations there are good demographic data (e.g. Gulf of Maine) and photo-identification catalogs so that individual whales could be biopsy sampled over time. Sufficient contaminant and biological data are available for bottlenose dolphins including the Sarasota Bay population, other well-studied populations in US coastal waters, as well as animals in the Navy dolphin program in San Diego, California. Harbor porpoise were also considered as they are a coastal species with site fidelity; thus they could be used to evaluate the population effects of certain classes of chemical contaminants near 'hot spots' or point sources. Similarly, other small coastal cetacean species, such as South American small cetaceans (*Sotalia guianensis* and *Pontoporia blainvillei*), could be used for these types of studies. Some populations are widely distributed off the coast of Brazil with a general chemical contaminant gradient increasing from North to South, with the highest concentrations being found in the southeast region (Rio de Janeiro and São Paulo states). In this latter region, there are some photo-identification catalog data, but demographic and exposure data tend to be somewhat spotty. However, these cetaceans have a high degree of site fidelity, and many of the urban embayments in the southeast region have unique contaminant signatures, which again could be used to elucidate effects from different chemicals or mixtures. In species for which there are both nearshore and offshore populations, it could be useful to compare these populations, as nearshore animals would likely have higher levels of many contaminants whereas offshore/oceanic populations may have higher levels of mercury and cadmium due potentially to enrichment of these compounds in upwelling regions of marine waters and other environmental and physiological factors (Dorneles *et al.*, 2007). Similarly, other cetacean species, such as Mediterranean striped dolphin (*Stenella coeruleoalba*) and bottlenose dolphin (*Tursiops truncatus*), could be used for these types of studies. Some populations are widely distributed off the coast of Italy and Spain with a chemical contaminant gradient increasing from South to North in the Mediterranean Sea region. High levels of POPs and responses of biomarkers were detected in specimens of striped dolphin of the Pelagos Sanctuary (Ligurian Sea) in comparison with other Mediterranean areas (Fossi *et al.*, 2008; Marsili *et al.*, 2008; Spinsanti *et al.*, 2006).

3. RISK ASSESSMENT FRAMEWORK

3.1 Overview of Risk Assessment Paradigm

Schwacke and Hall presented information on how a risk assessment process for cetaceans could be carried out using a tiered approach. At the end of each phase or tier, risk characterisation results will be evaluated to determine whether there is sufficient concern and/or uncertainty to justify continuation of additional assessment tiers. If the results from the current analysis indicate that estimated exposures do not likely exceed a threshold for effects, then the process is considered complete. Alternatively, if the results indicate a significant risk with an appropriate level of confidence to warrant management action then the risk assessment is considered complete and will then be used to inform a risk management plan. If a potential risk exists but further research or data collections are required to achieve an appropriate level of confidence to be practical for management planning, then the risk assessment process should be continued, advancing to the next tier. The results from initial tiers will inform plans for subsequent tiers, identifying research priorities and data collection needs. A generalised framework for risk assessment tiers is elaborated below (Fig. 1). It should be emphasised that the identified tiers, information sources and research approaches are only general suggestions and may not be feasible or appropriate for some cetacean species and/or contaminants of concern. For cetaceans the largest data gap is in the effects category.

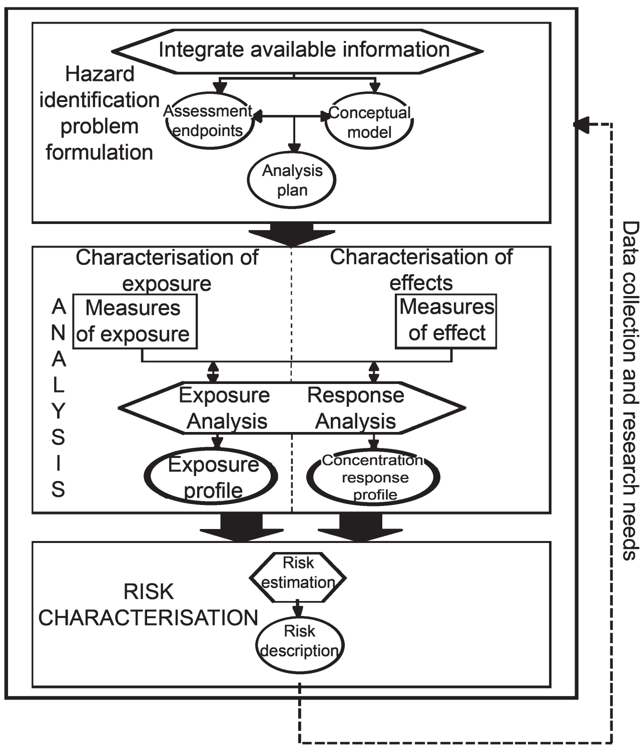

Fig. 1. Proposed risk assessment framework – adapted from US Environmental Protection Agency Guidelines for Ecological Risk Assessment (1998). Risk assessment would be an iterative process following a tiered approach.

3.2 Tiered risk assessment approaches

Tier 1

HAZARD IDENTIFICATION/PROBLEM FORMULATION

The first tier of the risk assessment should be a timely analysis utilising existing environmental characterisations and/or information on status and trends of marine ecosystems (e.g. Mussel Watch) to identify priority hazards. In many cases, evidence of die-offs (cetaceans or other wildlife) may inform the hazard identification process or even be the impetus for a risk assessment. From these data, conceptual models of potential exposure and/or effects pathways can be constructed to aid in the definition of specific assessment endpoints and problem formulation.

EXPOSURE CHARACTERISATION

Existing measurements (or analysis of archived samples) for contaminant concentrations from biomonitoring efforts could support Tier 1 exposure characterisation. Alternatively, concentrations in prey species in combination with models such as pharmacokinetic or bioenergetic models, or even simple bioaccumulation factors could be used to estimate cetacean tissue concentrations. Most of the available contaminant data will come from marine mammal tissue levels as levels for prey are scarce. The use of contemporary environmentally relevant contaminant data is best as organic contaminant levels change with time.

EFFECTS CHARACTERISATION

Effects characterisations for Tier 1 could be based on laboratory or epidemiological studies using surrogate species. The aim would be to identify a threshold level for minimal effects from the existing literature.

RISK CHARACTERISATION

To characterise risks as part of Tier 1, simple threshold models could be employed, potentially as part of a probabilistic analysis. If probabilistic analyses are not feasible, uncertainty factors could be applied for conservative risk characterisation.

Tier 2

HAZARD IDENTIFICATION/PROBLEM FORMULATION

For Tier 2 and subsequent tiers, hazard identification and problem formulation should be based on risk characterisation from the prior tier. In addition, sampling and analysis for nonspecific biomarkers may be pursued to aid in identification of hazards from a general class of compounds (e.g. CYP1A expression as a marker for Ah-receptor agonists).

EXPOSURE CHARACTERISATION

In Tier 2, minimally invasive sampling techniques such as remote dart biopsy may be employed to gather information (*i.e.*, exposure distributions) on a specific population's exposures. Dart biopsy samples of blubber and skin can be analysed for a variety of persistent organochlorine contaminants (blubber) as well as mercury or other metals (skin). In addition to the remote tissue sampling, monitoring surveys such as photo-identification studies can be initiated or intensified to better understand the population's distribution, movements and demographics to aid in the characterisation of exposures.

EFFECTS CHARACTERISATION

Tier 2 effects characterisation may also be based on existing data from laboratory studies but additional complexity in analyses may be pursued. For example, rather than estimating single point threshold for effects, raw data from published studies may be integrated to define a continuous concentration-response function. In addition, laboratory studies such as in-vitro studies (fibroblast cell colture, skin slices) to elucidate toxic mechanisms or species sensitivities could also contribute and help to refine effects characterisation. Experimental in-vivo studies using surrogate species could also be pursued.

RISK CHARACTERISATION

Concentration-response functions derived from the effects characterisation can be integrated with exposure distributions for probabilistic analyses and/or incorporated into simple population models. A key component of this preliminary modeling exercise should be sensitivity and uncertainty analyses which will help to identify data needs.

Tier 3

HAZARD IDENTIFICATION/PROBLEM FORMULATION

See Tier 2.

EXPOSURE CHARACTERISATION

Exposure characterisation may be refined by conducting additional sampling, possibly to include capture-release techniques (for small cetaceans) or sampling of subsistence hunt animals. The purpose of the expanded sampling would be to elucidate important covariates for exposure (e.g. age, sex and reproductive state) in order to more accurately describe the population's exposures. Additional chemical analyses such as analysis for PCB hydroxylated metabolites could also help to refine exposure characterisation.

EFFECTS CHARACTERISATION

For the final tiers of the risk assessment, epidemiological studies could be designed based on findings of previous tiers and conducted to refine effects characterisation. Many types of studies, including correlational, case-control, or longitudinal studies may be feasible depending on the species and population under study. Correlational studies (comparing effects among populations) would be particularly useful if baseline populations with lower exposures could be identified.

In some cases, it may also be appropriate to examine effect biomarkers such as retinol or functional immune indicators that could help to refine derived concentration-response functions (if the marker provides direct measure of reproductions or survival) or even expand the effects characterisation to include multi-stage models. Multi-stage models would be appropriate for biomarkers of indirect effects – e.g. retinol → immune function → susceptibility to infectious agents → survival.

RISK CHARACTERISATION

More complex population models, such as Individual Based Models (IBM), Monte Carlo simulations, spatially-explicit models or other stochastic population models which would allow for the inclusion of exposure distributions and concentration-response functions along with associated uncertainties, would be appropriate for Tier 3 assessment.

4. PRIORITISATION SCHEMA FOR CHEMICAL HAZARDS FOR CETACEANS

4.1 Overview of contaminants of emerging concern in marine ecosystems

Information on contaminants of emerging concern in marine ecosystems was presented by Collier. Many new chemicals are appearing in marine and coastal waters as a result of human activities, and some are being found in a diverse array of biota as well. Collectively, these are now referred to as chemicals of emerging concern (CECs). Examples include halogenated flame retardants, perfluorinated compounds, current use pesticides, hormones, pharmaceuticals and nanomaterials. NOAA's Status and Trends Program is developing a pilot program in the State of California to assess whether CECs are being found in coastal environments, and the Arctic Monitoring and Assessment Programme is also analysing for many CECs in both biotic (marine mammals) and abiotic (air, water and sediment) matrices. For example, a 2009 NOAA Mussel Watch Program report identified several polybrominated diphenyl ether (PBDE) hotspots in the US, such as Southern California. In addition, international 'mussel watch' programs have been established in the U.K. and other parts of the world (e.g., East Asia). Data obtained from regional, national and international monitoring programs such as NOAA Mussel Watch could help identify CECs that may pose the greatest risk for cetaceans as well as the geographical regions where these compounds occur. However, programs like Mussel Watch that rely on measured tissue concentrations need to be supplemented with other approaches that would capture risks posed by non-accumulative CECs. Very recently, the California State Water Board, together with the David and Lucile Packard Foundation, have empaneled a group of experts to provide an overall assessment of the risks posed by CECs to the coastal ecosystems of California.

The Workshop discussed factors that could affect contaminant exposure in cetaceans. For example, sewage treatment processes can vary from place to place even within 'developed' countries. Certain contaminants may not be eliminated from the sewage waste stream even during secondary treatment. In addition, minimal oxygen zones are known to inhibit metabolism of many compounds including hormones and other endocrine disruptors, which could lengthen the potential time frame for exposure. Comparing contaminant levels in nearshore to offshore cetacean populations may also be useful in determining populations that are at higher risk to exposure effects.

4.2 Summary of exposure and effects in cetaceans

Kucklick presented a summary on pollutant exposure and effects in cetaceans, focusing on findings in bottlenose dolphins. Contaminant exposure in marine mammals is assessed through samples obtained through strandings, dart biopsies, samples collected from health assessments, and through modelling. Of these, dart biopsies have been used extensively for assessing lipophilic pollutant in marine mammal blubber. However, the reliability of this technique has been called into question due to the potential for stratification of pollutants in blubber. A study was conducted examining the stratification of lipophilic contaminants in stranded bottlenose dolphins (J. Kucklick, pers. comm.). Concentrations of lipophilic pollutants were not significantly different among the three layers for the animals studied in agreement with a field study finding no significant differences between surgical versus dart biopsies; however, dart biopsy results appeared to provide more variable concentrations than surgically collected biopsies. Tissue distributions of lipophilic pollutants can vary mainly based on lipid distribution, however there are some differences in overall pollutant profiles among tissues. For instance, blood and blubber levels of total lipophilic pollutants have been shown to be highly correlated, however individual contaminant distributions may vary among tissues based on the physical property of the compound being studied. Proteophilic compounds include hydroxylated PCB metabolites, organomercury, organotin and perfluorinated compounds. These compounds are best measured in blood, however mercury can be determined in skin samples. In the US, lipophilic pollutants, mercury, and perfluorinated contaminants vary with location. For lipophilic pollutants, the highest concentrations are observed in bottlenose dolphins living near large urban centers and near known sources of point-source pollution. Levels of perfluorinated compounds also vary in bottlenose dolphin blood samples based on location as do concentrations of mercury in skin biopsy samples.

Exposure assessment in marine mammals should be mindful of temporal trends of contaminants. For example, many legacy pollutants appear to be declining or are stable in most locations whereas some current use flame retardants are increasing in concentration in marine mammal blubber. There have been a number of effect studies done on marine mammals and these fall into several categories including correlative, in vitro work, and modeling at the individual and population levels. Correlative studies have mainly been done on endocrine and immune endpoints. In vitro work has been focused primarily on immune function. Overall the number of studies on toxicity are fewer than on exposure; however there have been correlative effects observed primarily in immune function. Several promising new approaches are currently under development including cDNA microarrays for bottlenose and striped dolphins as well as new cell lines (fibroblast cell culture) and organotypic cultures for in vitro studies.

4.3 Prioritisation protocol for chemical hazard identification

An objective of the Workshop was to develop a prioritisation hazard identification framework to evaluate the broad number of environmental pollutants of concern to cetaceans. The Workshop agreed upon an international prioritisation survey of subject matter experts in marine mammals and/or toxicology. To develop the survey, the general approach was to establish cetacean, geographical, and contaminant categories; assess existing information on contaminant exposures and biological effects (negative impacts on reproduction and health); determine where information was strong enough to prioritise contaminants; develop international survey format; and identify and query subject matter experts.

4.3.1 Classification methods

To develop a survey, two work groups were formed to establish cetacean life history and contaminant categories (see Items 4.3.1.1 and 4.3.1.2 below). Once the categories were agreed upon by the Workshop, the Workshop assessed existing information on contaminant exposures and biological effects (negative impacts on reproduction and health); determined where information was strong enough to prioritise contaminants and worked towards developing an international survey format. The Workshop then worked towards identifying subject matter experts from various countries to participate in the survey.

4.3.1.1 CETACEANS BY LIFE HISTORY

The cetacean life history work group categorised the cetaceans using the diet composition and trophic level data presented in Pauly *et al*. (1998) (see below).

Cetacean Category 1: Trophic Level 3.2–3.3	
Northern right whale	Pygmy right whale
Southern right whale	Blue whale
Bowhead whale	Gray whale
Cetacean Category 2: Trophic Level 3.4–3.9	
Fin whale	Humpback whale
Common minke whale	Antarctic minke whale
Sei whale	Bryde's whale
Commerson's dolphin	
Cetacean Category 3: Trophic Level 4.0–4.2	
Arnoux's beaked whale	Pacific white-sided dolphin
Baird's beaked whale	Fraser's dolphin
Southern bottlenose whale	Common bottlenose dolphin
Northern bottlenose whale	Striped dolphin
Narwhal	Long-beaked common dolphin
White whale (beluga)	Hector's dolphin
Rough toothed dolphin	Harbor porpoise
Tucuxi	Vaquita
Franciscana dolphin	Burmeister's porpoise
Indo-Pacific hump-backed dolphin	Dall's porpoise
Atlantic hump-backed dolphin	Finless porpoise
Irrawaddy dolphin	Short-beaked common dolphin
White beaked dolphin	
Atlantic white-sided dolphin	
Dusky dolphin	
Peale's dolphin	
Indo-Pacific bottlenose dolphin	
Yangtze dolphin (Baiji) (possibly extinct)	
Ganges dolphin	
Amazon dolphin (Boto)	
Indus dolphin	
Cetacean Category 4: Trophic Level 4.3–4.5	
Other beaked whales	Risso's dolphin
Strap-toothed whale	Spinner dolphin
Sperm whale	Pantropical spotted dolphin
Pygmy sperm whale	Atlantic spotted dolphin
Dwarf sperm whale	Guiana dolphin
Melon-headed whale	Clymene dolphin
Pygmy killer whale	Southern right whale dolphin
Killer whale	Northern right whale dolphin
Long finned pilot whale	Heaviside's dolphin
Short finned pilot whale	Chilean dolphin

4.3.1.2 CHEMICALS BY FATE AND BEHAVIOR

The chemical contaminants work group classified the chemicals based chemical property (e.g., lipophilic, proteophilic) and by bioaccumulation and exposure potential (see below).

Lipophilic chemicals
Legacy organochlorines
PCBs
OC pesticides
Sulfone metabolites of PCBs and DDTs
Chlorinated paraffins
Polybrominated diphenyl ethers (PBDEs)
Polychlorinated dibenzo dioxins/furans
New persistent organic pollutants
- New/replacement brominated flame retardants/flame retardants
- Musks
- Methoxychlor, endosulfan

Proteophilic chemicals
Perfluorinated compounds
Mercury, cadmium, other heavy metals
Organotins
Phenolic metabolites (e.g. hydroxylated PCBs and PBDEs)

Low bioaccumulative/high exposure chemicals
Current use pesticides (CUPs)
- Picloram
- Pyrethroids
- Carbamates
- Diquat

Pharmaceuticals and personal care products (PPCPs)
- Surfactants
- Triclosan
- Phthalates
- Chlorophenols
- Bisphenol A
- Pharmaceuticals that have been measured in prey (e.g. statins, diazepam)

Other chemicals
Polycyclic aromatic hydrocarbons (PAHs) and their metabolites
PBDE 209
Nanomaterials
Non-PAH chemicals associated with discharges from oil and natural gas production

4.3.1.3 GEOGRAPHIC REGIONS

After some discussion, the Workshop agreed to use the 18 geographical regions of the IUCN ecosytem-based regional framework used by the World Commission of Protected Areas – Marine Regions (Kelleher *et al.*, 1995). The regions include the following: Antarctic, Arctic, Mediterranean, Northwest Atlantic, Northeast Atlantic, Baltic, Wider Caribbean, West Africa, South Atlantic, Central Indian Ocean, Arabian Sea, East Africa, East Asian Sea, South Pacific, North East Pacific, North West Pacific, South East Pacific and Australia/New Zealand.

4.4 Chemical hazard survey design and outcomes

Several approaches were discussed with regard to a chemical hazard survey design. The Workshop agreed that the prioritisation survey should be quick and easy to fill out, in order to maximise response rates. It should also be designed so that the maximum amount of information on prioritisation of chemicals of concern, species at risk and identification of potential hot spots can be obtained from a single survey.

Desired outcomes from the needs assessment survey are the following:

(1) prioritisation of chemicals of concern;
(2) prioritisation of species at risk; and
(3) identification of potential hot spots.

It was agreed that each Workshop participant would send the survey to 2–3 subject matter experts, with a cover letter from the Steering Committee. The selection criteria for subject matter experts to query should be some combination of expertise in marine mammals, toxicology or analytical chemistry. The Workshop proposed that the survey would be finalised in spring 2010, and would then be sent to subject matter experts and compiled during 2010. A final report on the prioritisation survey results would be presented at the 2011 IWC Scientific Meeting.

5. IDENTIFICATION OF BIOMARKERS FOR POPULATION MODELLING APPROACHES

The Workshop purposefully selected biomarkers that have been validated in cetaceans and would most likely provide relevant information for the assessment of effects at the population level (see Table 1). It was recognised that there are many additional biomarkers of effects providing very valuable information at the molecular and cellular levels (including drug metabolising enzyme expression, genotoxicity endpoints, oxidative stress, etc.) and that there are promising research efforts currently focused on identifying and validating links between effects at these lower levels of biological organisation and effects at the individual or population levels. The use of toxicopanomics (genomics, transcriptomics, proteomics, metabolomics, etc), *in vitro* (cell culture), and *ex vivo* (organ slice culture) tools are deemed of particular interest in this endeavor.

Table 1

List of biomarkers of effects most likely to provide information for population-level effects in cetaceans.

Hazard identification (validated in cetaceans)
Cytochrome P450 1 enzymes (particularly CYP1As)
PAH-DNA adducts
Metallothioneins

Biomarkers of exposure (validated in cetaceans)
Cytochrome P450 1 enzymes (particularly CYP1As)
PAH-DNA adducts

Biomarkers of effects with potential for population-level assessment
Retinol
Immune assays
Reproductive hormones
Thyroid hormones

Although there is increased variability using dart biopsy samples with respect to contaminants and biomarkers of exposure and effects, these samples can still provide useful information, particularly if all the biopsies for a program are collected the same way, facilitating comparisons between samples in the same data set, even across geographical regions, species, sexes and age classes. Currently, development of *in vivo*, *ex vivo*, and *in vitro* biomarkers is ongoing (see Annex C for selected biomarkers and their descriptions) but information is lacking on how most of these biomarkers can be linked to population-level effects, such as fecundity and survivorship. Biomarkers of stress or resilience, which could reflect on the overall general health and reproduction of cetaceans, would be useful at a population level, but current biomarkers such as cortisol levels are not specific to contaminant exposures. Biomarkers can help pinpoint which populations are most in need of in-depth study of population effects. Some biomarkers, such as hormone levels, may have some direct relevance to fecundity. It was noted that categorisation of biomarkers by known relevance to population level effects would be useful, particularly those associated with reproduction.

Another Workshop discussion point included selecting the appropriate whale populations, as well as tissues needed to help develop and validate biomarkers of effects in cetaceans. Samples collected during subsistence activities could be used to conduct biomarker studies on certain Alaskan beluga whale populations as demographic data, exposure level gradients and temporal trends are available. As noted in Phase I, the Workshop also recognised that harbor porpoise might also be useful for biomarker development and validation, particularly well-studied populations (e.g. United Kingdom). Dolphins in the US Navy Dolphin Program could provide a unique opportunity for study, as the population is a known quantity demographically and samples are collected routinely as part of their health assessment. In addition to full thickness biopsies, sloughed skin, blowhole, blow, urine and fecal samples could also be used for biomarker development. Rosa noted recent data on subsistence-harvested bowhead whales indicate that the baleen may provide a record of fecundity (calving intervals) based on its trace element content. The Workshop noted that surrogate species could also be used to examine links between biomarkers and survival because cetaceans cannot be studied directly. In some surrogate species, LC50 values, in addition to other effect threshold values, have been established for certain contaminants.

Development of new technologies for measuring biomarkers of effects is currently under way. For example, new techniques are being developed to link skin biomarker results with effects in other organs, such as liver or gonad, and therefore skin samples may have the potential to give additional information about the overall health of an animal. Validation of these techniques could be conducted on animals that are freshly stranded or collected during subsistence activities. Although it is unclear how biomarkers are related to survivorship, as the state of knowledge improves, these relationships can be characterised in surrogate species, as well as in cetaceans. Longitudinal studies on individuals using gene probes, and linking gene expressions to exposures and outcomes (such as survivability) could also prove to be useful.

6. MODELLING APPROACHES

6.1 Overview of Phase I model

Hall described a risk assessment model that examined the effect of different polychlorinated biphenyl (PCB) accumulation scenarios on potential population growth rates using, as an example, data obtained for the population of bottlenose dolphins from Sarasota Bay, Florida. To achieve this goal, an individual-based model framework was developed that simulates the accumulation of PCBs in the population and modifies first-year calf survival based on maternal blubber PCB levels. In this example, the current estimated annual PCB accumulation rate for the Sarasota Bay dolphin population may be depressing the potential population growth rate. However, these predictions are limited both by model naivety and parameter uncertainty. More data on the relationship between maternal blubber PCB levels and calf survivorship, the annual accumulation of PCBs in the blubber of females, and the transfer of PCBs to the calf through the placenta and during lactation are needed. Such data require continued efforts directed toward long-term studies of known individuals in wild and semi-wild populations. During discussion, it was noted that contaminant data are available for some prey species of Sarasota Bay dolphins but, because they are opportunistic feeders, analysing all their potential prey for contaminants is prohibitively expensive. As a result, examination of effects related to tissue burdens rather than oral dose would be useful to incorporate into the model. In addition, the model could be refined to examine sublethal effects in cetaceans, as well as temporal trends in legacy contaminant exposure. The Workshop also recognised that case study models are useful in that they can help answer the 'what if' questions, for example, would reducing fisheries bycatch by half or reducing environmental levels of a specific contaminant by half have a larger beneficial effect on survival of a population? The information obtained could be helpful in making resource management decisions.

6.2 Dose response approaches

Human risk assessments routinely rely on using surrogate (laboratory model) species concentration (or, if given orally, dose) response data. It is now well accepted that this is the best available strategy to use, despite all the drawbacks and caveats but given that directed studies using human subjects are not possible there is little alternative. This situation is directly comparable to that in the cetaceans and it should be emphasised that in the absence of robust concentration-response data from cetaceans, surrogate species data (including pinnipeds and vertebrate laboratory animal models) should be used. Surrogate data already used in cetacean risk assessments include studies in mink (Kihlström *et al.*, 1992; Restum *et al.*, 1998) and monkeys (Barsotti *et al.*, 1976) because the studies reported tissue levels in relation to a reproductive outcome (offspring survival) of direct relevance to understanding perturbations in population dynamics and growth rate.

These standard toxicological studies are carried out on a wide variety of species but it should be possible to combine the data from different species (e.g. using a Bayesian approach) to improve the reliability of the concentration response curve, particularly if the LC50's for the different species are generally of the same order of magnitude (e.g. mink and monkey LC50's in relation to offspring survival are both around 30 mg/kg lipid weight in adipose). Additional recent studies on, for example, sled dogs fed contaminated whale blubber might yield data with population-relevant endpoints and the data from these should be investigated (Sonne *et al.*, 2008a; 2006; 2008b). A wider literature search should also be carried out to see what other recent studies have been published (see reference list below for some promising recent studies that report concentration – response information). There are many caveats in using these surrogate data and where possible reproductive strategy matching would be preferable (e.g. using data from primates might be better than other model species as they give birth to single offspring rather than litters). Older pinniped datasets also exist (e.g. Reijnders, 1986) and if the raw data could be obtained (the published results are in summary form not amenable to concentration-response modelling) these would be a very valuable addition to the existing datasets. Other surrogate species concentration response data that could be incorporated in future models include those recently estimated using a mark-recapture study with contaminants as covariates of survival. For example, a study by Hall *et al.* (2009) reported the concentration-response relationship between first year survival probability and PBDE and PCB uptake during lactation in grey seals. In addition there may be more recent cetacean studies (e.g. Pierce *et al.*, 2008) that report useful reproductive endpoints.

For some species in some situations it might be possible to use physiologically-based pharmokinetic (PBPK) model (e.g. Hickie *et al.*, 1999) to determine blubber concentrations from ingested fish and vice versa. That would then allow the integration of dose-response data from studies for which only ingested doses have been reported. Many of the vertebrate laboratory model species studies do not measure tissue concentrations at the end of the study, only reporting ingested concentrations or doses. A variety of toxicological, contaminant feeding studies are carried out to determine a range of endpoints and if collaborations were set up it might be possible to obtain tissue levels for concentration response studies at the conclusion of the research when the laboratory animals are usually sacrificed. For example, current research is focussing on the effects of POPs and emerging contaminants on neurological and neurophysiological endpoints. Additional added value for marine mammalogists could therefore be gained by encouraging integration and collaboration between marine mammal and other toxicologists.

Effects of relevance to population level impact can be grouped into direct and indirect effects. The direct effects can be readily incorporated into a population effects model by including a concentration response function. Endpoints include effects on reproduction particularly fecundity, neonatal survival, juvenile survival and adult survival. Where age-specific survival rates in relation to changes in exposure are available these could also be embedded into a model.

Indirect effects include impacts on growth (possibly through thyroid mediated effects) and immune suppression which could result in higher juvenile mortality rates or higher mortality rates following exposure to infectious disease, respectively. Although more difficult to model, additional steps in the model process could be included and strandings data could be utilised to estimate age-specific survival in relation to cause of death. For example, using bottlenose dolphin strandings data available from a wide geographical area and infectious disease as the cause of death, age-specific survival probabilities for different geographical groups could be generated using for example maximum likelihood and Bayesian uncertainty models (Joly *et al.*, 2009; Moore and Read, 2008). If these groups have different exposures (comparing cleaner regions with regions of higher exposure), relative age-specific survivals from infectious disease mortality could be compared. Another approach, if individual tissue concentrations were available, would be to split the data into animals that have less than or greater than some independent estimated toxic threshold, e.g. using the Kannan *et al* estimated threshold for effects of 17mg/kg (Kannan *et al.*, 2000), and compare infectious disease mortality rates. For example, it would be possible to use the large body of harbour porpoise strandings data from the UK and Europe where blubber PCBs and other POP contaminants have been measured in over 500 individuals (Deaville and Jepson, 2008) in an age-specific infectious disease survival model by using these blubber levels as covariates.

6.3 Individual-based model approach

There is an individual-based model (IBM) framework (Hall *et al.*, 2006) available to the community for use and development and this will continue to be refined with the ultimate objective of making it available as open source software via the web. However, it is recognised that other population dynamics models for cetaceans could also be modified to specifically include the direct effects of exposure due to contaminants e.g. matrix population models, state space models, PVA models etc.

There are also a variety of population model outputs and some may be of more interest in the context of the risk assessment framework than others. For example are we concerned about the decline in overall abundance and if so, over what timescale? Or is a decline or depression in population growth rate (i.e. lambda as used by Hall *et al.*, 2006) more important? Other parameters include quasi-extinction probability (defined as the probability of a population falling below a critical density) which has been used in relation to the impact of infectious disease mortality in marine mammals.

6.4 Sensitivity analysis

Sensitivity analysis is an important part of the rationale for using a model to determine the impact of contaminants on populations to investigate where the uncertainties in the data lie. For example a variety of model simulations can be run to see which parameters and relationships have the largest impact on the outcome of interest (population growth rate or abundance etc.) This then helps to prioritise and focus research on parameters that most affect the critical outcome of interest. Studies carried out to date suggest uncertainties around the concentration response relationship can have a large impact.

It is also recognised that other stressors (e.g. climate change, ocean noise, habitat degradation, exposure to contaminant mixtures, etc.) could also affect cetacean population dynamics. It is envisaged that in the future some of these additional stressors should be incorporated into the risk assessment framework and, using sensitivity analyses, the relative impact of various combinations could be determined.

6.5 Example of risk assessment modelling approach in bottlenose dolphins

The following is an example of how the population level risk assessment approach would be carried out. Long term studies into the ecology and health of bottlenose dolphins along the east coast of the US have been ongoing (Schwacke *et al.*, 2004) and have generated an excellent body of relevant data that can be used to answer the question: is PCB exposure and uptake likely to result in a reduction in the potential population growth rate? This illustrates an approach that is possible at Tier III because intensive studies, including live capture/release have been conducted on bottlenose dolphin. A stochastic individual based model framework that has been developed (Hall *et al.*, 2006) and is currently being refined, will be used in this example approach (recognising that this may not be applicable at all Tiers or for all identified case study species).

(1) Hazard identification/problem formulation

The first stage of the process involves identifying a possible hazard. For example, the possibility that PCBs may pose a risk to the health and population of bottlenose dolphins along the east coast of the US was raised based on information about high PCBs in the coastal food web and in lower level marine biota.

Conceptual model:

PCBs in sediments and fish → biomagnification through food web → bottlenose dolphins

(2) Exposure characterisation

The second stage is to determine exposure in the species of interest. In this example PCBs were measured in blubber (as the most appropriate target tissue for these compounds, listed in chronological order):

(a) blubber samples from stranded animals on a lipid weight basis (together with information on confounding factors such as sex, and age class (length));
(b) blubber from biopsy dart samples from live animals; and
(c) blubber from biopsy wedges from live capture release studies.

(3) Effect characterisation

There is a wealth of published toxicological data (going back to the early 1970s) indicating that exposure to PCBs affects the health of vertebrate laboratory model species. Direct effects of PCBs on fecundity and offspring survival have been reported in many different species, including marine mammals. This evidence suggests that higher exposure in bottlenose dolphins could have effects at the population level since fecundity and survival are key parameters in determining the population dynamics in general and potential population growth rate in particular. However, to reach the final goal of risk characterisation a concentration-response relationship specifically linking contaminant blubber levels to fecundity or survival is required.

(a) Bottlenose dolphin concentration-response data. One dataset has been published linking maternal PCB blubber concentration with offspring survival probability in captive bottlenose dolphins (Reddy *et al.*, 2001). However the uncertainty around this relationship is very large and the EC50 is much lower when compared with the results of toxicological studies in other species.
(b) Surrogate species concentration-response data. Other published datasets from surrogate species include two studies in mink (Kihlström *et al.*, 1992; Restum *et al.*, 1998) and monkeys (one study, Barsotti *et al.*, 1976). There are disadvantages and caveats associated with using these data but when the relationships were compared there was no evidence of a statistically significant difference between the two models. This enabled the generation of a generic concentration response curve combining these data (weighted by number of offspring in each concentration category). The resulting relationship is shown in Fig. 2a, with associated uncertainty estimated by resampling with replacement 500 times from the original data and recalculating the regression equation. A Bayesian approach was also taken (Fig. 2b) to determine the most appropriate concentration-response curve. This resulted in an EC50 of 29.5mg/kg. This combined concentration-response was then embedded into the model at the next stage.

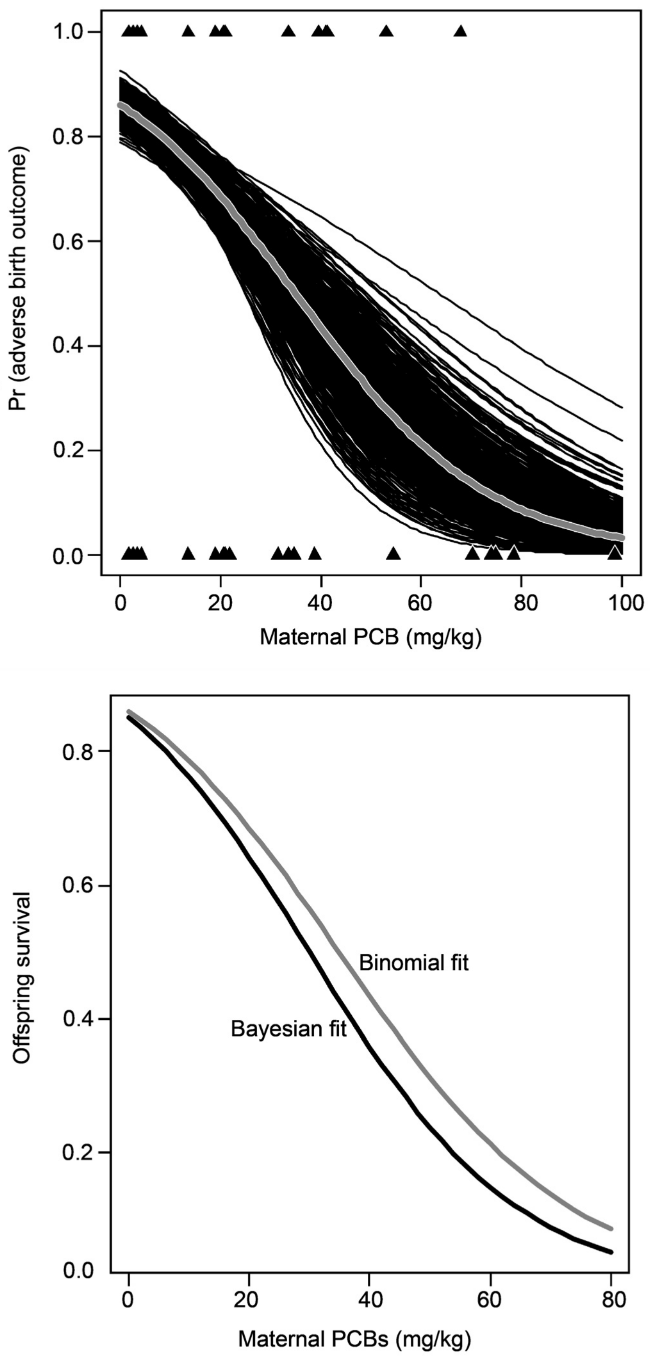

Fig. 2. Example of combined surrogate species (combined results from published mink and monkey studies) dose response relationship relating maternal PCB fat concentration to the probability of (a) adverse birth outcome (black lines show 500 predictions from resampling the data) and (b) a Bayesian fit to the data compared to the binomial fit.

(3) Risk characterisation

This approach is based on the framework outlined in Hall *et al.* (2005) (see paper for details of the model parameters). The effect of PCB exposure on potential population growth rate was assessed (through maternal PCB exposure affecting first calf survival). A simplified flow diagram of how the model functions is shown in Fig. 3.

The model was run for 100 years (Fig. 4 shows 25 simulations for clarity). The black line connects the mean of the population size for each year, and blue lines connect the 95% CI of the population size for each year). In summary the mean potential population growth rate over the final 40yr of the model runs was 1.0007 (95% CI 0.9934-1.0051). In this scenario, there was no evidence that potential population growth rate was affected. However, it should be recognised that PCBs may have additional effects on fecundity or survival not incorporated in this version of the model.

7. IDENTIFICATION OF DATA GAPS AND RESEARCH NEEDS

The Workshop prioritised the research needs with respect to the amount of time and effort needed as follows:

A = can be conducted with existing information and efforts.
B = can be conducted if existing efforts were bolstered.
C = new effort required.

Short term (within 18 months)
- Develop a standardised sampling protocol, including blood, blubber, skin, and fecal samples (A).
- Through modeling, investigate how contaminants that impact individual health can then affect population dynamics (A).
- Investigate how to measure proteophilic contaminants in cetaceans (B).
- Determine framework for a global cetacean sample inventory that is not attached to other animal data (B).
- Determine dose-response levels of contaminants in cetaceans, including linking with toxicologists to determine tissue residue levels in vertebrates; accessing raw dose-response data related to pinnipeds; and targeting ideal surrogate species by contaminant class (B).
- Address the issue of mixed contaminant exposure as it relates to biological effects among cetaceans (B).

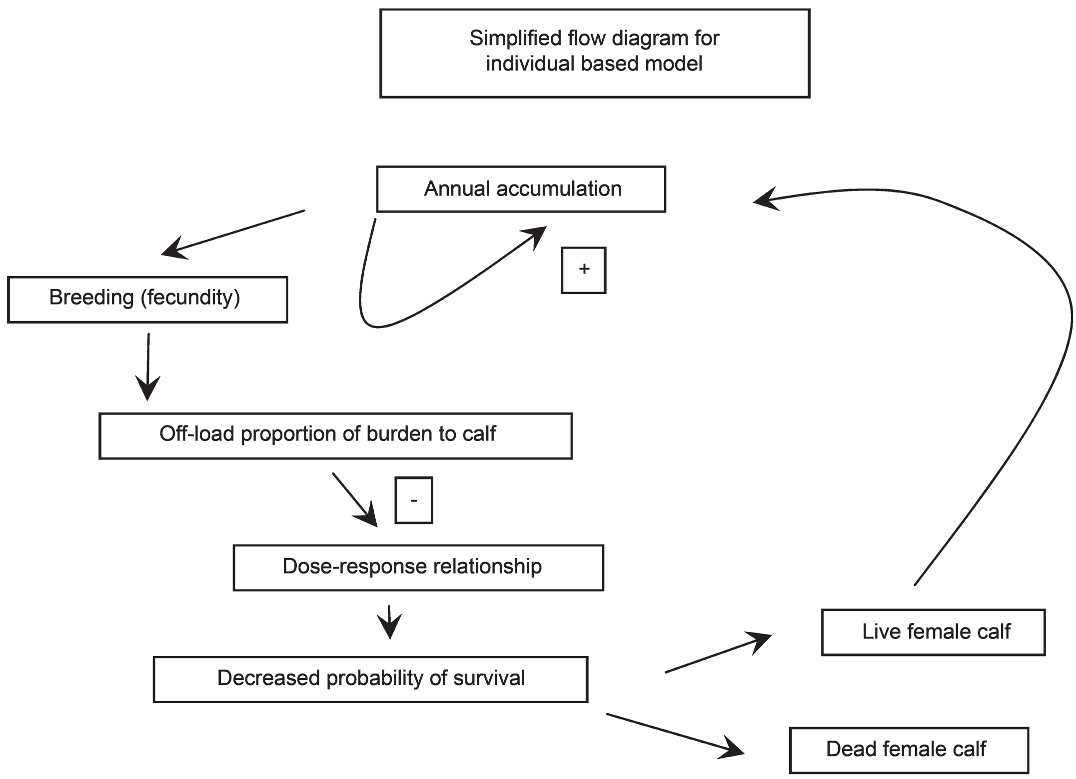

Fig. 3. Simplified flow diagram of bottlenose dolphin PCB exposure model.

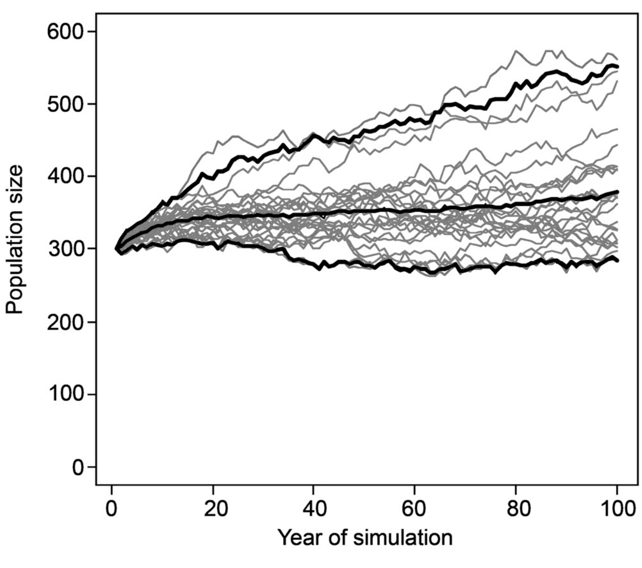

Fig. 4. Simulations to project the population of bottlenose dolphins for 100 years. The figure shows results for 25 simulations.

Examples include review of existing mixed contaminant research; in vitro studies (fibroblast cell culture, skin slices); surrogate species; and SCID mice with cetacean immune systems (B).

- Develop blubber sampling technique involving larger sample mass (C).
- Maximise use of captive cetacean populations by sharing a prioritised list of research, surveillance, and data needs (C)

Moderate term (>18 months–3 years)

- Intensify epidemiology studies. May include efforts to integrate existing databases and standardising definitions (B).

Long term (3–5 years)

- Better understand measurements of reproduction and nutritive state to be used as measures of biological effect (B).
- Validate contaminant load in biopsies by comparing results with internal organs or body burden (B).
- Develop and validate biomarkers and chemical metabolites as measures of effects (impacts on reproduction, survival, and health) (B).
- Develop rapid, inexpensive screening assays for contaminants (C).
- Develop and evaluate measurements of contaminant metabolites for evidence of exposure. May include technique and tool development and pharmacokinetics (C).

8. RECOMMENDATIONS

The Workshop **recommended** the following:

(1) Improve existing concentration-response (CR) function for PCB-related reproductive effects. Re-initiate efforts to derive a CR function based on surrogate species for reproductive effects in relation to PCB exposure. This can build upon prior efforts by Hall *et al.* (2006) that resulted in a CR component for an individual-based model based on data from captive bottlenose dolphin, mink, and monkeys. The CR component could be improved by conducting a literature search and integrating data from more recent studies.

(2) Derive additional CR functions to address other endpoints (i.e. survival) in relation to PCB exposure. This may be accomplished through a multi-stage modeling approach, e.g. a series of functions that provide a connection from PCB exposure → functional immune endpoints → increased pathogen susceptibility → increased likelihood of mortality. Additional CR

functions could be derived using data from surrogate species (e.g. experimental studies and/or wildlife and human epidemiological studies) as well as through synthesis of recently acquired information from small cetaceans (European harbor porpoise strandings and US bottlenose dolphin capture-release health assessments).

(3) Integrate improved concentration-response components into a population risk model (e.g. individual-based model) for one or more case study species (e.g. bottlenose dolphin and/or humpback whale).

(4) Develop new biomarkers and improve the linkages between lower and higher levels of organisation (molecular → individual → population). The highest priority for biomarker development should include those with direct relevance to population-level endpoints such as reproduction and survival.

9. ADOPTION OF REPORT

The report was adopted on 24 February 2010.

REFERENCES

Barsotti, D.A., Marlar, R.J. and Allen, J.R. 1976. Reproductive dysfunction in rhesus monkeys exposed to low levels of polychlorinated biphenyls (Aroclor 1248). *Toxicology* 14: 99–103.

Deaville, R. and Jepson, P.J. 2008. *Report on the UK Strandings Investigation Programme*. Report to the Department for Food, Environmental and Rural Affairs, Bristol. 52pp.

Dorneles, P.R., Lailson-Brito, J., Azevedo, A.F., Meyer, J.A., Vidal, L.G., Fragoso, A.B., Torres, J.P., Malm, O., Blust, R. and Das, K. 2008a. High accumulation of perfluorooctane sulfonate (PFOS) in marine tucuxi dolphins (*Sotalia guianensis*) from the Brazilian coast. *Envir. Science Tech.* 42: 5363–73.

Dorneles, P.R., Lailson-Brito, J., Dirtu, A.C., Weijs, L., Azevedo, A.F., Torres, J.P.M., Malm, O., Neels, H., Blust, R., Das, K. and Covaci, A. 2010. Anthropogenic and naturally-produced organobrominated compounds in marine mammals from Brazil. *Envir. Int.l* 36: 60–67.

Dorneles, P.R., Lailson-Brito, J., dos Santos, R.A., Silva da Costa, P.A., Malm, O., Azevedo, A.F. and Torres, J.P.M. 2007. Cephalopods and cetaceans as indicators of offshore bioavailability of cadmium off Central South Brazil Bight. *Envir. Pollut.* 148: 352–59.

Dorneles, P.R., Lailson-Brito, J., Fernandez, M.A.S., Vidal, L.G., Barbosa, L.A., Azevedo, A.F., Fragoso, A.B., Torres, J.P. and Malm, O. 2008b. Evaluation of cetacean exposure to organotin compounds in Brazilian waters through hepatic total tin concentrations. *Envir. Pollut.* 156: 1263–75.

Fossi, M.C., Casini, S., Bucalossi, D. and Marsili, L. 2008. First detection of CP1A1 and CYP2B induction in Mediterranean cetacean skin biopsies and cultured fibroblasts by western blot analysis. *Mar. Enviro. Res.* 66: 3–6.

Fossi, M.C., Urban, J., Casini, S., Maltese, S., Spinsanti, G., Panti, C., Porcelloni, S., Lauriano, G., Niño-Torres, C., Rojas-Bracho, L., Jimenez, B., Munoz-Arnanz, J. and Marsili, L. In Press. A multi-trial diagnostic tool in fin whale (*Balaenoptera physalus*) skin biopsies of the Pelagos Sanctuary (Mediterranean Sea) and the Gulf of California (Mexico). *Mar. Enviro. Res.*: 4pp.

Godard, C.A.J., Smolowitz, R.M., Wilson, J.Y., Payne, R.S. and Stegeman, J.J. 2004. Induction of cetacean cytochrome P450 1A1 by á-naphthoflavone exposure of skin biopsy slices. *Toxicol. Sci.* 80: 268–75.

Hall, A.J., Hugunin, K., Deaville, R., Law, R.J., Allchin, C.R. and Jepson, P.D. 2006. The risk of infection from polychlorinated biphenyl exposure in the harbour porpoise (*beta*): a case-control approach. *Environmental Health Perspectives* 114(5): 704–11.

Hall, A.J., McConnell, B.J., Rowles, T.K., Aguilar, A., Borrell, A., Schwacke, L., Reijnders, P.J.H. and Wells, R.S. 2006. An individual based model framework to assess the population consequences of polychlorinated biphenyl exposure in bottlenose dolphins. *Environmental Health Perspectives* 114(3): 60–64

Hall, A.J., Thomas, G.O. and McConnell, B.J. 2009. Exposure to persistent organic pollutants and first-year survival probability in gray seal pups. *Environmental Science and Technology* 43(16): 6364–69.

Hickie, B., Mackay, D. and Koning, J.D. 1999. Lifetime pharmacokinetic model for hydrophobic contaminants in marine mammals. *Environmental Toxicology and Chemistry* 18(11): 2622–33.

International Whaling Commission. 2008. Report of the Scientific Committee. Annex K. Report of the standing working group on environmental concerns. Appendix 3. POLLUTION 2000+ Phase II: steering group and terms of reference (TOR). *J. Cetacean Res. Manage. (Suppl.)* 10:277.

Joly, D.O., Helsey, D.M., Samuel, M.D., Ribic, C.A., Thomas, N.J., Wright, S.D. and Wright, I.E. 2009. Estimating cause-specific mortality rates using recovered carcasses. *Journal of Wildlife Diseases* 45(1): 122–27.

Kannan, K., Blankenship, A.L., Jones, P.D. and Giesy, J.P. 2000. Toxicity reference values for the toxic effects of polychlorinated biphenyls to aquatic mammals. *Human and Ecological Risk Assessment* 6(1): 181–201.

Kelleher, G., Bleakley, C. and Wells, S. 1995. *A Global Representative System of Marine Protected Areas.* Volume 1. *Antarctic, Arctic, Mediterranean, Northwest Atlantic, Northeast Atlantic and Baltic*. Four volume report to the World Bank Environment Department, Washington DC.

Kihlström, J.E., Olsson, M., Jensen, Å., Johansson, J., Ahlbom, J. and Bergman, Å. 1992. Effects of PCB and different fractions of PCB on the reproduction of the mink (*Mustela vison*). *Ambio* 21(8): 563–69.

Lailson-Brito, J., Dorneles, P.R., Azevedo-Silva, C.E., Azevedo, A.F., Vidal, L.G., Zanelatto, R.C., Loziniski, C.P.C., Azeredo, A., Fragoso, A.B., Cunha, H.A., Torres, J.P.M. and Malm, O. 2010. High organochlorine accumulation in blubber of Guiana dolphin, *Sotalia guianensis*, from Brazilian coast and its use to establish geographical differences among populations. *Environmental Pollution* 158: 1800–08.

Marsili, L., Casini, S., Bucalossi, D., Porcelloni, S., Maltese, S. and Fossi, M.C. 2008. Use of immunofluorescence technique in cultured fibroblasts from Mediterranean cetaceans as new '*in vitro*' tool to investigate effects of environmental contaminants. *Marine Environmental Research* 66: 151–53.

Moore, J.E. and Read, A.J. 2008. A Bayesian uncertainty analysis of cetacean demography and by-catch mortality using age-at-death data. *Ecological Applications* 18(8): 1914–31.

Muir, D.C.G. and Howard, P.H. 2006. Are there other persistent organic pollutants? A challenge for environmental chemists. *Environ. Sci. Technol.* 40: 7157–66.

Pauly, D., Trites, A.W., Capuli, E. and Christensen, V. 1998. Diet composition and trophic levels of marine mammals. *ICES Journal of Marine Science* 55: 467–81.

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. *Environmental Pollution* 153: 401–15.

Reddy, M.L., Reif, J.S., Bachand, A. and Ridgeway, S.H. 2001. Opportunities for using Navy marine mammals to explore associations between organochlorine contaminants and unfavourable effects on reproduction. *Science of the Total Environment* 274(1–3): 171–82.

Reijnders, P., Wells, R., Aguilar, A., Donovan, G., Bjørge, A., O'Hara, T., Rowles, T. and Siebert, U. 2007. Report of the Scientific Committee. Annex K. Report of the Standing Working Group on Environmental Concerns. Appendix 2. Report from POLLUTION 2000+: Phase I. *Journal of Cetacean Research and Management (Supplement)* 9: 261–74.

Reijnders, P.J.H. 1986. Reproductive failure in common seals feeding on fish from polluted coastal waters. *Nature* 324: 456–57.

Restum, J.C., Bursian, S.J., Giesy, J.P., Render, J.A., Helferich, W.G., Shipp, E.G., Vergrugge, D.A. and Aulerich, R.J. 1998. A multigenerational study of the effects of consumption of PCB-contaminated carp from Saginaw Bay, Lake Huron, on mink. I. Effects on mink reproduction, kit growth and survival, and selected biological parameters. *Archives of Environmental Contamination and Toxicology* 5(5): 343–75.

Schwacke, L.H., Hall, A., Wells, R.S., Bossart, G.D., Fair, P.A., Becker, P.R., Kucklick, J.R., Mitchum, G.B., Rosel, P.E., Whaley, J.E. and Rowles, T.K. 2004. Health and risk assessment for bottlenose dolphin (*Tursiops truncatus*) populations along the southeast United States coast: current status and future plans. Paper SC/56/E20 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 15pp. [Paper available from the Office of this Journal].

Sonne, C., Dietz, R., Born, E.W., Leifsson, P.S. and Andersen, S. 2008a. Is there a link between hypospadias and organochlorine exposure in East Greenland seld dogs (*Canis familiaris*)? *Ecotoxicology and Environmental Safety* 69(3): 391–95.

Sonne, C., Dietz, R., Larsen, H.J.S., Loft, K.E., Kirkegaard, M., Letcher, R.J., Shahmiri, A. and Møller, P. 2006. Impairment of cellular immunity in West Greenland sledge dogs (*Canis familiaris*) dietary exposed to polluted minke whale (*Balaenoptera acutorostrata*) blubber. *Environ. Sci. Technol.* 40: 2056–62.

Sonne, C., Leifsson, P.S., Dietz, R., Kirkegaard, M., Jensen, A.L., Shahmiri, S. and Letcher, R.J. 2008b. Greenland seld dogs (*Canis familiaris*) develop liver lesions when exposed to a chronic and dietary low dose of an environmental organohalogen cocktail. *Environmental Research* 106(1): 72–80.

Spinsanti, G., Panti, C., Lazzeri, E., Marsili, L., Casini, S., Frati, F. and Fossi, C.M. 2006. Selection of reference genes for quantitative RT-PCR studies in striped dolphin (*Stenella coeruleoalba*) skin biopsies. *MBMC Molecular Biology* 7: 32–43.

Annex A

List of Participants

Susan Bengtson Nash
Atmospheric Environment Research Group
School of Environment
Griffith University
170 Kessels Road, Nathan
Brisbane, Queensland 4111 Australia
E-mail: *s.bengtsonnash@griffith.edu.au*

Jennie Bolton
NOAA Fisheries
Northwest Fisheries Science Center
2725 Montlake Boulevard East
Seattle, WA 98112 USA
E-mail: *Jennie.Bolton@noaa.gov*

Robert Brownell
NOAA Fisheries
Southwest Fisheries Science Center
1352 Lighthouse Avenue
Pacific Grove, CA 93950 USA
E-mail: *rlbcetacea@aol.com*

Tracy Collier
NOAA Fisheries
Northwest Fisheries Science Center
2725 Montlake Boulevard East
Seattle, WA 98112 USA
E-mail: *Tracy.K.Collier@noaa.gov*

Paulo Renato Dorneles
Biophysics Institute
Rio de Janeiro Federal
University (UFRJ)
21941-902 Rio de Janeiro
RJ, Brazil
E-mail: *dorneles@biof.ufrj.br*

Céline Godard-Codding
The Institute of Environmental
and Human Health
Texas Tech University and
TTU Health Sciences Center
Box 41163
Lubbock, Texas 79409 USA
E-mail: *celine.godard-codding@TIEHH.TTU.edu*

Frances Gulland
The Marine Mammal Center
2000 Bunker Roa
Fort Cronkhite
Sausalito, CA 9496 USA
E-mail: *Gullandf@TMMC.org*

John Kucklick
National Institute of Standards and Technology
Hollings Marine Laboratory
331 Fort Johnson Road
Charleston, SC 29412 USA
E-mail: *John.Kucklick@noaa.gov*

Lori Schwacke
NOAA Fisheries
Hollings Marine Laboratory
331 Fort Johnson Road
Charleston, SC 29412 USA
E-mail: *Lori.Schwacke@noaa.gov*

Stephanie Venn-Watson
National Marine Mammal Foundation
1220 Rosencrans Street #284
San Diego, CA 92016 USA
E-mail: *stephanie.venn-watson@nmmpfoundation.org*

POLLUTION 2000+ Steering Committee Members

Patricia Burkhardt-Holm
Department of Environmental Sciences
University of Basel, Switzerland
Vesalgasse 1, CH-4051 Basel
E-mail: *Patricia.holm@unibas.ch*

Greg Donovan
International Whaling Commission
The Red House
135 Station Road
Impington, Cambridge
CB24 9NP
E-mail: *greg.donovan@iwcoffice.org*

Cristina Fossi
Department of Environmental Sciences
University of Siena
Via Mattioli 4
53100 Siena, Italy
E-mail: *fossi@unisi.it*

Ailsa Hall
Sea Mammal Research Unit
Scottish Oceans Institute
University of St. Andrews
St. Andrews, Fife
KY16 8LB, Scotland, UK
E-mail: *ajh7@st-andrews.ac.uk*

Cheryl Rosa
U.S. Arctic Research Council
420 L Street, Suite 315
Anchorage, AK 99501 USA
E-mail:*crosa@arctic.gov*

Mark Simmonds
Whale and Dolphin Conservation Society
Brookfield House
Chippenham, Wiltshire
SN15 1LJ UK
E-mail: *mark.simmonds@wdcs.org*

Teri Rowles
NOAA Fisheries
Office of Protected Resources
1315 East-West Highway
Silver Spring, MD 20910 USA
E-mail: *teri.rowles@noaa.gov*

Gina Ylitalo
NOAA Fisheries
Northwest Fisheries Science Center
2725 Montlake Boulevard East
Seattle, WA 98112 USA
E-mail: *gina.ylitalo@noaa.gov*

Annex B

Agenda

1. Introductory items
   - 1.1 Welcoming remarks
   - 1.2 Introduction of participants
   - 1.3 Election of Chair
   - 1.4 Appointment of Rapporteur
   - 1.5 Adoption of Agenda
   - 1.6 Available documents
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   - 2.1 Pollution 2000 Phase I
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3. Risk assessment framework
   - 3.1 Overview of risk assessment paradigm
   - 3.2 Tiered risk assessment approaches
4. Prioritisation schema for chemical hazards for cetaceans
   - 4.1 Overview of contaminants of emerging concern in marine ecosystems
   - 4.2 Summary of exposure and effects in cetaceans
   - 4.3 Prioritisation protocol for chemical hazard identification
     - 4.3.1 Classification methods
       - 4.3.1.1 Cetaceans by life history
       - 4.3.1.2 Chemicals by fate and behavior
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5. Identification of biomarkers for population modelling approaches
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   - 6.1 Overview of Phase I model
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10. References

Annex C

Other Suggested Biomarkers to be Validated in Cetacean Biopsy Samples

The **E2F transcription factor** is a member of the E2F family (E2F1-6), which is important in regulating the cell cycle and has a dual role: controlling some genes that regulate the progression of DNA synthesis or being involved in apoptotic processes (Attwooll *et al.*, 2004; La Thangue, 2003). Overexpression of E2F-1 promotes upregulation of several genes involved in the activation of apoptosis and appears to interact with and be modulated by the aryl hydrocarbon receptor. DNA damage in general seems to be responsible for induction of the apoptotic pathway by E2F-1 (Stevens and La Thangue, 2004). Stress signals (such as UV exposure or hypoxia) can induce expression of E2F-1 (O'Connor and Lu, 2000), supporting the use of this gene as a putative biomarker for response to ecotoxicological stress.

The **heat shock protein 70 (HSP70)** is a stress-related protein belonging to a multigene family. HSPs are stress-related proteins induced by a variety of agents and conditions that either directly damage proteins or indirectly act by causing production of abnormal proteins in cells (Nollen and Morimoto, 2002). HSPs are induced as a first response, their main role being to protect cells exposed to stress. Among all HSP families, HSP70 is often used as an early biomarker for environmental stress assessment in a wide variety of organisms. Nevertheless, most studies that use HSP70 as a biomarker are carried out in invertebrate species such as terrestrial arthropods (e.g. *Chilopoda* and *Diptera*) (Pyza *et al.*, 1997) or marine invertebrates and vertebrates (Cruz-Rodriguez and Chu, 2002; Porte *et al.*, 2001). Studies on vertebrates in the wild are very limited, with most studies focusing on fishes (Boone and Vijayan, 2002; Deane *et al.*, 2004) and information about marine mammals is lacking so far.

Oestrogen receptors (ERs) are members of the nuclear receptor superfamily and are ligand-inducible transcription factors. Two isoforms of ERs are known, ERα and ERβ, which have differing tissue distributions and physiological roles (Muller and Korach, 2002) and are encoded by different genes located on different chromosomes. Ligand-induced signalling is due to binding of oestrogen (or a structurally similar compound such as organochlorines or PBDEs) and a specific transcriptional response is subsequently activated. The affinity of chemicals with oestrogenic or antioestrogenic activity is due to the ability of these compounds to interact with ERs (Mueller 2004). Because of the central role of ERs in cell differentiation and proliferation, abnormalities in ER signalling pathways can interfere with sexual development and the endocrine system, both in wildlife and humans. The exposure to exogenous compounds (such as EDCs) with high affinity for ER may therefore cause impairment of endocrine functions. To date, most studies on ERs and their interactions with xenobiotic compounds have been carried out *in vitro* to understand better the toxic effects they can have on living organisms (Tiemann, 2008). Compounds like PCBs and PBDEs that have dioxin-like property can bind oestrogen receptors and interfere with signalling pathways, having an agonist potency measured *in vitro* more preferential for ERα than ERβ. The binding of xeno-oestrogens or xeno-antioestrogens to ER, indeed, can enhance responses of endogenous oestrogens or agonistically bind the receptor to inhibit the physiological action of those oestrogens (Carpenter *et al.*, 2002).

REFERENCES

Attwooll, C., Denchi, E.L. and Helin, K. 2004. The E2 family: specific functions and overlapping interests. *European Molecular Biology Organization Journal* 23(24): 479–4716.

Boone, A.N. and Vijayan, M.M. 2002. Constitutive heat shock protein 70 (HSC70) expression in rainbow trout hepatocytes: effect of heat shock and heavy metal exposure. *Comparative Biochemistry and Physiology C* 132(2): 223–33.

Carpenter, D.O., Arcaro, K. and Spink, D.C. 2002. Understanding the human health effects of chemical mixtures. *Environmental Health Perspectives* 100(Suppl. 1): 25–42.

Cruz-Rodriguez, L.A. and Chu, F.L.E. 2002. Heat-shock protein (HSP70) response in the eastern oyster, *Crassostrea virginica*, exposed to PAHs sorbed to suspended artificial clay particles and to suspended field contaminated sediments. *Aquatic Toxicology* 60(3–4): 157–68.

Deane, E.E., Li, J. and Woo, N.Y.S. 2004. Modulated heat shock protein expression during pathogenic *Vibrio alginolyticus* stress of sea bream. *Diseases of Aquatic Organisms* 62: 205–15.

La Thangue, N.B. 2003. The yin and yang of E2F-1: balancing life and death. *Natural Cell Biology* 5: 587–89.

Mueller, S.O. 2004. Xenoestrogens: mechanisms of action and detection methods. *Anal. Bioanal. Chem.* 378: 582–87.

Muller, S.O. and Korach, K.S. 2002. Estrogen receptors and endocrine diseases: lessons from estrogen receptor knockout mice. *Current Opinion in Pharmacology* 1(6): 613–19.

Nollen, E.A.A. and Morimoto, R.I. 2002. Chaperoning signalling pathways: molecular chaperones as stress-sensing 'heat shock' proteins. *Journal of Cell Science* 115: 2809–16.

O'Connor, D.J. and Lu, X. 2000. Stress signals induce transcriptionally inactive E2F-1 independently of p53 and Rb. *Oncogene* 19: 2369–76.

Porte, C., Biosca, X., Sole, M. and Albaiges, J. 2001. The integrated use of chemical analysis, cytochrome P450 and stress proteins in mussels to assess pollution along the Galician coast (NW Spain). *Environmental Pollution* 112(2): 261–68.

Pyza, E., Mak, P. and Laskowski, R. 1997. Heat shock proteins (HSP70) as biomarkers in ecotoxicological studies. *Ecotoxicology and Environmental Safety* 38(3): 244–51.

Stevens, C. and La Thangue, N.B. 2004. The emerging role of E2F-1 in the DNA damage response and checkpoint control. *DNA Repair* 3(8–9): 1071–79.

Tiemann, U. 2008. *In vivo* and *in vitro* effects of the organochlorine pesticides DDT, TCPM, methoxychlor, and lindane on the female reproductive tract of mammals: a review. *Reproductive Toxicol.* 25(3): 316–26.

Report of the Third AWMP Workshop on Greenlandic Hunts

Report of the Third AWMP Workshop on Greenlandic Hunts

1. INTRODUCTORY ITEMS

The meeting was held at DTU-Riso, Roskilde, Denmark from 14–17 December 2009. The participants were Donovan (Convenor), Allison, Apostolaki, Brandão, Butterworth, Punt, Schweder and Witting.

1.1 Convenor's opening remarks

Donovan welcomed the participants. He noted that this was primarily a technical workshop to try to ensure that sufficient progress was made to enable the Scientific Committee to make a decision at its next meeting as to whether the sex ratio method for West Greenland common minke whales could be used for management purposes. In addition, it would provide time for initial discussions on the development of long-term *SLA*s for the Greenlandic stocks.

1.2 Election of Chair

Donovan was elected Chair.

1.3 Appointment of rapporteurs

Donovan and Punt acted as rapporteurs.

1.4 Adoption of Agenda

The adopted Agenda is shown in Annex A.

1.5 Documents available

The documents available to the Workshop were relevant extracts of previous meeting reports.

2. PROGRESS WITH INTERSESSIONAL WORK ON THE SEX RATIO METHOD

2.1 Development of code

Allison reported that progress had been made since the 2009 Annual Meeting towards coding the method for calculating lower confidence intervals for carrying capacity based on the sex ratio method. However, there had not been sufficient time to finalise the coding and run the robustness tests.

The Workshop spent considerable time modifying and testing the code used to implement the method for computing lower confidence limits for model outputs such as carrying capacity, current population size and current depletion when assessments are based on the sex ratio method. In addition, code was developed to implement the model-based robustness tests. Modifications to the method led to fewer instances where there was evidence for a lack of convergence of the minimisation method.

3. FINALISING WORK ON THE SEX RATIO METHOD

3.1 Review the specifications for the sex ratio method

The estimates of carrying capacity, *K*, for some of the simulated datasets are smaller than the value of *K* used to generate those datasets. Annex B shows that including the deviance for such cases when computing lower confidence intervals leads to biased estimates of lower confidence intervals. Annex B also shows that setting the deviance to zero in this instance removes this source of bias. The Workshop **agreed** to revise the specifications for how lower confidence intervals are computed to impose the constraint outlined in Annex B. The full specifications for the sex ratio method, the data used for parameter estimation, and method for computing confidence limits for model outputs are given in Annex C.

The Workshop **agreed** that applications of the sex ratio method to estimate lower confidence intervals for model outputs would be conducted for:

(1) assessments based on different models (Closed [three versions – see Item 3.4], Site Fidelity, Influx) and MSYR rates (1% and 2%); and
(2) restrospective analyses (dropping off years of data one by one starting from the most recent year for the 10 most recent years).

3.2 Review the specifications for the existing robustness test

The Workshop revised and clarified the specifications for the robustness tests based on population dynamics models. The output statistics from the robustness tests were expanded (see Annex D) and it was **agreed** that the deviance for any simulated datasets for which the estimate of *K* exceeds the value of *K* used to generate the dataset concerned, would be set to zero.

3.3 Determination of need for any further robustness test

The Workshop **agreed** to add four additional robustness tests. Two of these tests (17 and 18) explore the performance of the sex ratio method when $MSYR_{1+} = 4\%$ while the other two robustness tests (4 and 5) explore the impact of using the standard version of the Closed model (see Annex C for specifications) when conducting assessments when the Closed-a and Closed-b models are the 'true' models. The final set of robustness trials are listed in Tables 1 and 2.

3.4 Evaluation of new specification of the closed model

The Workshop reviewed an alternative parameterisation of the Closed model (Witting and Brandão, 2010). The Workshop noted that problems had been encountered with finding the maximum likelihood estimates for the parameters for this version of the Closed model due to possible over-parameterisation. It was noted that more parsimonious versions of the Closed model exist which fit the data almost as well as the standard model (a difference of <0.2 likelihood units). The Workshop agreed that two additional variants of the Closed model should be considered for assessments and the robustness tests in addition to the current (standard) Closed model in order to encompass a range of assumptions regarding how the sex ratio changes over time and by area. These variants are:

(1) Closed-a. As for the standard Closed model, except that the proportion of females in the northern and southern area does not change over time (implemented by setting the parameter $\beta^f = 0$).
(2) Closed-b. The proportion of females in the southern area is a time-invariant proportion of the number of females off west Greenland and the sex ratio for the southern area is a logistic function of time.

4. CONSIDERATION OF WORK REQUIRED TO DEVELOP *SLAS* FOR ALL GREENLAND FISHERIES BEFORE THE END OF THE INTERIM PERIOD

In Greenland, a multispecies hunt occurs. The expressed 'need' is for 670 tonnes of edible products from large whales for West Greenland; at present this involves catches of common minke whales, fin whales and bowhead whales – Greenland has also requested a catch of humpback whales from the Commission. The flexibility among species is important to the hunters.

The issue of what is the 'correct' level of need itself is outside the scope of the Scientific Committee. In generic terms, the relevant Governments submit a 'need statement' to the Commission and it is then a Commission decision as to whether to accept that need request. Once that is agreed then the task of the Scientific Committee is to evaluate whether that need request can be achieved within the agreed conservation objectives of the Commission.

Where need is expressed as a number of animals of a particular species/stock this can be a relatively straightforward exercise. However, in developing long-term *SLA*s in the context of a 100-year simulation period, then the Committee (and the Commission) has agreed that it is important to bound the likely levels of future need for testing purposes in order to avoid having to re-evaluate the *SLA* itself every time an increased need request is accepted (should that occur). This bound is termed the 'need envelope' and has been developed by the Chair of the AWMP in conjunction with the hunters. It is important to note that this is a hypothetical upper bound in terms of the robustness of the *SLA* and neither commits the Commission to accepting increased need requests should these be presented nor indeed prevents the submission of need requests greater than the bound at some time in the future. In the latter case, the *SLA* would have to be re-evaluated as the circumstances would be outside the tested parameter space (this could be undertaken in the context of an *Implementation Review* in the same way that other new information might be obtained that led to the conclusion that further Robustness Trials were needed).

For both the bowhead and gray whale *SLA* development process, the need envelope took the form of a linear increase in need from 'current' in year zero to three times that value by the 100th year (see Fig. 1).

However, in the case of a multispecies fishery where need is expressed in terms of numbers of tonnes of edible products, the issue can be more complex. One approach is that conversion factors of tonnes of edible products (per strike) could be used for each species so that conservation implications can be examined in terms of numbers of animals by species/stock. However, the need can be met with many combinations of different catches of the different species. One possible approach would be to develop separate *SLA*s for each species and then develop an algorithm to determine flexibility within safe limits among the species. Further consideration is needed with respect to the issue of a combined approach to catch limits for more than one species which has up until now been the norm, and of course, this will require consultation with both the hunters and the Commission.

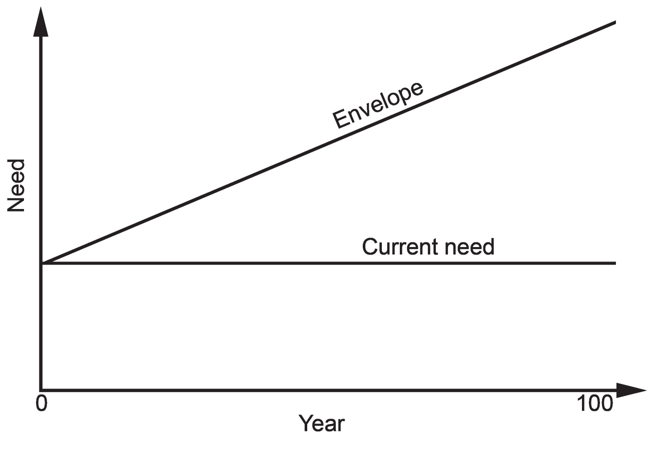

Fig. 1. Need envelope.

At present for the Greenland hunt, the Committee has been asked by the Commission to provide advice by species/stock and the Commission has set strike limits by species/stock. For common minke whales, the Committee had been unable to provide unequivocal advice until the 2009 Annual Meeting when it used the most recent aerial survey abundance and the agreed 'safe interim advice algorithm' adopted two years ago (IWC, 2010, p.139); this advice (178 per year) was less than the limits set by the Commission in 2008 (200 per year in a five-year block quota; IWC, 2008). In the case of fin whales, the situation was similar. Until recently, the Committee was unable to provide advice on strike limits for fin whales but the Commission set a limit of 19 (IWC, 2008). Two years ago, the Committee, using the 'safe interim advice algorithm', agreed that an annual strike limit of 19 would not harm the stock (IWC, 2009). In the case of bowhead and humpback whales, the 'safe interim advice algorithm' was used to determine that strike limits proposed by Denmark on behalf of Greenland (2 and 10 animals per year, respectively) would not harm the stocks (IWC, 2009).

4.1 Future work

The Workshop considered this briefly but agreed that full consideration for common minke whales should await the results of work on the sex-ratio method. The present assessment method for fin whales could prove a starting point for consideration of an *SLA* for fin whales. The question of flexibility amongst species in terms of meeting a total yield of edible products requires considerable further thought as well as consultation with hunters and the Commission. In the meantime, the Workshop **agreed** that it would be useful for a working paper to be developed for the 2010 Annual Meeting that summarises for both fin whales and common minke whales in terms of:

(1) the existing stock structure hypotheses used in the RMP *Implementations*;
(2) the available information and data on stock structure, with an emphasis on the western and central North Atlantic;
(3) the available information on abundance.

5. WORK PLAN

The Workshop **agreed** to the following work plan in the period before the Annual Meeting:

(1) undertake the computing work and running of the revised trials on the sex-ratio method outlined under Item 3 (Allison, Schweder, Witting); and
(2) provide a short working paper on *inter alia* the stock structure hypotheses for North Atlantic fin and common minke whales used in the RMP *Implementations* as suggested under Item 4 (Donovan and Punt).

6. ADOPTION OF REPORT

The report was adopted by e-mail.

REFERENCES

International Whaling Commission. 2008. Chair's report of the 59th Annual Meeting. Annex L. Amendments to the Schedule adopted at the 59th Annual Meeting. *Ann. Rep. int. Whal. Comm.* 2007: 131.

Table 1

List of robustness tests based on population models (unless specified otherwise the estimator should match the population model used to generate the data).

Case	Population model	K^1	Over-dispersion	MSYR	Other
1	Influx	150,000	Estimated	2%	
2	Closed	150,000	Estimated	2%	
3	Model 5	150,000	Estimated	2%	
4	Closed-b	150,000	Estimated	2%	Closed estimator
5	Closed-a	150,000	Estimated	2%	Closed estimator
6	Influx	75,000	Estimated	2%	
7	Influx	50,000	Estimated	2%	
8	Influx	20,000[1]	Estimated	2%	
9	Influx	150,000	Estimated	2%	Closed estimator
10	Closed	150,000	Estimated	2%	Influx estimator
11	Influx	150,000	2 × estimated	2%	
12	Influx	150,000	1	2%	
13	Influx	150,000	Estimated	1%	
14	Closed	150,000	Estimated	1%	
15	Influx	150,000	Estimated	2%	+ 20-yrs extra data
16	Closed	150,000	Estimated	2%	+ 20-yrs extra data
17	Influx	150,000	Estimated	4%	
18	Closed	150,000	Estimated	4%	

Table 2

Specifications for the model-free robustness tests (separately for each dataset and for all datasets at the same time).

Case	Slope	Mean
1	Unchanged	Unchanged
2	+0.05	Unchanged
3	–0.05	Unchanged
4	Unchanged	+0.05
5	Unchanged	–0.05

International Whaling Commission. 2009. Report of the Scientific Committee. Annex E. Report of the standing working group on the Aboriginal Whaling Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 11: 145–68.

International Whaling Commission. 2010. Report of the Scientific Committee. Annex E. Report of the standing working group on the Aboriginal Whaling Management Procedure. *J. Cetacean. Res. Manage. (Suppl.)* 11(2): 135–53.

Witting, L. and Brandão, A. 2010. Report of the Scientific Committee. Annex E. Report of the standing working group on the Aboriginal Whaling Mangement Procedure. Appendix 5. Closed models for West Greenland minke whales. *J. Cetacean Res. Manage. (Suppl)* 11(2): 151–52.

Annex A

Agenda

1. Introductory items
   - 1.1 Convenor's opening remarks
   - 1.2 Arrangements for the meeting
   - 1.3 Election of Chair
   - 1.4 Appointment of rapporteurs
   - 1.5 Adoption of Agenda
   - 1.6 Documents available
2. Progress with intersessional work on the sex ratio method
   - 2.1 Development of code
   - 2.2 Results from first runs of the robustness test
3. Finalising work on the sex ratio method
   - 3.1 Review the specifications for the sex ratio method
   - 3.2 Review the specifications for the existing robustness test
   - 3.3 Determination of need for any further robustness test
   - 3.4 Evaluation of new specification of the closed model
4. Consideration of work required to develop *SLA*s for all Greenland fisheries before the end of the interim period
5. Work plan
6. Adoption of Report

Annex B

One-Sided Confidence Limits from Likelihood Functions

Tore Schweder

One-sided confidence intervals might be required for subject matter reasons, or simply because data are insufficient to provide ordinary two-sided confidence intervals. In case of the abundance of minke whales subject to aboriginal subsistence whaling off West Greenland, both reasons apply. To enable safe management, lower confidence bounds are required. Also, the data on sex ratios in the catches, to be considered below, yield a likelihood function with maximum for infinite abundance.

In general terms, let θ be a scalar parameter of interest, and let ζ be a vector of nuisance parameters. The data X yield a likelihood function $L(\theta;\zeta;X)$, profile likelihood $L(\theta;X) = L(\theta;\hat{\xi}(\theta);X)$ where $\hat{\xi}\ (\theta) = \arg\max L(\theta;\zeta;X)$ and with the maximum likelihood estimate $\hat{\theta}$.

The profile deviance function is $D(\theta;X) = 2\log(L(\hat{\theta};X)/L(\theta,X))$ is assumed well behaved, with a left branch declining continuously to zero at $\hat{\theta}$ and a right branch increasing continuously from this point. Traditional confidence intervals are obtained by probability scaling the profile deviance function by the chi-square distribution. Thus the left limit is obtained from the left branch, and the right endpoint of the confidence interval is found from the right branch. Lower one-sided confidence limits with degree above 50% are found from the left branch of the deviance function, while upper one-sided confidence limits are found from the right branch.

Focusing on one-sided confidence intervals of the form $(\theta^L(\alpha;x),\infty)$ based on observed data $X = x$ with degree α not too far below 0 (>0.5). Lower confidence limits are obtained from the left deviance branch:

$$LD(\theta;X) = D(\theta;X)I(\hat{\theta} > \theta)$$

From probability calculation or simulation, the cumulative null distribution of the left deviance branch is

$$F^{LF}\ (\upsilon;\theta) = P_{\theta}(LD(\theta;X) \leq \upsilon)$$

The left confidence curve for an observation $X = x$ is defined as the probability re-scaled left deviance branch re-scaled left deviance branch:

$$LC(\theta;x) = F^{LD}\ (LD(\theta;x);\theta)$$

for $LD(\theta;x)>0$, i.e. the $(\theta,\ LD(\theta;x))$ on the left deviance branch,

$$P_{\theta}(LD(\theta;X) \leq LD(\theta;x)) = LC(\theta;x)$$

Since the left confidence curve is decreasing for $\theta<\hat{\theta}$, $LC(\theta;x)<LC(\theta^L;x)$, is equivalent to $\theta\geq\theta^L$. With $\theta^L = \theta^L(\alpha;x)$ solving $\alpha = LC(\theta^L;x)$ the statement $\theta^L\geq\theta^L(\alpha;x)$ has confidence α and $\theta^L\ (\alpha;x)$ is indeed a lower confidence limit for a one-sided confidence interval of degree α.

Illustration

To illustrate the basic argument consider the simplest of cases with a sufficient statistic X being normally distributed with mean θ and unit variance. Here a lower confidence limit

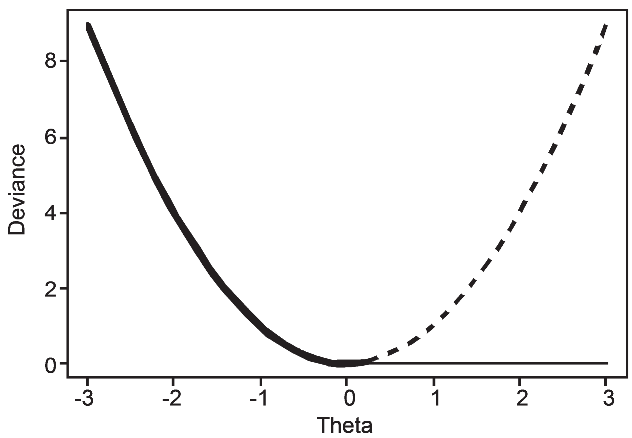

Fig. 1. The normal deviance function (dashed) and its left branch (solid line) for an observation $x = 0$.

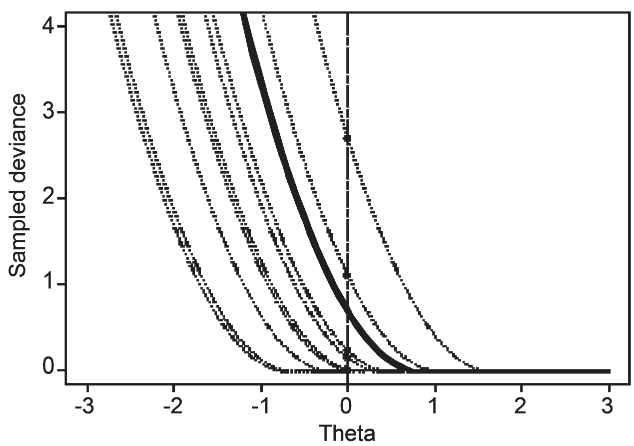

Fig. 2. One observed left deviance branch (solid line) and 10 simulated left deviance branches (dotted). Normal likelihood, $\theta = 0$.

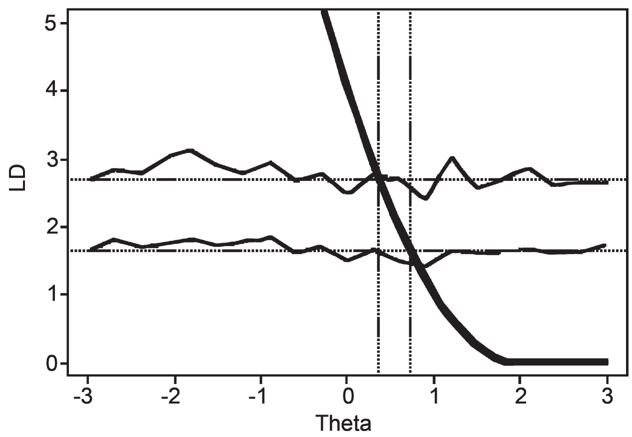

Fig. 3. The left deviance branch from an observation $x = 2$ from a $N(\theta,1)$ distribution (solid line). The dashed curves are simulated 95% and 90% quantiles (1,000 replicates) of $LD(\theta;X)$ and the dotted lines are the respective theoretical quantiles $\Phi{-}1(\alpha)$; $\alpha = 0.9$; 0.95. The vertical dotted lines are at the lower α confidence limit $\theta L(\alpha;x) = x - \Phi{-}1(\alpha)$.

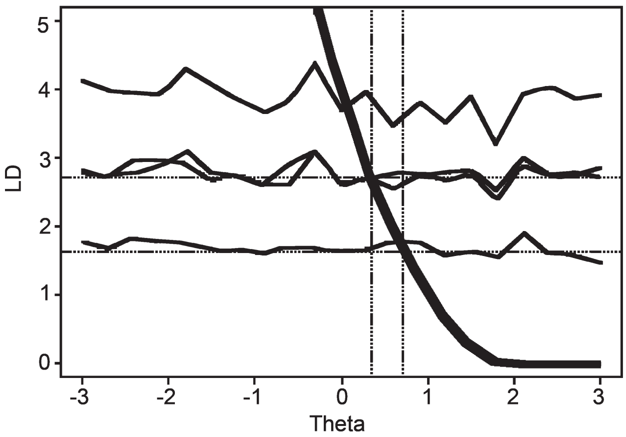

Fig. 4. Left deviance branch for $x = 2$ with correctly simulated quantile curves (95% and 90%), theoretical quantile curves, and quantiles 95% and 90% quantiles obtained by simulating the deviance rather than the left deviance branch. The correct 95% quantile coincides with the 90% quantile for the deviance.

based on an observation $X = x$ is $\theta^L(\alpha;x) = x - \Phi^{-1}(\alpha)$. This is easily argued from the pivotal quantity θ–X.

The same result is obtained from considering the monotonous left branch of the deviance function:

$$LD(\theta;x) = D(\theta;x)I(\theta - x) = (\theta < x)^2\, I(\theta < x)$$

where I is the indicator function and D is the deviance. Fig. 1 shows the normal deviance as a dashed curve, and its left branch as a solid line. To probability scale the observed left branch in Fig. 2 at $\theta(= 0)$, one might simulate $X \sim N(\theta,1)$ to obtain an empirical distribution of $LD(\theta;X)$. Ten simulated left deviance branches are shown in Fig. 2, and the sample of $LD(\theta;X)$ are shown as the intersections with the vertical line at $\theta = 0$. The frequency of $LD(\theta;X) \leq LD(0;X)$ is 8/10 in this illustration. The confidence of $\theta \geq 0$ is thus simulation estimated to 8/10, and the lower confidence limit of degree $\alpha > 0.8$ is below 0. Fig. 3 shows the left deviance branch and quantiles based on simulating 1,000 replicates for each of 21 values of θ. Fig. 4 shows the same, and also the result of simulating the deviance rather than the left deviance branch. As expected, the 90% quantile for the deviance coincides with the 95% quantile for the left deviance. This is so because the deviance function is symmetric.

Simulation is not necessary in this sample case. For $\upsilon > 0$:

$$LD(\theta;X) \leq \upsilon \Leftrightarrow LD^{-1}(\upsilon;X)$$

Thus, $LD^{-1}(\upsilon;x)$ is a lower confidence limit of degree $P_\theta(LD(\theta;X) \leq \upsilon) = \alpha$. In the sample normal case:

$$P_\theta(LD(\theta;X) \leq \upsilon) = \Phi(\sqrt{\upsilon}) = \alpha$$

For $\upsilon>0$, and $\theta^L(\alpha;x) = LD^{-1}(\upsilon;x) = x - \sqrt{\upsilon} = x - \Phi^{-1}(\alpha)$ is indeed the required one-sided lower confidence limit.

Annex C

Specifications of West Greenland Minke Whale Sex Ratio Method Robustness Trials

Population dynamics

A sex-structured age-structured model is used:

$$N^g_{t+1,0} = 0.5\rho_{t+1}N^{mat(f)}_{t+1} \qquad \text{(P1)}$$

$$N^g_{t+1,a+1} = (N^g_{t,a} - C^g_{t,a})\, s_a \qquad 0 \leq a \leq x\text{–}2 \qquad \text{(P2)}$$

$$N^g_{t+1,x} = (N^g_{t,x} - C^g_{t,x})\, s_x + (N^g_{t,x-1} - C^g_{t,x-1})\, s_{x-1} \qquad \text{(P3)}$$

where:

g is the whale gender (male/female),

$N^g_{t,a}$ is the total number of minke whales of gender g of age a in year t,

$N_{t,a}$ is the total number of minke whales of age a in year t, which is given by: $N_{t,a} = N^m_{t,a} + N^f_{t,a}$,

$C^g_{t,a}$ is the number of West Greenland minke whales of gender g of age a caught in year t,

ρ_{t+1} is the fecundity rate for year t+1, which takes the Pella-Tomlinson form:

$$\rho_{t+1} = b_k + [b_{\max} - b_k]\left[1 - (N^{1+}_{t+1}/K^{1+})^z\right] \quad \text{where} \qquad \text{(P4)}$$

b_k is the birth rate at carrying capacity K,

b_{max} is the maximal birth rate,

z relates to the strength of density dependence (the degree of compensation parameter).

N^{1+}_{t+1} is the total number of 1+ minke whales in year t+1, given by:

$$N^{1+}_{t+1} = \sum_{a=1}^{x}(N^f_{t+1,a} + N^m_{t+1,a}) \qquad \text{(P5)}$$

K^{1+} is the carrying capacity of 1+ minke whales, given by:

$$K^{1+} = \sum_{a=1}^{x}(N^{f}_{1948,a} + N^{m}_{1948,a}) = N^{1+}_{1948} \quad \text{(P6)}$$

$N^{mat(f)}_{t+1}$ is the number of mature females at the start of year t+1, given by:

$$N^{mat(f)}_{t+1} = \sum \gamma_a N^{f}_{t+1,a}, \text{ where} \quad \text{(P7)}$$

$$\gamma_a = \begin{cases} 0 & a < a_{mat} \\ 1 & a \geq a_{mat} \end{cases} \quad \text{and } a_{mat} \text{ is the age of reproductive maturity;} \quad \text{(P8)}$$

x is the maximum age considered (i.e. the 'plus group').

s_a is the age specific annual survival rate, given by:

$$s_a = \begin{cases} s_{juv}s_{ad} & a = 0 \\ s_{juv} & 1 \leq a \leq a_{ad}, \\ s_{ad} & a > a_{ad} \end{cases} \quad \text{where:} \quad \text{(P9)}$$

s_{juv} is the survival rate for juveniles, s_{ad} is the survival rate for adults, and

a_{ad} is the greatest age at which the 'juvenile' survival rate applies (taken as a_{ad} = 1).

The number of whales of gender g of age a caught in year t is given by:

$$C^{g}_{t,a} = C^{g}_{t} R^{g}_{t,a} \Big/ \sum_{a'=0}^{x} R^{g}_{t,a'} \quad \text{(P10)}$$

where:

C^{g}_{t} is the total catch of minke whales of gender g in year t,

$R^{g}_{t,a}$ is the number of recruited minke whales of age a and gender g in year t, given by

$$R^{g}_{t,a} = G_a N^{g}_{t,a} \quad \text{where} \quad \text{(P11)}$$

G_a is the age-specific differentiation of the catch relative to the age composition of the overall population, given by:

$$G_a = \begin{cases} 0 & a = 0 \\ a / a_c & 1 \leq a < a_c, \\ 1 & a \geq a_c \end{cases} \quad \text{(P12)}$$

where a_c is the age at full recruitment.

Parameters

The parameter values used are given in Table 1.

Table 1

The parameters used.

Parameter			
Age of adult a_{ad}	1		
Age at maturity a_{mat}	7		
Age at first capture a_c	6		
Maximum age considered (the 'plus group') x	6		
Adult survival s_{ad}	0.91		
	MSYR = 1%	**MSYR = 2%**	**MSYR = 4%**
Juvenile survival s_{juv}	0.646321	0.724728	0.886542
Maximal birthrate b_{max}	0.94	0.94	0.94
Birthrate at equilibrium b_k	0.886542	0.603496	0.403297
Strength of density dependence z	1.164367	2.052816	1.724999

Initial setup

The numbers for each gender g at each age a in the pristine population are set up as follows:

$$N^{g}_{1948,a} = 0.5\eta N^{*}_{a} \quad \text{where} \quad \eta = \mathrm{K} \Big/ \sum_{a=0}^{x} N^{*}_{a} \quad \text{and} \quad \text{(P13)}$$

$$N^{*}_{a} = \begin{cases} 1 & a = 0 \\ s_{a-1}N^{*}_{a-1} & 1 \leq a < x-1 \\ s_{x-1}N^{*}_{x-1}/(1-s_x) & a = x_c \end{cases} \quad \text{(P14)}$$

Fishery models

Three (of an original six) models form the focus of this work (Fig. 1): (IWC, 2009, pp. 21)

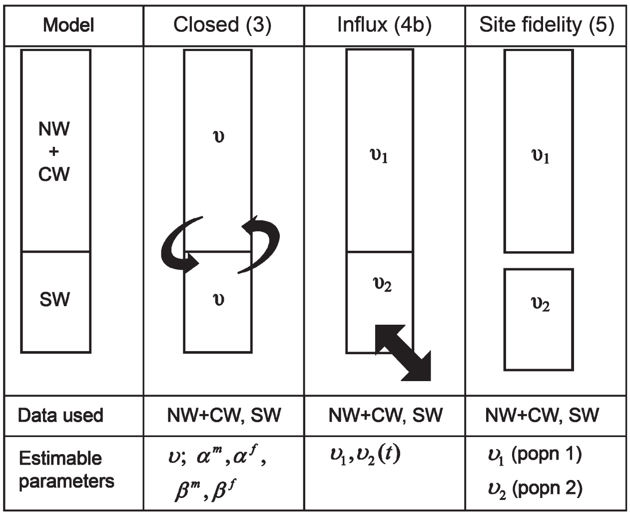

Fig. 1. Sex-ratio models for common minke whales off West Greenland. ν determines the degree of sex imbalance; α and β determines how ν changes over time.

(1) **'Closed' model (previously model 3)**. West Greenland is divided into two strata (NW+CW and SW); data for the two strata are included separately in the likelihood function. Separate (and time invariant) values for the parameters determining the degree of sex imbalance are estimated for each stratum. Allowance is made for time-dependent exchange of females and males between the two strata.
(2) **'Influx' model (4b).** As for the 'closed' model, except that there in no time-dependent exchange; rather the parameter determining the fraction of males in the SW stratum is assumed to change over time (or as a function of temperature).
(3) **'Site Fidelity' model (5)**. The animals in the NW+CW and SW strata exhibit site fidelity. For computational simplicity, this model is implemented by treating the animals in the NW+CW and SW strata as separate populations.

The number of minke whales caught in the whaling fishery/period *i* in year *t* **which are known by sex** is given by:

$$C_t^i = C_t^{m(i)} + C_t^{f(i)} \quad \text{where} \tag{M1}$$

$C_t^{m(i)}$ is the number of males caught in fishery/period *i* in year *t* and is $C_t^{f(i)}$ the corresponding catch of females.

'Site Fidelity' Model (5)
In the **'Site Fidelity' model** (5), the expected number of female minke whales caught by each fishery/period *i* in year *t* is given by:

$$\hat{C}_t^{f(i)} = C_t^i \frac{R_t^f}{R_t^f + \lambda^i R_t^m}, \quad \text{where } R_t^g = \sum_{a=0}^{x} R_{t,a}^g \tag{M2}$$

$R_{t,a}^g$ is defined by equation P11 and

λ^i is the selectivity of males relative to females for the fishery and period concerned, which is assumed to remain constant over that period, with equation (M1) following from the associated assumptions that:

$$\hat{C}_t^{f(i)} = F_t^{(i)} R_t^f; \quad \hat{C}_t^{m(i)} = \lambda^i F_t^{(i)} R_t^m \text{ , and} \tag{M3}$$

In this model the period/fishery North and South strata are run separately (using either the total Northern or the total Southern catch series) and so *i* represents:

$i = $
- *I* — the early Northern or the early Southern Greenlandic fishery (1955–1978)
- *II* — the Northern or the Southern Norwegian fishery (1968–1985)
- *III* — the late Northern or the late Southern Greenlandic fishery (1987–2007)

'Influx' Model (4b)
In this model the fishery/period *i* represents:

$i = $
- *I* — the early Greenlandic fishery (1955–1978)
- *II* — the late Southern Greenlandic fishery (1987–2007)
- *III* — the late Northern Greenlandic fishery (1987–2007)

The number of male whales in the SW stratum is assumed to be influenced by whales moving in from other areas in recent years. To effect this, the λ parameter in fishery *III* is assumed to vary linearly over the period from 1987 to 2007 when these Greenlandic catches were sampled for sex i.e. expected number of female minke whales caught in fishery/period *III* in year *t* is given by:

$$\hat{C}_t^{f(III)} = C_t^{III} \frac{R_t^f}{R_t^f + \lambda_t^{III} R_t^m} \qquad \text{(M4)}$$

where

$$\lambda_t^{III} = \frac{\lambda^{III}}{1 + (t - 1987)\left(\left(\lambda^{III} / \gamma\right) - 1\right) / (2007\text{–}1987)} \quad \text{so} \quad \lambda_{2007}^{III} = \frac{\lambda^{III}}{1 + \left(\left(\lambda^{III} / \gamma\right) - 1\right)} = \gamma \qquad \text{(M5)}$$

The expected number of female minke whales caught in fishery/periods *I* and *II* in year *t* ($\hat{C}_t^{f(I)}$ and $\hat{C}_t^{f(II)}$) are set as in equation M2 above.

'Closed' Model (3)
In this model the fishery/period *i* represents:

$$i = \begin{cases} I & \text{the early Greenlandic fishery (1955–1978)} \\ II & \text{the late Southern Greenlandic fishery (1987–2007)} \\ III & \text{the late Northern Greenlandic fishery (1987–2007)} \end{cases}$$

Model 3 is a closed population model with time dependence of the fractions of females and of males distributed in the NW + CW and SW strata in the later period of Greenlandic whaling commencing in 1987. The expected number of female minke whales caught in fishery/period *I* in year *t* ($\hat{C}_t^{f(I)}$) is set as in equation M2 above.

The proportion of whales of gender *g* in the northern area is assumed to change with time during the recent period of Greenlandic whaling as:

$$p_t^g = R_t^{n,g} / R_t^{WG,g} = e^{\alpha^g + \beta^g \tilde{t}} / \left[1 + e^{\alpha^g + \beta^g \tilde{t}}\right] \qquad \text{(M7)}$$

where $R_t^{n,g}$ is the number of recruited whales in the northern area of gender *g* in year *t*.

Since the overall West Greenland (WG) area is closed, it follows that $R_t^{n,g} = R_t^{WG,g} - R_t^{s,g}$ where *n* denotes the northern and *s* the southern area. So the proportion of whales of gender *g* in the SW stratum is given by $1 - p_t^g$. With two genders, there are four parameters ($\alpha^m, \beta^m, \alpha^f, \beta^f$) to describe the allocation of the two sexes between the two areas.

Thus, the expected number of female minke whales caught in fisheries *II* and *III* in year *t* is given by

$$\hat{C}_t^{f(II)} = C_t^{II} \frac{R_t^f p_t^f}{R_t^f p_t^f + \lambda_t^{III} R_t^m p_t^m} \qquad \text{(M8)}$$

and

$$\hat{C}_t^{f(III)} = C_t^{III} \frac{R_t^f (1 - p_t^f)}{R_t^f (1 - p_t^f) + \lambda_t^{III} R_t^m (1 - p_t^m)} \qquad \text{(M8)}$$

Note: in the 'Closed' model λ^{II} and λ^{III} are identical by definition.

The time *t* is specified by $\tilde{t} = t - 1987$.

In the code the α and β parameters are re-parameterised in terms of the proportions in years 1987 and 2007 (p_{87}^g and p_{07}^g):

$$\alpha^g = \frac{\tilde{t}_{07} \, 1\text{n}\left(p_{87}^g / (1 - p_{87}^g)\right) - \tilde{t}_{87} \, 1\text{n}\left(p_{07}^g / (1 - p_{07}^g)\right)}{(\tilde{t}_{07} - \tilde{t}_{87})} \quad \text{and} \qquad \text{(M9)}$$

$$\beta^g = \frac{1\text{n}\left(p_{07}^g / (1 - p_{07}^g)\right) \, 1\text{n}\left(p_{87}^g / (1 - p_{87}^g)\right)}{(\tilde{t}_{07} - \tilde{t}_{87})} = \frac{1\text{n}\left(p_{07}^g / (1 - p_{07}^g)\right) \, 1\text{n}\left(p_{87}^g / (1 - p_{87}^g)\right)}{(2007\text{–}1987)} \qquad \text{(M10)}$$

The likelihood function
The **Schweder likelihood** function is used (see IWC, 2009). The negative of the approximate log-likelihood (ignoring constants) which is minimised in the fitting procedure is given by:

$$-1\text{n}\, L = \sum_{i=I}^{III} \sum_{y=y_i^1}^{y_i^*} \left\{ \frac{1}{\sigma_i^2} (C_y^{f(i)} - \hat{C}_y^{f(i)})^2 / \left(2\, \hat{C}_y^{f(i)} \left(1 - \frac{\hat{C}_y^{f(i)}}{C_y^i}\right)\right) + 1\text{n}\, \sigma_i + 1\text{n} \sqrt{\hat{C}_y^{f(i)} \left(1 - \frac{\hat{C}_y^{f(i)}}{C_y^i}\right)} \right\} \qquad \text{(L1)}$$

where

y_i^1 is the first year of catches for period i,

y_i^* is the last year of catches for period i,

σ_i measures overdispersion of the distribution of catches compared to a Poisson distribution for which the variance is equal to the expected catch for the period and fishery concerned, whose maximum likelihood estimate is given by:

$$\sigma_i = \sqrt{\frac{1}{n_i} \sum_{y=y_i^1}^{y_i^*} \left\{ (C_y^{f(i)} - \hat{C}_y^{f(i)})^2 / \left(2\, \hat{C}_y^{f(i)} \left(1 - \frac{\hat{C}_y^{f(i)}}{C_y^i}\right)\right) \right\}}. \qquad \text{(L1)}$$

n_i is the total number of years in the summation of each whaling period.

Simulation algorithm
For the best estimate of virgin biomass (*K*) (here taken to be 200,000 as a surrogate for infinity), the models are fitted to the original data to obtain estimates for the overdispersion (σ's) and the selectivity of males relative to females (λ's) for the period and fishery concerned. Then, for a given value of the true virgin biomass (*K*), and the overdispersion as estimated for *K* =

200,000, the models are fitted to the original data to obtain estimates of the λ's. For each model the deviance as a function of K is obtained for the original data.

The following method is used to calculate the confidence intervals:

(a) Estimate the overdispersion (σ's) for $K = \infty$ (taken as $K = 200{,}000$) using the true catch data.
(b) For each of a specified set of values of K (denoted K_L):
 (c) Estimate the parameter values (denoted P_L) for fixed K (= K_L) using the true catch data and using P_{L-1} to initialise the run;
 (d) Generate the catch data using $K = K_L$, the parameters P_L (except for the dispersion) and the σ's from step a using the following method:
  (i) set up the pristine population (equation P13);
  (ii) generate the catch data (for each year generate the catch data and then project the population forward by one year removing the generated catches (equations P1–3))
 (e) Fit the model to the catch data generated in step (d) with for the case when K is fixed (= K_L) [initialised with P_L] and the case when K is estimated [initialised using the fixed K fit parameters just obtained] to give the deviance value for the generated data[1].
 (f) Steps (d) to (e) are repeated 1,000 times to get the distribution of the deviance values corresponding to $K = K_L$.

Data generation

The data generation takes into account that not all whales are sampled for sex, and that there is a period over which both Norwegian and Greenlandic catches occurred. The assumption is made that the Norwegian catch was always fully sampled, so the sampled Greenland catch is generated from the total Greenland catch each year.

The values of the selectivity parameters (λ^i and γ) used below are those estimated for the value of K under consideration whereas the overdispersion estimates (σ_i) are those estimated for $K = 200{,}000$.

Data generation for the Influx model (4b)

The catches by sex for the sampled animals (animals for which sex is known in the actual data) are generated under the assumption that they are governed by an overdispersed binomial distribution as detailed below. The catches by sex for the unsampled animals are then generated using the same approach. The removals by sex from the population are the sum (by sex) of the sampled and unsampled catches. In the data generation algorithm described below, in instances in which a negative catch is generated for one of the sexes, the catch for that sex is set to zero and consequently the catch for the opposite sex is set to the total number being sampled.

C_t^i is the catch from Fishery i catch in year t which **is known by sex** (see equation M1).

In the period 1948–86 the numbers of catches sampled by sex ($\tilde{S}_t^{f(I)}$ and $\tilde{S}_t^{m(I)}$) for the early Greenlandic fishery are generated from the normal distribution given by equation D.1.

$$\tilde{S}_t^{f(i)} = N\left(\frac{R_t^f}{R_t^f + \lambda^i R_t^m} C_t^i,\quad \sigma_i^2 \frac{R_t^f}{R_t^f + \lambda^i R_t^m} C_t^i\right), \text{ and } \tilde{S}_t^{m(i)} = C_t^i - \tilde{S}_t^{f(i)} \tag{D1}$$

where i = I (the early Greenlandic fishery 1955–1978). In the years 1948–1954 and 1979–1986 there was no sampling so C_t^i and $\tilde{S}_t^{f(I)} = \tilde{S}_t^{m(I)} = 0$.

The numbers of unsampled catches by sex ($\tilde{U}_t^{f(I)}$ and $\tilde{U}_t^{m(I)}$) from 1948–86 are generated from the normal distribution given by equation D.2.

$$\tilde{U}_t^{f(i)} = N\left(\frac{R_t^f}{R_t^f + \lambda^i R_t^m} C_t^{U(i)},\quad \sigma_i^2 \frac{R_t^f}{R_t^f + \lambda^i R_t^m} C_t^{U(i)}\right), \text{ and } \tilde{U}_t^{m(i)} = C_t^{U(i)} - \tilde{U}_t^{f(i)} \tag{D2}$$

where i = I, $C_t^{U(I)} = C_t^{WG} - C_t^i$ and C_t^{WG} is the total Greenlandic catch in year t. (D3)

The generated sampled and unsampled numbers are added to the (known) Norwegian catches by sex to give the total generated catch by sex

$$\text{e.g. } \tilde{C}_t^f = C_t^{f,Nwy} + \tilde{S}_t^{f(I)} + \tilde{U}_t^{f(I)} \tag{D4}$$

Note the total catch in year t, is the sum of the Greenlandic and Norwegian catches in that year, i.e

$$C_t = C_t^{WG} + C_t^{Nwy} \tag{D5}$$

In the period 1987–2007 the total Greenland catches (C_y) are split into the NW+CW and SW strata (C_t^{NW+CW} and C_t^{SW}), where these are taken to be the observed data as used for Model 5 (NW+CW) and Model 5 (SW).

The numbers of sampled and unsampled catches ($\tilde{S}_t^{f(II)}$, $\tilde{S}_t^{m(II)}$, $\tilde{U}_t^{f(II)}$ and $\tilde{U}_t^{m(II)}$) for the period 1987–2007 Northern strata are generated in a similar manner to those for 1946–86 using equations D1 and D2 with $i = II = NW+CW$ i.e. the λ^i, σ_i correspond to the Greenlandic (1987–2007) period and

$$C_t^{U(II)} = C_t^{NW+CW} - C_t^{II} \tag{D6}$$

[1]When fitting the model the approach of Brandão and Butterworth (2009) is used to overcome convergence problem, using a combination of several re-runs and various initialisation values of K. The procedure adopted consists of seven different K initialisation values, which span the range of K values as proportions of the true K, with one of these Ks being the true K. For each set, the one with the lowest negative log-likelihood is chosen and convergence checked. If the convergence criterion is not met, the model fitting procedure is re-run with initial parameter values set to be those obtained in the last run and a further set of K initialisation values as before. A total of five such re-runs takes place unless the convergence criterion is met.

The number of sampled females in the SW Greenlandic catch $\tilde{S}_t^{III,f}$ is generated from:

$$N\left(\frac{R_t^f}{R_t^f+\lambda_t^{III}R_t^m}C_t^{III},\quad \sigma_{III}^2\frac{R_t^f}{R_t^f+\lambda_t^{III}R_t^m}C_t^{III}\right), \tag{D7}$$

and number of unsampled females in the SW Greenlandic catch $\tilde{U}_t^{SW,f}$ is generated from:

$$N\left(\frac{R_t^f}{R_t^f+\lambda_t^{III}R_t^m}C_t^{U_{III}},\quad \sigma_{III}^2\frac{R_t^f}{R_t^f+\lambda_t^{III}R_t^m}C_t^{U_{III}}\right), \tag{D7}$$

where λ_t^{III} is assumed to change linearly over time during the period and is defined as given in equation M5

and $C_t^{U_{III}} = C_t^{SW} - C_t^{III}$.

The generated catches from each strata are summed to give the total generated catch by sex, e.g.

$$\tilde{C}_t^f = \tilde{C}_t^{NW+CW,f} + \tilde{C}_t^{SW,f} = \tilde{S}_t^{II,f} + \tilde{U}_t^{NW+CW,f} + \tilde{S}_t^{III,f} + \tilde{U}_t^{SW,f} \tag{D9}$$

Data generation for the Closed Model (3)

The data generation algorithm is essentially the same as for the Influx Model (above), but with the following changes:

- When generating data for the NW+CW strata: $R_t^g \rightarrow R_t^g p_t^g$ where p_t^g is defined in equation M7.
- When generating data for the SW strata: $R_t^g \rightarrow R_t^g (1-p_t^g)$

Robustness trials

The robustness tests are based on two classes of data sets: (a) data sets generated using a population dynamics model under alternative sets of assumptions, and (b) data sets generated using ad hoc algorithms to alter the observed data (model-free data sets). The model-based robustness tests are used to examine how the estimation results change in response to:

(1) different 'true' K (and hence N_{2007}) values [when the population dynamics model is known];
(2) different extents of overdispersion [when the population dynamics model is known];
(3) model mis-specification [when the model used to generate the data sets differs from that on which the estimation method is based, such as an intentional confusion between models 3 and 4b, but not necessarily limited to these two models]; and
(4) data sets that are longer than the current data set. The future data will be generated by projecting the population dynamics model forward under the average catch over the last 10 or 20 years.

The model-free data sets explore the behaviour of the estimation method when the trend of the sex-ratios is changed in a systematic manner.

'Adequate performance' will be evaluated under the principle that changing the data should lead to changes in the model output in the expected direction and of the expected magnitude or that it should be possible to provide a qualitative explanation for any discrepancies between the model output and *a priori* expectations.

(a) Data sets generated using a population dynamics model under alternative sets of assumptions

The initial set of robustness trials is listed in Table 2. The values for K in Table 2 are selected in order to allow a range of stock status levels to be examined in the simulations; the values are preliminary and may need to be refined once initial results are available.

The following process will be used in conducting and evaluating the results of model-based robustness trials:

(1) Estimate the overdispersion and other parameters (denoted P_{op}) by fitting the population dynamics model to the actual data set given the specified 'true' model and value of K.

Table 2

An initial list of robustness tests based on population models (unless specified otherwise the estimator should match the population model used to generate the data).

Case	Population model	K[1]	Overdispersion	MSYR	Other
1	Influx	150,000	Estimated	2%	
2	Closed	150,000	Estimated	2%	
3	Model 5	150,000	Estimated	2%	
4	Closed-b	150,000	Estimated	2%	Closed estimator
5	Closed-a	150,000	Estimated	2%	Closed estimator
6	Influx	75,000	Estimated	2%	
7	Influx	50,000	Estimated	2%	
8	Influx	20,000[1]	Estimated	2%	
9	Influx	150,000	Estimated	2%	Closed estimator
10	Closed	150,000	Estimated	2%	Influx estimator
11	Influx	150,000	2 × Estimated	2%	
12	Influx	150,000	1	2%	
13	Influx	150,000	Estimated	1%	
14	Closed	150,000	Estimated	1%	
15	Influx	150,000	Estimated	2%	+20 yr extra data
16	Closed	150,000	Estimated	2%	+20 yr extra data
17	Influx	150,000	Estimated	4%	
18	Closed	150,000	Estimated	4%	

(2) Generate 1,000 data sets taking account of uncertainty in the sex ratios of the catches, using the 'true' K and 'true' model (i.e. using the P_{op} parameters).
(3) For each data set:
   (a) Calculate the deviance[2] for the data set corresponding to the 'true' value of K when the estimation is based on the 'estimation' model (i.e. the difference in log likelihoods between the fit with fixed K (= K_{true}) and the fit estimating K). The parameters corresponding to the fit with fixed K are denoted P_{est} .
   (b) Generate a large number (e.g. 1,000) of data sets based on the true value of K and the values for the other parameters of the model (the P_{est} parameters obtained in step (a)) and compute the deviance for each of these data sets. The model used to generate the data sets and compute the deviance is the 'estimation' model.
   (c) Record the percentile that the deviance from step (a) represents in the distribution generated from step (b).
   (d) Record if the deviance of the upper 5%- and 10%-iles of the distribution obtained from step (b) is smaller than the deviance obtained from step (a).
(4) Plot the collection of 1,000 percentiles (one for each simulated data set) and assess the frequency of the percentages being larger than 2%, 5%, 10%, etc. (Fig. 2b).
(5) Calculate the percentage of times for the 1,000 generated data sets that the deviance of the 95%- and 90%-iles is smaller than the deviance of the generated data.

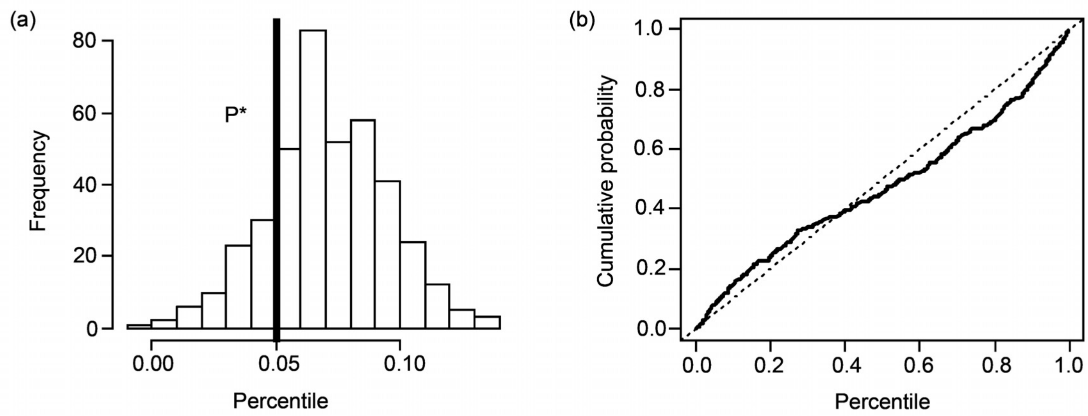

Fig. 2. (a) Histogram of percentiles from 400 simulated data sets along with the P* based on the actual data. (b) Cumulative distribution of percentiles.

(b) Model-free data sets

The initial set of robustness trials is listed in Table 3 to be combined with the values in Table 2. The values in Table 3 (particularly those for the slopes in mean sex-ratio) are preliminary and may need to be refined once initial results are available.

The process for evaluating model-free robustness tests is similar. Specifically:–

(1) Select a set of values for K. For each value of K:
   (a) Calculate the deviance for the original data set.
   (b) Generate a large number (e.g. 1,000) of data sets based on the true value of K and the values for the other parameters of the model (these would be obtained from step (a)) based on an overdispersed binomial distribution for both the sexed and unsexed component of the catch.
   (c) Record the percentile, P^*, that the deviance from step (a) represents in the distribution generated from step (b).
(2) Repeat steps a–c above for each data set and value of K.
(3) For each value of K plot the percentiles obtained at step 2 using a histogram and P^* using a vertical line.

Table 3

Specifications for the model-free robustness tests (separately for each data set and for all data sets at the same time).

Case	Slope	Mean
1	Unchanged	Unchanged
2	+0.05	Unchanged
3	–0.05	Unchanged
4	Unchanged	+0.05
5	Unchanged	–0.05

REFERENCES

International Whaling Commission. 2009. Report of the Scientific Committee. *J. Cetacean Res. Manage.* (*Suppl.*) 11: 21.

Brandão, A. and Butterworth, D.S. 2009. Yet further results for lower confidence limits for the abundance of West Greenland minke whales. Paper SC/61/AWMP7 presented to the IWC Scientific Committee, June 2009. Madeira, Portugal (unpublished). 28pp. [Paper available from the Office of this Journal]

[2]The deviance is set to zero if the estimated K is less than the true value.

Appendix 1

TOTAL CATCH SERIES BY SEX

The total catch series by sex is listed in Table 1. To generate these data the sex ratio of the sex specific reporting in any year from the Greenland or Norwegian fishery was set to apply to the total number of whales landed and struck and loss by that fishery in that year. For years with no or almost no sex information on the removals by Greenlandic whalers (1948–54; 1979–84), the sex specific removals were estimated from the sex ratio of the reported removals in that fishery over all years with sex specific reporting. The estimated sex specific removals were then added to provide a time series of total sex specific removal.

Table 1

Total catches:

Year	Female	Male	Year	Female	Male	Year	Female	Male
1948	3	1	1968	273	62	1988	95	14
1949	4	1	1969	252	184	1989	43	20
1950	7	2	1970	181	152	1990	72	17
1951	12	4	1971	340	127	1991	81	28
1952	24	8	1972	278	114	1992	89	21
1953	24	8	1973	383	114	1993	84	28
1954	16	6	1974	393	76	1994	81	23
1955	12	10	1975	301	23	1995	108	47
1956	16	6	1976	323	55	1996	130	40
1957	18	6	1977	260	100	1997	105	43
1958	16	14	1978	221	34	1998	126	43
1959	49	6	1979	230	95	1999	134	38
1960	49	7	1980	257	80	2000	107	38
1961	20	15	1981	198	67	2001	103	36
1962	52	20	1982	228	88	2002	103	36
1963	99	67	1983	242	94	2003	124	62
1964	95	67	1984	225	80	2004	133	46
1965	120	76	1985	186	87	2005	141	35
1966	151	74	1986	107	38	2006	134	47
1967	209	35	1987	65	21	2007	127	40

Catches by period:

Period 1 (Greenlandic 1955–78)			Period 2 (late N Greenland)			Period 2 (late S Greenland)		
Year	Female	Male	Year	Female	Male	Year	Female	Male
1955	8	7	1987	9	6	1987	3	1
1956	15	5	1988	27	4	1988	8	1
1957	18	6	1989	13	12	1989	21	4
1958	6	5	1990	32	13	1990	27	1
1959	17	2	1991	38	10	1991	25	9
1960	15	2	1992	44	9	1992	30	9
1961	9	7	1993	44	22	1993	26	3
1962	43	17	1994	50	14	1994	27	6
1963	47	32	1995	68	36	1995	37	10
1964	37	26	1996	76	31	1996	48	7
1965	30	19	1997	70	33	1997	31	9
1966	49	24	1998	81	33	1998	42	9
1967	42	7	1999	86	26	1999	45	11
1968	47	10	2000	57	17	2000	24	8
1969	42	14	2001	56	25	2001	30	5
1970	20	12	2002	60	21	2002	36	11
1971	25	6	2003	59	34	2003	57	22
1972	40	6	2004	88	26	2004	39	18
1973	39	8	2005	93	20	2005	42	14
1974	34	6	2006	106	34	2006	19	10
1975	17	1	2007	97	30	2007	22	8
1976	20	2						
1977	39	15						
1978	13	2						

Annex D

Model-Based Robustness Tests for the Sex Ratio Method

The model-based robustness tests are used to examine how the estimation results change in response to:

(1) different 'true' K (and hence N_{2007}) values [when the population dynamics model is known];
(2) different extents of overdispersion [when the population dynamics model is known];
(3) model mis-specification [when the model used to generate the data sets differs from that on which the estimation method is based]; and
(4) data sets that are longer than the current data set. The future data will be generated by projecting the population dynamics model forward under the average catch over the last 10 or 20 years.

The following is the process for conducting and evaluating the results:

(1) Set a new 'true' value for K and select a 'true' model. Estimate the overdispersion parameters and any other parameters by fitting the population dynamics model to the actual data set given the chosen model and value of K.
(2) Generate 1,000 data sets taking account of uncertainty in the sex ratios of the catches, using the 'true' K and 'true' model.
(3) For each data set:
    (a) Calculate the deviance[1] for the data set corresponding to the 'true' value of K when the estimation is based on the 'estimation' model.
    (b) Generate a large number (e.g. 1,000) of data sets based on the true value of K and the values for the other parameters of the model (these would be obtained from step (a) and compute the deviance for each of these data sets. The model used to generate the data sets and compute the deviance is the 'estimation' model.
    (c) Record the percentile that the deviance from step (a) represents in the distribution generated from step (b).
    (d) Record if the deviance of the upper 5%- and 10%-iles of the distribution obtained from step (b) is smaller than the deviance obtained from step (a).
(4) Plot the collection of 1,000 percentiles (one for each simulated data set) and assess the frequency of the percentages being larger than 2%, 5%, 10%, etc.
(5) Calculate the percentage of times for the 1,000 generated data sets that the deviance of the 95%- and 90%-iles is smaller than the deviance of the generated data.

[1]The deviance is set to zero if the estimated K is less than the value.

The process for evaluating model-free robustness tests is similar.

(1) Select a set of values for K. For each value of K:
    (a) Calculate the deviance for the original data set.
    (b) Generate a large number (e.g. 1,000) of data sets based on the true value of K and the values for the other parameters of the model – these would be obtained from step (a) based on an overdispersed binomial distribution for both the sexed and unsexed component of the catch.
    (c) Record the percentile, P^*, that the deviance from step (a) represents in the distribution generated from step (b).
(2) Repeat steps a–c above for each data set and value of K.
(3) For each value of K plot the percentiles obtained at step 2 using a histogram and P^* using a vertical line.