Annex K

Report of the Standing Working Group on Environmental Concerns

Members: Rowles (Chair), Parsons (co-Chair), Antonopoulou, Bando, Baulch, Bell, Bickham, Bjørge, Brockington, Chilvers, Collins, Currey, Donovan, Double, Feindt-Herr, Fortuna, Funahashi, Gallego, Galletti Vernazzani, Garrigue, Gedamke, Genov, George, Gonzalez, Hall, Haug, Holm, Iñíguez, Jímenez, Kaufman, Kim, Kitakado, Kock, Konishi, Lauriano, Leaper, Leslie, Liebschner, Marcondes, Mate, Mattila, Moronuki, Murase, Nawaz, Palka, Panigada, Parsons, Prewitt, Rendell, Reyes Reyes, Ridoux, Ritter, Rojas-Bracho, Rosa, Rose, Rosenbaum, Rowles, Santos, Scheidat, Simmonds, Sironi, Skaug, Solvang, Stachowitsch, Stimmelmayr, Suydam, Thomas, Urban, Vély, Víkingsson, Vladimirov, Wade, Weinrich, Weller, Williams, Ylitalo, Yoshida, Zerbini.

1. OPENING REMARKS

Rowles and Parsons welcomed the participants to the Standing Working Group on Environmental Concerns (SWG).

2. ELECTION OF CHAIR

Rowles and Parsons were elected as co-Chairs.

3. ADOPTION OF AGENDA

The adopted Agenda is given in Appendix 1. A number of members of the SC were unable to participate in discussions regarding papers originating from JARPA II (see Annex U for details). Therefore, it should be noted that the discussion in the report on these papers does not include the views of those members of the SWG.

4. APPOINTMENT OF RAPPORTEURS

Cipriano, Rosa and Ylitalo were appointed rapporteurs, with Rose assisting with final report.

5. REVIEW OF AVAILABLE DOCUMENTS

The documents available to the sub-committee were identified as: SC/65b/E01-E13; SC/65b/BRG08; Isoda *et al.* (2014), SC/65b/SP02-SP05; SC/65b/Rep03, SC/65b/Rep05; SC/65b/SM03, SC/65b/SM25, Di Guardo and Mazzariol (2013a; 2013b; 2014), Jacobs (2014), National Academy of Sciences (2014), Nowacek *et al.* (2013), Reeves *et al.* (2014), Rosenbaum *et al.* (2014), (Schwacke *et al.* (2014a; 2014b), Simmonds *et al.* (2014), and Wildlife Conservation Society (2013).

6. SOCER: RECEIVE THE STATE OF THE CETACEAN ENVIRONMENT REPORT

The SOCER provides an annual update, as initially requested by Commission Resolutions 1997-7 (IWC, 1998) and 1998-5 (IWC, 1999), on: (a) environmental matters that potentially affect cetaceans; and (b) developments in cetacean populations/species that reflect environmental issues. It is tailored for a non-scientific audience. Commission Resolution 2000-7 (IWC, 2001) acknowledged the value of this effort and requested annual submission of the report. The first SOCER (Stachowitsch *et al.*, 2003) was submitted in 2003 and focused on the Mediterranean and Black Seas and the Atlantic Ocean. Subsequent SOCERs are now scheduled to review issues for ocean regions in a continuing yearly cycle: Mediterranean and Black Sea; Atlantic Ocean, Caribbean and Gulf of Mexico; Southern Ocean/Arctic Seas; Pacific Ocean; and Indian Ocean. Each compilation has also provided information on topical issues of global concern.

The 2014 SOCER (SC/65b/E01; see Appendix 4) focused on the Atlantic Ocean, Caribbean and Gulf of Mexico, summarising key papers and articles published from 2012 through 2014. As in previous years, the papers selected as entries covered a wide range of topics. Glossaries of scientific and common names of the species mentioned, and of technical terms and acronyms used, are also provided.

The SOCER editors presented an overview of this year's SOCER entries to the SWG and noted that the report was still a draft and encouraged submission of additions and corrections by members where necessary. Two Atlantic papers reported on work using remote sensing (satellite imagery): an effort to monitor the coastal waters of Spain for chlorophyll content and an effort, in Florida waters, to use GIS approaches to more effectively combat lost and discarded fishing gear. Another debris-related paper discussed riverine input via the Thames, highlighting the importance of reducing both floating and submerged items.

An extensive South Atlantic 'garbage patch' was detected. High persistent organic pollutant contents were found in the blubber of common dolphins (*Delphinus delphis*) off the UK's south-western coast, and the high levels of perfluorinated compounds at one site in South Carolina were of the same order of magnitude as occupationally exposed humans. On a positive note, a ban on tributyltin as an additive in antifouling paints in the EU has substantially reduced concentrations in harbour porpoises (*Phocoena phocoena*). In the western Atlantic, DDT and its breakdown products are also declining. Regarding disease, a novel *morbillivirus* strain has been found in a Guiana dolphin (*Sotalia guianensis*) in Brazil, and possible larger-scale transmission of *morbillivirus* is supported by finds of nearly identical strains in a Canary Island bottlenose dolphin (*Tursiops truncatus*) and striped dolphins (*Stenella coeruleoalba*) in the Mediterranean. No new mass strandings of beaked whales have been reported in the Canary Islands since the Spanish government imposed a moratorium on naval exercises there. The success of temporary regulations to reduce ship collisions with North Atlantic right whales (*Eubalaena glacialis*) has led to their permanent implementation. Finally, potential indications of climate change were reflected in UK waters by northward shifts of at least four cetacean species and by a first-time stranding of a warmer-water species (Blainville's beaked whale, *Mesoplodon densirostris*).

Globally, impacts of climate change continue to be documented and concerns about its effects on the marine environment and ecosystem function escalate. The wide-scale impacts of climate change on the oceans may be one of the most pressing and pervasive issues environmentally over

the next decades. On a more positive note, guidelines from the International Maritime Organization on reducing noise from shipping is a major first step in reducing the impact of this ubiquitous form of marine pollution.

Also, scientific understanding of underwater noise impacts is also improving, including the fact that more species are vulnerable than previously thought. Behavioural responses that could lead to long-term and population-level effects may be occurring at much lower sound levels than expected or predicted by scientists and at much greater distances than previously considered possible (e.g. beaked whales responded to sonar use by a vessel over 100km away). Therefore the impacts of underwater noise, especially military sonar and military exercise-related noise, may be more serious, common and widespread than previously thought.

The SWG congratulated the SOCER editors on another thorough and informative summary.

It was noted that the SOCER would be posted to the Commission website, and the Secretariat would circulate an email to appropriate parties to inform them of the posting and provide them with the web link to the report. The SWG thanked the SOCER editors for compiling this year's report and **encouraged** participation in the upcoming version. In 2015 (SC/66a) the focus of the SOCER will be on the Pacific Ocean region and in 2016 (SC/66b) the focus will be the Arctic and Antarctic.

7. POLLUTION

7.1 Pollution 2020+

The potential for microplastics to impact cetaceans was raised in the Marine Debris Workshop report (IWC, 2014a) and discussed at SC/65a, where the Committee agreed that an initial review of microplastics was needed. SC/65b/E13 provided a review of microplastics in the marine environment and the potential impact of microplastics on cetaceans. Microplastics are small plastic particles (<5mm), manufactured as beads, (primary microplastics), which are raw materials for the plastics industry or used as abrasives, or arising as a result of fragmentation of larger plastic debris (secondary microplastics). They have a global distribution, do not biodegrade and are only partially removed in wastewater or sewage treatment. The toxicological consequences for marine life range from the mechanical hazards, particularly to small organisms in which they can block feeding appendages, to hindering the passage of food or causing pseudo-satiation and inhibit feeding by filling the stomach. They can leach chemicals, such as plasticisers (e.g. phthalates), additives (e.g. bisphenol A) and stabilisers (e.g. organotins), and adsorb water-borne contaminants (e.g. organochlorines, polycyclic aromatic hydrocarbons and other persistent organic pollutants). In higher organisms, evidence for direct effects is limited. Studies in dogs have shown that ingested polyvinyl chloride (PVC) particles can appear in the portal vein; however, no *in vivo* or *in vitro* direct toxicity studies have been carried out. There is toxicological and epidemiological evidence that the leaching chemicals (such as phthalates and bisphenol A), although highly hydrophilic and rapidly metabolised, are endocrine disruptors in laboratory animals and in environmentally exposed humans and they have been associated with oestrogenic activity and male infertility. To date, the only studies to have investigated the occurrence of leachate chemicals in a cetacean species showed the presence of plastic additive metabolites in the blubber of stranded Mediterranean fin whales (*Balaenoptera physalus*), see Fossi *et al.* (2012; 2014). The concentrations of mono-(2-ethylhexyl) phthalate (MEHP), a metabolite of di(2-ethylhexyl)phthalate or DEHP, found in the blubber and in euphausiid prey, suggested that phthalates might be useful as an indicator of microplastics exposure. Although phthalates are excreted largely in the urine (greater than 90%), studies in humans and primates (Peck and Albro, 1982) found DEHP to be excreted as conjugated (glucuronide) oxidation products of MEHP, with excretion in faeces accounting for 10% of the administered DEHP. If this pathway is similar in cetaceans, then faeces may provide a useful exposure matrix and could be used together with stomach contents information to investigate assimilation and excretion of microplastics. Due to the very short half-life and the hydrophilic nature of phthalates, monitoring exposure through levels in excreta may be much more valuable than using tissue concentrations. Similarly, Kurebayashi *et al.* (2003) demonstrated that the main excretory route for bisphenol A in rodents is the faeces, as it is mainly metabolised to BPA-glucuronide, excreted through the bile. Experimental studies in seabirds have shown that adsorbed contaminants (such as organochlorines) can be transferred and assimilated into the body from ingested microplastics (Yamashita *et al.*, 2014). This may therefore present a supplementary source of persistent organic pollutant exposure to cetaceans, additional to direct assimilation of these compounds through the food chain.

The SWG thanked the authors for their comprehensive report. It was noted that the SWG may wish to revisit prior advice regarding microplastics and readdress them with additional vigour based on the additional information gained from this paper and SC/65b/Rep05.

SC/65b/Rep05 reported on the IWC Pollution 2020 Steering Group Meeting held from 25-28 March 2014 at the Sea Mammal Research Unit, Scottish Oceans Institute, University of St Andrews. The complete report can be found in this volume. The last four years have seen the completion of Phases II and III of the Pollution 2000+ initiative, which has included the finalisation of an individual-based model that can be used to investigate the effects of pollution (particularly polychlorinated biphenyl or PCB) exposure on cetacean *populations* (Hall *et al.*, 2013). The group discussed the applicability of the model as it currently stands and how it could be further improved. The major points were: (1) that the model should include the ability to change the annual accumulation over time, as this would be better to reflect the gradual decrease in environmental PCBs. There are a number of longer term datasets that could assist in determining the rate of decrease over decades; (2) the vital rates used to parameterise both the dolphin and the humpback model may be outdated so efforts to update those where possible would be helpful; (3) one of the major sources of uncertainty in the model are the parameters that control the offloading of PCBs from mothers to their calves; both *in utero* transfer and transfer during lactation. Better data on maternal transfer would greatly improve the model; and (4) currently, there is no uncertainty incorporated into the model around the relationship between immune function and reduced survival probability. When uncertainty is included, the confidence intervals around the population projections are likely to be very large. However, it would be worth including uncertainty into this relationship using the standard errors presented in the National Toxicology Programme studies. These changes will be made to the model before the web-based online version is finally released.

In Phase III the individual-based model framework also included a physiologically based toxicokinetic (PBTK) model

to investigate the possibility of including oral dose data as dose-response relationships (Hall *et al.*, 2013). However, there are many uncertainties based on physiological assumptions and further discussions led to suggestions for refinement of this part of the model. Again these modifications will be carried out but will take time; therefore, the PBTK approach will not be included in the web-based version of the model at this time.

The potential impacts of microplastics ingestion on cetaceans were discussed and the findings of the review presented. Current studies and findings on the exposure of cetaceans in the Mediterranean Sea to leachate chemicals associated with microplastics (phthalates) were presented and the implications of the results were discussed. Suggestions for further work in this area were made.

The Pollution 2020 Steering Group discussed the issue of the utility of biomarkers in cetacean pollution research. This field has developed widely over the past decade but some consolidation of those markers that are of real utility because they are specific, sensitive and reliable, is needed. There needs to be a standardisation of measurement methods and cross-validation studies. Metabolite screening in different matrices could be more widely used, as they are proportional to the body burden as well as assimilation. They can therefore give more meaningful information on metabolic processes.

At the 2010 Pollution 2000+ Steering Group meeting in California, it was concluded that prioritisation regarding current contaminants of concern for cetaceans should be based on a fixed set of criteria. A literature review of pollutant data currently available for cetaceans was carried out following the meeting and a prioritisation questionnaire for experts to complete was compiled. The Steering Group felt that it would be important to continue and complete this task.

A demonstration of the web-based model interface for the individual based model was then shown and the further planned improvements described.

Next steps in Pollution 2020 were discussed, including the suggestions for future work identified at the March 2014 Pollution 2020 Steering Group meeting, and the SWG developed and **agreed** to a work plan for 2016 to 2017 (see Appendix 3).

The SWG was pleased at the maturation of these plans and the group was **commended** for its work. Questions specific to additional microplastics-related work were asked and it was noted that suggestions for additional research in this area were included in SC/65b/Rep05. The SWG **endorsed** the steering group advice and **recommended** the addition of leachate and adsorbed chemicals from microplastics to the questionnaire that will be circulated among experts for input on chemicals of concern. In addition, the SWG **recognised** that continued investigation into the effects of adsorbed chemicals from microplastics on cetaceans is needed. The SWG looks forward to the results of contaminant prioritisation and identification of chemicals of concern.

7.2 Oil spill impacts

7.2.1 Update on Deepwater Horizon oil spill

An update on the 2010 Deepwater Horizon oil spill Natural Resource Damage Assessment investigation on the injuries and impacts to cetaceans in the Gulf of Mexico was provided. As reported to SC/63-65a, this investigation included stranding response in the Northern Gulf of Mexico; photo-id and biopsy surveys for bay, sound and estuary dolphins in four sites across the northern Gulf; aerial and boat surveys, including biopsy and tagging activities, for cetacean abundance and distribution in coastal and offshore habitats; and live capture release health assessments of bay, sound and estuary bottlenose dolphins.

In Schwacke *et al.* (2014a; 2014b), data were provided from the bottlenose dolphin health assessments in 2011 from Barataria Bay, Louisiana (an area that received heavy and prolonged oiling) and Sarasota Bay, Florida (a reference area with long-term health assessments studies and did not receive oiling from the DWH spill). Dolphins sampled in Barataria Bay showed evidence of hypoadrenocorticism, consistent with adrenal toxicity. Adrenal effects have been previously noted in laboratory studies of oil impacts. In addition, Barataria Bay dolphins were 5 times more likely to have moderate-severe lung disease, with significant alveolar interstitial syndrome, lung masses, and pulmonary consolidation. Of the 29 animals evaluated in Barataria Bay, 48% were given a guarded or worse prognosis and 17% had a poor or guarded prognosis. Disease conditions in Barataria Bay dolphins were significantly greater in prevalence and severity than those in Sarasota Bay dolphins. Some of the disease conditions observed in the Barataria Bay dolphins are uncommon in wild bottlenose dolphins but consistent with petroleum hydrocarbon exposure and toxicity. Additional health assessment studies in 2013 were conducted in Sarasota Bay, Florida (n=15 dolphins); Barataria Bay, Louisiana (n=31 dolphins); and Mississippi Sound, Alabama/Mississippi (n=20 dolphins). Analyses and interpretation of the results from these studies are underway. Additional health assessments are planned for June 2014 in Barataria Bay, Louisiana.

Information on a continuing Unusual Mortality Event (UME) investigation for cetaceans in the northern Gulf of Mexico (NGOM) was also provided. The declared start date of the UME was February 2010 and the UME is ongoing as of May 14, 2014. As noted previously, most of the strandings (87%) have been bottlenose dolphins, 95% of which were dead. The geographical range of the UME is from the Texas-Louisiana border to Franklin County, Florida. As discussed in SC/65a, histological evidence of bacterial pneumonia in a number of non-perinate dolphins from Louisiana has been documented. Dolphins in this group were statistically more likely to have bacterial pneumonia compared to control populations. Animals also had an increased prevalence of adrenal gland abnormalities compared to control populations. To date, diagnostic tests do not support the cause of the UME to be *morbillivirus* or marine biotoxins, or brucellosis among non-perinates. Currently, histopathology examinations are being carried out on dolphins that stranded in 2012, 2013 and 2014. Additional diagnostic testing of dolphin samples is being conducted to determine the role of *Brucella* in the deaths of perinates in this UME. Based on the testing results thus far, the Deepwater Horizon oil spill has not been ruled out as a possible contributing factor to this UME. Currently, investigations are continuing with new data collection on strandings, dolphin health assessments, photo-ID and biopsy as well as completing analyses of collected samples along with compilation and interpretation of previous data. The synthesis of all the data and interpretation will contribute to the cetacean injury assessment report that will inform the overall Damage Assessment and Restoration Plan for the Deepwater Horizon oil spill.

In discussion, it was noted that no dolphins in the health assessment studies had been euthanised but that tissue samples for adrenal studies had been obtained from fresh dead stranded dolphins. Additionally, one of the Barataria Bay dolphins previously evaluated in the 2011 health assessment was found dead several months after evaluation, but was in a

state of advanced decomposition, thus tissues collected were not as useful for all analyses. Questions arose about the pre-spill mortality rates. During March and April 2010, a cluster of high dolphin mortalities occurred in northern Louisiana (centred on Lake Pontchartrain) and western Mississippi Sound, initiating discussions of a possible UME. In 2013, another peak in mortality of dolphins occurred in Lake Pontchartrain. Some animals were observed in the Lake for several years prior to the increased mortalities in 2010. During several years of observations, the animals in Lake Pontchartrain periodically showed evidence of skin lesions. In the spring of 2010, however, a large number of carcasses were found after a period of cold weather. The carcasses were too decomposed to determine cause of death. Surveys after the mortalities did not observe the group of animals in the Lake.

In further discussions it was noted that some dolphins caught and released for health assessments from Barataria Bay had exhibited significant tooth loss. Therefore in the 2013 captures additional radiological analyses were performed. Finally, there was a discussion of the presence of atypical stress hormone levels in some arctic birds as a normal finding for high arctic species (Romero *et al.*, 1997; Wingfield *et al.*, 1994a; 1994b). It was noted that interpretation of stress hormone levels must be in the context of baselines for physiology, status and behaviour, as well as the level of stressors. It was also noted that low levels of stress hormones do not necessarily indicate a healthy animal or a low stress situation.

The SWG thanked Rowles for presenting these interesting findings. The SWG **recommended** the continuation of these studies in actual spill injury assessments and looked forward to future publications on the impacts of oil on cetaceans and their habitats. The SWG **recommended** that baseline data from populations at risk be collected and knowledge about exposure and impacts following spill events maximised. The SWG also **recommended** that analytical methods for oil spill-related compounds be standardised and, finally, that pre-planning for an oil spill workshop (planned for SC/66a) be organised to inform the Committee on the impacts of oil, dispersants, spill response on cetaceans and the methodological tools for injury assessment.

7.2.2 Other oil spill information

The US National Research Council's (NRC) report entitled *Responding to Oil Spills in the US Arctic Marine Environment* was summarised in National Academy of Sciences (2014). The full report can be downloaded from *http://www.nationalacademies.org*. The NRC panel recognised the unique challenges of oil spill responses and impacts associated with cleaning up spilled oil in the Arctic. Response actions will have to deal with the remoteness, limited infrastructure and capacity, and might have to deal with sea ice, low temperatures, and days with very little or no sun light. Preventing an oil spill is the most important goal but one could occur because of oil and gas activities, shipping, or resupply to villages.

The report discusses the various oil spill response tools, such as mechanical clean-up, dispersants, *in situ* burning, detection and monitoring of spilled oil under sea ice, and modelling the fate and trajectory of spilled oil. Major challenges for a spill response in the US Arctic, especially for a large spill, include limited infrastructure, long logistics and supply chain, operations, coordination and collaboration across international borders, and maintaining a trained and prepared group of local responders. Recommendations are included in the report about all of these topics.

Some items in the report are directly related to cetaceans and their habitat. There is a need for the collection of baseline or benchmark data. Those information gaps include items related to: ocean circulation, surface currents, ice cover, storm surges, weather, coastal erosion, bathymetry, community structure and function and other topics. Improved documentation is needed about how local communities use and depend on marine mammals for meeting nutritional and cultural needs. Information is also needed on important ecological areas, such as those used by marine mammals for feeding, migration, breeding, calving, etc. The data will be valuable in preparing for oil spill response and damage assessments.

The report highlights the need for a 'Net Environmental Benefit Analysis', which assesses oil spill response options that will result in the greatest overall reduction in adverse environmental impacts. Techniques, protocols, permitting, and training are essential for developing and implementing plans to deter whales away from spilled oil. Improvement is needed in planning, coordination, communication, logistics, and techniques for possible treating and rehabilitating of wildlife.

The SWG thanked Suydam for bringing forward this information. The SWG again **stressed** the importance of baseline information on both marine mammals (and other wildlife) and their prey. It was noted that the assessment of impacts is very difficult to complete without this type of data available for comparisons. In addition the SWG **recognised** the importance of subsistence species to local communities dependent upon these resources for sustenance and cultural well-being. It was also noted that both actual and perceived contamination would likely have severe impacts upon local consumption habits, potentially resulting in a dietary shift to less healthy, store-bought foods.

A report from the workshop on Community Oil Spill Response in Bering and Anadyr Straits, hosted by the Wildlife Conservation Society (2013), provided a brief summary of a community-led oil spill response workshop that took place in 2013. This workshop aimed to give attendees a basic understanding of the existing policies, planning processes, infrastructure, and efforts in place to prevent, plan for, and respond to oil spills in the Bering and Anadyr straits. The workshop specifically focused on: (1) the role of communities in policies and planning processes; (2) the location and role of emergency response equipment in the region; and (3) examples of how other communities in Alaska and elsewhere engage with prevention, planning, and response needs. Throughout the workshop, participants discussed the desire for more action in the region alongside the need to ensure human safety.

Discussions over the course of the workshop focused on identifying tangible next steps that can lead to progress in this arena. The workshop identified the following seven key themes.

(1) Secure dedicated funding sources for training, equipment, and infrastructure.
(2) Ensure meaningful community input into community-specific response plans and associated Geographic Response Strategies.
(3) Develop and implement training plans for oil spill emergency response in communities.
(4) Ensure adequate infrastructure, equipment, and logistical resources are available in the region.
(5) Develop effective communication plans within communities, and between communities, agencies, organisations, and responsible operating bodies.

(6) Facilitate cross-border communication and cooperation.
(7) Improve understanding of legal authority, protocols, and roles around subsistence food security.

The workshop developed ten-year visions with associated goals and strategies for advancing each theme and identified 38 tangible opportunities for advancing community understanding, planning, and preparedness for oil spills.

Further to discussions about oil spills, whether from shipping or oil and gas activities, the SWG **agreed** that absolute priority should be given to preventing oil spills in the highly vulnerable Arctic region. However, recognising that even when preventative measures are taken, oil spills may still occur, response preparedness must be maintained. Responding to an oil spill, especially a large one in a polar area, is hindered because of limited capacity particularly due to infrastructure. Additionally, there is a need for baseline data on cetaceans and their habitats. The baseline study needs to include: health assessments, contaminant levels, biomarker measurements, and habitat/prey quality. It was noted that cetaceans in other countries, such as Brazil, are experiencing both oil and gas development and increased shipping. Brazil and other countries in similar circumstances were encouraged to give recommendation input. The SWG **recommended** that Commission members: (1) enhance the collection of baseline data related to health assessments, prey, and habitat of cetaceans for an improved capacity for damage assessment and monitoring recovery in the event of a spill; and (2) build capacity for responding to an oil spill in polar regions or other vulnerable or high risk areas. The SWG also **recommended** that the Commission gives consideration to seeking observer status at the Arctic Council for improved communication and coordination of Arctic issues related to cetaceans, including issues related to shipping and oil and gas activities.

7.3 Other pollution information

Ylitalo provided an update on the 2011 Fukushima Nuclear Accident. More than three years after this catastrophic event, public concerns persist in regard to the release and transport of radioactive contaminants and tsunami-related marine debris to the eastern North Pacific region. Monitoring efforts to determine levels of radionuclides in environmental samples have increased since the 2011 Fukushima disaster. Thakur *et al.* (2013) provided a recent overview of radionuclide measurements in environmental samples collected in the northern hemisphere. The majority of the releases occurred between March 12 and March 22, 2011 and included primarily isotopes of volatile fission products (e.g. xenon, krypton, caesium). Isotopes of iodine and caesium were detected in air, water, milk and food samples collected across the entire northern hemisphere. Fukushima-radionuclides were also detected in samples collected in the southern hemisphere, including New Guinea and Fiji. Based on the levels of radioactive contaminants reported in environmental samples tested around the world, the authors concluded that the radiation levels were very low and did not pose a risk to the public.

In another study, anthropogenic (Fukushima-derived) and naturally-occurring radionuclides were measured in marine organisms, including copepods, euphausiids, jellyfish and Pacific bluefin tuna captured in waters off the coast of Japan and waters near San Diego, California, three and four months after this event (Fisher *et al.*, 2013). The naturally occurring radionuclides were the predominant compounds measured in all species tested, with Fukushima-derived radionuclides occurring at levels that were at least three orders of magnitude lower than those of the naturally occurring radionuclides. For US tuna consumers, the additional radiation dose from Fukushima radionuclides was calculated to be comparable to, or less than, the dose to which people are routinely exposed from naturally occurring radionuclides. The authors also noted that the levels measured in marine biota were much lower than the benchmark protection concentrations proposed for ecosystems. Seafood safety monitoring efforts have included measuring radioactivity in edible tissues of salmon and groundfish collected in waters along the west coast of Canada (Chen *et al.*, 2014) and Pacific albacore collected from coastal waters of the US Pacific Northwest (Neville *et al.*, 2014). In both studies, it was estimated that the Fukushima-associated radiation measured in seafood samples would not cause significant changes in annual radiation doses to consumers.

Shortly following the spill, tsunami-related marine debris fields were tracked by satellite. Although this debris is no longer visible via satellite, it has been documented at various locations along the west coast of North America since the winter of 2011 and 2012, as predicted from NOAA modelling efforts[1]. In August 2013, NOAA released an overview report to Congress entitled 'Severe Marine Debris Event Report: Japan Tsunami Marine Debris', which provides information on the potential impacts and the national monitoring efforts being conducted[2]. West coast state agencies and NOAA are working together to communicate the facts about the potential risks associated with the tsunami debris. NOAA's Marine Mammal Health and Stranding Response Program continues to partner with governmental and non-governmental entities to assess the impacts of tsunami-released marine debris on marine mammals with regard to potential increased ingestion of marine debris or increased risk of entanglement.

During discussion, the SWG noted that the Government of Japan has measured Fukushima-associated radionuclides in more than 45,000 seafood samples, including tissues of minke whale. A wide range of concentrations of radionuclides have been measured in seafood collected from various coastal waters of Japan since March 2011, up to March 2014[3]. Modelling efforts have projected the input of Fukushima-associated radionuclides into marine waters of eastern North Pacific over the next 20-30 years (Behrens *et al.*, 2012; Rossi *et al.*, 2013). Based on the Rossi model radionuclide estimate, the levels of these compounds in some regions of the eastern North Pacific could approach those reported in the 1950-60s, i.e., a period during nuclear testing and activity in the region. The SWG **expressed concern** and noted that it was unclear what impact the radionuclides released as a result of the Fukushima accident may have on wildlife and humans.

8. CETACEAN EMERGING AND RESURGING DISEASES (CERD) AND MORTALITY EVENTS

8.1 Update from the CERD intersessional group

The Cetacean Emerging and Resurging Disease (CERD) Group was created in 2008 in recognition of the increased need for information on emerging diseases and the fact that for most cetacean species there is insufficient information on diseases, particularly those with potential anthropogenic

[1] *http://marinedebris.noaa.gov/tsunamidebris/debris_model.html.*
[2] *http://marinedebris.noaa.gov/sites/default/files/Japan_Tsunami_Marine_Debris_Report.pdf.*
[3] Data can be downloaded at *http://www.jfa.maff.go.jp/e/inspection/index.html.*

drivers, to evaluate the risks to populations (IWC, 2009). The group was established in response to the growing need to address disease issues in cetaceans at an international level. The purpose of CERD is to focus on diseases that may impact cetacean populations, particularly those that may have anthropogenic causes or contributions. Though many well-coordinated national or regional programs exist around the world, disease research activities and outbreak/stranding information for cetaceans have traditionally been poorly coordinated in terms of common direction, field methods, reporting and information exchange. Because cetaceans are migratory species spanning many countries and regions, and because infectious disease has the potential to be introduced and disseminated rapidly across national boundaries and ocean basins, the assessment of infectious disease (risks and early warning) is particularly challenging. Currently, international Harmful Algal Bloom (and associated biotoxins) coordination efforts are underway in some geographic regions (e.g. west coast of USA, Europe); however, in many cases, the coordination with cetacean scientists and resource managers is minimal. Improved coordination between disease (infectious and non-infectious) specialists/regional stranding response groups/cetacean researchers and managers and a means of recognising disease outbreaks and understanding disease processes and risks were noted as important goals of the CERD group.

At SC/64 (IWC, 2012), the attending members of the CERD subgroup met and discussed priorities and approaches to the website (mainly) and the CERD framework as a mechanism of enhanced communication and coordination. The group agreed that a plan for the aggregation of website information and input was crucial to maintaining momentum on enhancing communication and information exchange. The CERD group met at SC/65b and developed the work plan.

The SWG thanked Rosa for the background information on the activities of the CERD intersessional group.

8.2 CERD website and database

In 2012, at SC/64, the CERD working group proposed to develop a website that provides information on infectious and non-infectious diseases (e.g. viral, bacterial, fungal, parasitic), as well as nutritional disorders and biotoxins. In the summer of 2014, the CERD will advertise internships, both in the USA and internationally, to assist with data validation and input into the CERD database. Over the last year, standardisation of the data that will be collected for both the public and technical levels of the CERD website was developed and presented to the SWG.

8.3 Strandings and mortality events

SC/65b/E03 presented information on an Unusual Mortality Event (UME) that was declared by the US NOAA Fisheries agency on 8 August 2013, due to increased numbers of bottlenose dolphin strandings documented in New York, New Jersey, Delaware, Maryland and Virginia during the months of July and August. Strandings have remained elevated and the geographic scope of the event extends more than 1,500 miles from New York to northern Florida (through Brevard County), with the UME still ongoing. From 1 July 2013 to 27 April 2014, more than 1,200 bottlenose dolphins stranded from potentially multiple stocks within the UME area, with 18% of animals stranding alive or fresh dead, and 82% of the carcasses in moderate to advanced states of decomposition. Gross necropsy findings included dermal, oral, joint, and pulmonary lesions. Consistent histopathologic findings included bronchointerstitial pneumonia and/or pulmonary fibrosis, lymphoid depletion, syncytial cells, and viral inclusions. Secondary bacterial, fungal, viral (non-*morbillivirus*), and protozoal infections were observed. Tissue samples from dolphins were tested for *morbillivirus* via polymerase chain reaction (PCR) and/or immunohistochemistry and culture, and positive PCR results were confirmed by sequencing as dolphin *morbillivirus*. Of note were the *morbillivirus* PCR-positive cetaceans, including humpback whales (*Megaptera novaeangliae*), fin whales (*Balaenoptera physalus*) pygmy sperm whales (*Kogia sima*) and striped dolphins. The impacts of dolphin *morbillivirus* on these species are still unknown. Research is ongoing to better understand the impacts of this large-scale outbreak on bottlenose dolphin populations and affected coastal stocks, as well as the implications and impacts of the disease on whale stocks along the Atlantic coast and associated oceanic areas.

In discussion, it was noted that NOAA's Marine Mammal Health and Stranding Response Program keeps a record of *morbillivirus* outbreak activity on its website[4], which is updated on a weekly basis, including an animated map of the progression of the outbreak. Currently, the most common age classes based on length in the event are calves, followed by adults. Age determinations have not been completed on all the stranded animals. As noted in a recent publication, the prevalence of antibodies to *morbillivirus* appeared to be low in many bottlenose dolphin populations along the Atlantic coast preceding this event (Rowles *et al.*, 2011). Genomic sequencing is underway to allow for full comparisons with other viruses and outbreaks. Scientists from several countries have agreed to collaborate on the study and have offered samples for comparisons. Vulnerability exercises are needed to determine impacts of this virus on populations and to identify vulnerable or impacted populations/regions. Determining the stocks affected in this event is important, as is the scaling to the actual number of mortalities. The SWG **encouraged** continuation of the investigation of this *morbillivirus* outbreak and the international collaboration and looks forward to additional information as it becomes available.

SC/65b/SM03 reported the first mass stranding of seven Longman's beaked whales (*Indopacetus pacificus*), which happened in New Caledonia on 16-17 November 2013. Species identification was confirmed by genetic markers using samples collected from four females and one male. The total lengths of the four females, between 5.64 and 6.40m, are in the range of the known adult females of this species. The only male was 5.90m, consistent with an adult. Only one haplotype was found. This result could be explained either by a low level of genetic diversity within the species/population or by matrilineal social structure. The animals were all in very good body condition, with the exception of gastritis in one animal, and an acute pleurisy in another. Stomachs were empty, with the exception of a plastic bag and a small piece of plastic in one animal. Trace elements quantified in muscle, kidney and liver of three animals revealed high concentrations of mercury, iron, zinc and selenium in the liver and of cadmium in the kidney. Low concentrations of nickel, cobalt and chromium, probably released by the mining activity in New Caledonia, were found in the tissues, strongly suggesting that industrial extracting activities in New Caledonia do not represent a significant source of contaminants for this species.

[4] *http://www.nmfs.noaa.gov/pr/health/mmume/midatldolphins2013.html.*

Morbillivirus was identified in one of the individuals via PCR analysis. Surprisingly it shows high similarity with dolphin *morbillivirus* (DMV) strains obtained from a long-finned pilot whale (*Globicephala melas*) and a striped dolphin during outbreaks in the Mediterranean.

During discussion, it was noted that the heads of some of the dead whales were buried but then were subsequently collected. However, samples of brain of these dead whales were not taken for further testing of *morbillivirus*.

On 1 April 2014, an atypical mass stranding of Cuvier's beaked whales occurred along the coasts of south and southwest Crete, Greece, Mediterranean Sea, inside an 'area of special concern for beaked whales' (see Item 9.4)[5]. This mass stranding comprised several stranding events of one, two and three whales that stranded in three different locations/areas: Kaloi Limenes, Keratokampos (Kastri area) and Kalikovrechtis, from west to east. Based on currently available data a minimum of six and a maximum of ten whales were involved in the mass stranding.

At the time of the Crete atypical mass stranding event, the 'Noble Dina' naval exercise was taking place in Greek offshore waters. The participating nations were Greece, Israel and the US. These exercises have been taking place in Greek waters for the past four years. However, at this time, no additional details are available for the Noble Dina exercise.

In discussion, it was noted that atypical mass stranding events such as this, occurring along a long area of coastline, have been associated with anthropogenic sound from military sonar. The SWG recommended that this event be investigated through the Stranding and Mortality Investigations Working Group and the findings reported at SC/66a. At the same time, efforts are underway to obtain operational details from the three navies that took part in the Noble Dina exercise. When data become available from the exercise, they can be integrated with the spatial and biological data from the stranding.

8.4 Other health-related activities

SC/65b/E04 evaluated marine *Brucella* infections in cetaceans in the United States. *Brucella* bacteria species have been documented in the marine environment since the mid-1990s, and exposure to *Brucella* has been documented globally in numerous marine mammal species. Sporadic cases of brucellosis in cetaceans have been reported for cetaceans in managed care facilities, rehabilitation facilities and in the wild. Manifestations of infection in cetaceans include late-term abortions, meningoencephalitis, pneumonia, orchitis, and osteomyelitis. The prevalence and impact of *Brucella* and brucellosis on cetacean populations are currently unknown. NOAA Fisheries, in cooperation with the US National Marine Mammal Stranding Network, US Department of Agriculture, Centers for Disease Control and Prevention and the University of Illinois have been testing numerous samples from wild cetacean populations along the US coasts and have identified more than 120 cetaceans positive for marine *Brucella* (by culture and/or PCR), many with clinical signs of brucellosis. Positive animals were found in the Pacific and Atlantic Oceans and the Gulf of Mexico, and thus far have consisted of five different small cetacean species: common bottlenose dolphin, common dolphin, harbour porpoise, Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) and striped dolphin. Thus far, the most commonly affected cetaceans were bottlenose dolphins. Brucellosis due to marine *Brucella* in humans has not been documented in the US but has been found in four human cases worldwide. Recently marine mammal stranding personnel were exposed to a *Brucella* positive porpoise at necropsy but no illness was reported. Increasing reports of positive *Brucella* tissues and brucellosis from marine mammals, especially cetaceans, have led to a need to answer key questions about marine *Brucella*.

In discussion it was noted that the marine *Brucella MLST 27* cases raised the most concern for public health, as this was the type implicated in the four human marine *Brucella* cases. Based on the concerns for cetacean populations and human health, the SWG **recommended** that the development of a reliable serological assay for the detection of marine *Brucella* antibodies be given high priority. It also **recommended** further research into virulence mechanisms, transmission pathways, pathogenesis and co-morbidity factors in cetaceans. The SWG **recognised** and **encouraged** the work on *Brucella* in the Southern Hemisphere and **welcomed** initiatives that would enable cetacean *Brucella* types being identified and compared (in particular using multi-locus sequence typing or MLST). In addition the SWG **recognised** the concern about the potential risk that the marine types may pose to humans, including stranding response workers, subsistence consumers and fishermen, and **recommended** that particular attention be given to elucidating the frequency and routes of transmission of the marine *Brucellas* to humans if that occurs and the efficacy of current safety precautions.

Information on a Marine Mammal Health Map for tracking heath data obtained from marine mammal strandings, mortality events, and health assessments during live capture release programs was described in SC/65b/E05. Marine mammal health can serve as an indicator for the health of the marine ecosystem and effects of climate change. Currently, there are no readily accessible, consistent, long-term data to track spatial and temporal changes in marine mammal health, or their associations with environmental factors. A pilot study using data from stranding responders representing a variety of institutions (federal, academic, NGO) in California was created to categorise causes of death for animals from 2005-10 and identify hurdles and issues in developing a web-based mapping tool. These data were integrated into a regional Integrated Ocean Observing System (IOOS) data portal. Investment in data management, data sharing and communication will enhance understanding of marine mammal health and the role of marine mammals as sentinels of ecosystem changes that impact health (e.g. harmful algal blooms, contaminants, pathogen spread, water temperature changes). The ultimate goal of the Marine Mammal Health Map would be to share marine mammal health and disease information on a national and international scale and evaluate potential impacts on populations.

The SWG expressed interest in the health mapping technology and **encouraged** updates on this work, as well as further development and potential application to the CERD effects.

SC/65b/E06 summarised information on skin lesions in southern right whales (*Eubalaena australis*) from the Península Valdés area. Over the past ten years, there has been an increase of skin lesions in southern right whales in this population. The overall aim of this project was to assess the health status of this species through the study of skin lesions. Both photographs and samples of skin lesions were used. Samples were obtained by biopsies of free-living whales and stranded dead whales. These samples

[5]An atypical mass stranding event is a mass stranding where three or more whales strand (live or dead) within a few days and in more than one location.

were analysed for histopathological and etiologic diagnosis, using molecular techniques such as electron microscopy, immunohistochemistry and PCR. Analysis of samples obtained during 2012 and 2013 showed the presence of viral and bacterial agents in whale skin lesions. The presence of poxvirus was also confirmed, and several bacteria (e.g. *Erysiphelotrix spp.*, *Staphylococcus epidermidis*, and *Streptococus spp*.) were isolated from wounds caused by kelp gulls. The results of this project provide novel information about the health status of whales in Argentina. It is necessary to determine the causes of the proliferation of these skin diseases because the increasing occurrence of skin lesions in this population may reflect their health status and may act as an indicator of deterioration and alteration of the marine ecosystem the whales inhabit.

The SWG **commended** Argentina for conducting skin lesion research on southern right whales, especially the recent investigations of pathogens that may be expressed in the lesions, and **recommended** that they continue the work given the prevalence and continued problems with kelp gulls. During discussion of the paper, it was noted that the results of this paper will be presented at a whale mortality Workshop funded by the Commission, which is planned for August 2014, as discussed in Annex F, item 4.1.

Information on pathological findings of subsistence-harvested bowhead whales by Alaskan Eskimos during 2013 was presented to the SWG (SC/65b/BRG08). An update on the ancillary diagnostic results will be presented at the next Committee meeting (SC/66a).

Di Guardo and Mazzariol (2013a) described some of the host and viral factors driving dolphin *morbillivirus* (DMV) infection, with particular emphasis on striped dolphins in the Mediterranean. This species in the Mediterranean has been the victim of four DMV epidemics since 1990. Several infected animals showed the presence of viral genomes and/or antigens exclusively in the brain. An expansion of the host range has recently been observed in the Mediterranean with, infection in fin whales (*Balaenoptera physalus*) and a captive harbour seal (*Phoca vitulina*). The viral strains isolated in the outbreaks exhibit marked genetic relatedness, which suggests prolonged circulation in the Western Mediterranean and supports the hypothesis that an inadequate level of anti-viral immunity exists in the striped dolphins, which may be due to high levels of immunotoxic pollutants. Future emphasis should be placed on immunopathogenesis, mechanisms of viral colonisation and persistence in the brain of cetaceans. The paper discusses the importance of cell receptors and suggests gene mutations may contribute to persistence in chronically infected animals.

A commentary on two papers recently published regarding cetacean *morbilliviruses* (CeMV) in the Southern Hemisphere (Groch *et al.*, 2014; Stephens *et al.*, 2014) was provided in Di Guardo and Mazzariol (2014). They report existence of strains infecting Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) and Guiana's dolphin (*Sotalia guianensis*) that exhibit marked genetic differences from the viruses infecting cetaceans of the Northern Hemisphere in the nucleoprotein and the phosphoprotein genes. No lesions or immunohistochemical evidence of *morbillivirus* antigens were observed in the brains of these two animals, which is different from the CeMV infected cetaceans in the Northern Hemisphere but similar to experimentally rinderpest-infected cattle. More data are needed on the genetic composition of the new strains and emphasis should on the host and agent-related factors that drive the complex *morbillivirus* cetacean interaction dynamics.

Of note was the number of new cases of *morbillivirus* globally, which may be a cause for concern. Princeton University is hosting a workshop on marine *morbilliviruses* in August 2014 and the SWG looks forward to a report from that workshop at SC/66a. The SWG expressed interest in the health mapping technology and **encouraged** further development and potential application to the CERD database.

Toxoplasma gondii is a protozoan parasite infecting a range of hosts worldwide, including several aquatic mammal species in which it may cause abortion and lethal systemic disease. In Di Guardo and Mazzariol (2013b), the authors reported that striped dolphins found stranded in 2007 and 2008 showed immunohistochemical and biomolecular evidence for *T. gondii* in association with brain lesions, with the brain parenchyma in three dolphins scoring positive for three of the protozoan's genes. In general, *T gondii* infection through faecal oocyst contamination flowing from land to sea appears less plausible for the striped dolphin, a typical pelagic species. The authors suggest that an 'open sea' life cycle involving this and other pelagic cetaceans should not be ruled out.

The SWG **welcomed** these health-related papers and thanked the authors for their hard work.

9. EFFECTS OF ANTHROPOGENIC SOUND ON CETACEANS AND APPROACHES TO MITIGATE THESE EFFECTS

9.1 IWC/IQOE Workshop report

This two-day Workshop on 15-16 April 2014 in Leiden, the Netherlands, was sponsored by the International Whaling Commission (IWC), the International Quiet Ocean Experiment (IQOE), the US National Oceanic and Atmospheric Administration (NOAA), Office of Naval Research Global, and the Netherlands Organisation for Applied Scientific Research (TNO) and Ministry of Infrastructure and the Environment. Twenty-six international experts came together from 11 countries to discuss regional and ocean-basin scale underwater sound field mapping techniques to provide support for decision makers seeking to characterise, monitor, and manage the potential impacts of chronic or cumulative anthropogenic noise on marine animals. The Workshop product is a meeting report that includes recommendations directed to sponsoring international organisations and/or their science advisory groups to support the development and implementation of soundscape modelling and mapping tools needed to make informed management decisions.

This Workshop has demonstrated that the capabilities to measure and model the ocean soundscape have advanced well beyond short-term, localised efforts. This now allows management agencies to look beyond acute, temporary impacts of sound exposure on marine mammals to concerns addressing chronic and cumulative impacts related to potential auditory masking. Many different agencies, countries, and/or organisations across the globe have already established or are in the process of launching soundscape monitoring and modelling programs: LIDO[6], QUONOPS[7], BIAS[8], SoundMap[9], SONIC[10], and AQUO[11]. While these

[6]*http://listentothedeep.com.*
[7]*http//:www.quiet-oceans.com.*
[8]*http://biasproject.wordpress.com.*
[9]*http://cetsound.noaa.gov.*
[10]*http://www.sonic-project.eu/.*
[11]*http://www.aquo.eu/.*

programs are an excellent start toward being able to predict ocean soundscapes at a global scale, they are not standardised in their measurement or modelling parameters, making it extremely difficult to compare products across regions. In addition, they are largely focused on US and European waters, while management concerns for marine organisms are far wider ranging. The recommendations stemming from this Workshop identify acoustic measurement and modelling protocols that if implemented world-wide would greatly add to the value of local and regional studies by allowing data to be combined and integrated at larger scales. The development of status assessment and predictive tools that are transferable to any region will aid in visual scenario building where sound maps can be constructed and deconstructed based on source type and distribution. The identified data gaps and research represent topic areas where progress can be made to extend current modelling efforts beyond where they are today in order to better inform sound-related management and conservation of marine species.

The SWG discussed next steps with regard to the information brought forward in the Workshop report. To support further development of sound modelling tools, it was noted that the Committee should consider its management needs and designate high priority areas for the next steps in this work. Possible areas that were highlighted during Workshop discussions for further evaluation by the Commission included the Arctic, Southern Ocean Sanctuary, South Atlantic, Mediterranean, North Sea and Gulf of Mexico-Caribbean waters. To best develop the quality of these tools at a worldwide scale, the areas selected should include at least two types of regions within which to apply these techniques: (1) regions where database products (e.g. acoustic records, information on anthropogenic noise sources, bathymetry) or preliminary noise map products are already available will allow focused case studies examining model uncertainty and model sensitivity to varying inputs, and ground-truthing of model output with empirical data; and (2) a region where such data products are incomplete, which would allow for expanded coverage and the initiation of research to obtain baseline data.

The SWG **commended** the IWC/IQOE Workshop participants for their efforts, and **strongly recommended** continuation of these sound mapping efforts and further work to implement the recommendations contained in the Workshop report. The SWG **endorsed** the recommendations from the Workshop report regarding the five topic areas: sources, soundscape measurements, soundscape modelling, management/visualisations tools, and short-term research. The SWG also expressed strong support of the Workshop recommendation for a modelling framework that allows for flexibility in use, and in investigation and comparison of alternate scenarios. This will be an essential element for any predictive sound modelling tools intended to address regions with changing human use and patterns of activity, or environmental conditions, and will allow managers to assess different potential management scenarios. As part of next steps, the SWG **recommended** conducting the two predictive sound field mapping studies in high priority areas as described in Appendix 2. The first study should expand the global application of sound mapping effort by initiating new regional scale modelling in regions where this effort has been limited (e.g. in the Arctic and/or South Atlantic), while the second should be a more narrowly focused study in a smaller region that already has developed mapping products (e.g. Cetsound or QUONOPS mapping regions) and high resolution baseline information (e.g. the Mediterranean, Gulf of Mexico, or North Sea) to assess model uncertainty and sensitivity to input variables. In addition, the SWG **recommended** the collection of empirical data (e.g. acoustic recordings) to assess baseline acoustic conditions in these high priority regions (particularly where rapid industrial or environmental change is occurring), and the expansion of efforts where data collection is currently limited. The SWG **recommended** continued international collaboration on the issue of underwater anthropogenic sound, and planning of additional workshops or projects with various regional management agencies, industry, and organisations (e.g. Workshop co-sponsor International Quiet Ocean Experiment). As with this Workshop, these multi-national discussions will allow areas of convergence between the various stakeholders and regional approaches to emerge and allow for standardisation of empirical data collection, modelling approaches, and visualisation tools that will have a higher utility across a wide range of governmental and non-governmental management bodies.

9.2 New information on the effects of anthropogenic sound

Simmonds *et al.* (2014) offer a history of marine noise pollution, explaining how it came to emerge as a 'significant mainstream issue', taking note of the role that the Commission has played in this. The latest activities include those by the International Maritime Organisation and the Convention for Biological Diversity. Simmonds *et al.* (2014) conclude that over the last two decades or so, significant progress has been made. In the USA in particular, relevant marine mammal research has seen an 'explosion of investment in the issue'. However, worldwide only limited practical steps have resulted and, in many cases, exposures of vulnerable populations to noise sources have increased. There are also growing concerns linked to increasing marine industrial activities and particularly in the Arctic (Moore *et al.*, 2012; Reeves *et al.*, 2012). Simmonds *et al.* (2014) conclude with a series of recommendations, including calling for enhanced international cooperation and the expeditious sharing of information from the various existing demonstration projects for marine renewable energy devices (which has emerged as a new issue) and stress that temporal and spatial separation should be the primary mitigation approach.

9.3 Update on new tools, approaches or efficacy of mitigation of effects of anthropogenic sound on cetaceans

The risk reduction associated with mitigation measures that attempt to reduce injuries to whales from loud sound sources based on shutting down the sound source if whales are detected visually within a certain 'safety zone' has rarely been quantified. SC/65b/E11 describes a simulation framework to evaluate the efficiency of using Marine Mammal Observers (MMOs) for mitigation of sound-related injury. Visual observations will only detect a proportion of the whales that enter the safety zone, with the proportion of animals directly on the trackline that are detected ($g(0)$) providing an upper bound. The simulation model uses data from sightings surveys and diving behaviour to estimate the probability of detection. This was combined with simple assumptions about sound propagation to estimate the proportion of animals that would be subject to sound exposure levels above a certain threshold during a seismic survey, with and without shut down procedures in place. Cumulative sound exposure during a pass by a seismic survey vessel was estimated relative to a single pulse. This

gave an indication of the mitigation efficiency or the level of risk reduction that can be achieved for a number of scenarios. Results indicate that there will be many cases where using visual observers' results in only a very small risk reduction, but these situations may not always be immediately apparent. Without an adequate quantified assessment of the risk reduction, mitigation measures may often be applied inappropriately or result in regulators granting approval for activities on the basis of measures that do little to reduce risk. The simple simulation model is easy to apply but does need to be performed on a case-by-case basis using input data that correspond as closely as possible to the scenario being investigated.

During discussion, it was noted that industries use MMOs on board their vessels to continue operations. There will not be 100% coverage with MMOs on-board, even in the best of situations. The SWG thanked the author for his presentation and **encouraged** publication of his findings.

Noise mitigation efforts globally can be broadly divided into: (i) operational procedures such as a 'soft start'; (ii) real-time mitigation measures based on the detection of animals close to airguns and other sources; and (iii) the use of time and area closure zones (from which noisy activities would be excluded or controlled to avoid vulnerable wildlife). SC/65b/E09 is concerned with the second method and, in particular, the role that MMOs play. Weir and Dolman (2007) and Parsons *et al.* (2009) previously raised some concerns, including the considerable variation in key parameters being used, such as the exclusion zone radius around a source, and that relatively few aspects of current mitigation have a firm scientific basis and proven efficacy in the field. Further to discussions with some MMOs, the authors suggest that the work of many MMOs has become increasingly complex, including, for example, advising on Environmental Assessments prior to surveys; striving to deal simultaneously with monitoring and interpreting the behaviour of a range of species; and interpreting complex legislative frameworks that vary around the world. SC/65b/E09 raises an important series of questions about the work of MMOs covering issues including increasing distances of monitoring from sound sources required, complex multispecies requirements, the authority and independence of MMOs, their training and assessment, numbers of observer required to be effective and data availability.

The SWG noted that such issues and answering these and others questions were potentially important in ensuring that MMOs were effective. Currently, there is no independent assessment of MMO practices. Hence, the SWG **agreed** that this issue would be a suitable focus for its consideration in the future at a session in which MMOs and their associations would be represented.

SC/65b/E08 provided a brief overview of the various options available to reduce anthropogenic ocean noise. The overarching recommendations were: (i) governments around the world should phase in increasingly strict noise level standards for all noise-producing activities; and (ii) governments, industry and NGOs should seek ways to address and reduce the underlying demand for noise producing activities. Other specific recommendations include (but are not limited to) that no more research is needed before acting to reduce noise at source; noise-producing activities should be avoided in areas where vulnerable species are located; mitigation measures should be taken: (a) that reduce sound levels; and (b) that reduce the amount of noise pollution at the source; transit areas that require lower speed to avoid cetaceans should be encouraged as part of marine spatial and voyage planning; every effort should be made to limit the use of seismic surveys; and governments should implement scientifically based noise limits for oil and gas activities.

In SC/65b/E07, six environmental impact statements or reports were examined to determine whether the focus on reducing Level A 'takes' (i.e. a predicted level of sound that could result in physical injury or death) under the US Marine Mammal Protection Act is sufficiently protective and effective by comparing the numbers of Level A with Level B takes (i.e. a level of sound that results in behavioural disturbance). Level A takes from mid-frequency naval sonar were found to comprise only 0.005-0.065% of the number of all animals predicted to be impacted by Level B takes, and 0.3-4.0% of Level B takes from a seismic survey. Thus, the focus on preventing near field, injurious Level A exposures seems out of proportion to the number of animals affected. Given new research showing dramatic behavioural responses to anthropogenic sound at received levels as low as 89 dB re 1 μPa, the current US threshold of 160 dB for Level B cetacean takes from impulsive sounds may not be precautionary enough (DeRuiter *et al.*, 2013)2013. If lower thresholds for Level B takes are adopted, Level A takes will make up smaller percentages of Level B takes, and impact radii will extend out to tens to hundreds of kilometres. Marine mammal observers (MMOs) and passive acoustic monitors (PAMs) are of limited usefulness even in small safety zones of 500m, but beyond 1km, their effectiveness will be even more questionable. Spatio-temporal mitigation (time-area closures) and quieting alternative technologies, such as marine vibroseis, in contrast to safety zones and ramp-up, can dramatically lower both Level A and B takes. Time-area closures are less effective when range-limited, year-round resident populations are involved or when projects can't easily be moved, such as with most seismic surveys. Marine vibroseis, which exposes only 1-15% of animals to higher noise levels compared with airguns, presents a better option in these cases. Only in these ways can noise producers minimise their 'takes' of cetaceans to small numbers as required by US law.

During discussion, the SWG noted that the overarching question (is there too little attention focused on Level B takes?) posed in this paper is valid, and worthy of further investigation, but there were questions regarding how useful a strict comparison of the numbers of Level A *vs.* Level B takes is, because the difference in degree of impact between Level A and B takes can be so large. It was noted that, when managing noise impacts, it is more difficult to determine the number of animals impacted by Level B effects due to the much larger areas over which these may occur. Although Level B effects may not be as serious as Level A effects at the individual level, the much greater numbers of animals impacted may prove to be problematic at the population scale, particularly with regard to sound associated with shipping activities. As a result, it may be that more animals are affected by noise, and as such the impacts to cetaceans are underestimated. The SWG also noted that there are different interests in different parts of world regarding various impacts of noise to cetaceans and that the levels of these impacts are not standardised.

The SWG thanked the author for presenting these findings, **recommended** that further consideration should be given to exposures to sound that result in behavioural disturbance and looked forward to receiving additional information from analyses such as this.

A German study about the development of noise mitigation measures in offshore wind farm construction was

presented to the SWG[12]. Its aim was to describe technical noise mitigation measures that can be applied during pile driving of offshore wind turbines, as well as alternative low-noise foundation concepts and to analyse their applicability. Because a threshold value of 160dB re 1 µPA (single event sound pressure level, SEL)/190dB (peak-to-peak) at 750m from the source is mandatory for the installation of offshore wind turbines in the German exclusive economic zone (EEZ), the German industry has increased efforts to improve available noise mitigation techniques for pile driving for offshore wind turbines or to invent new systems only in the last few years. Information presented in table 1 of the study includes a list of all available techniques and their development status, as well as the next steps that should be taken, and table 2 summarised the known alternative low-noise foundation concepts in the same way. Additionally, it was noted that, in Germany, an 'underwater noise concept' for the North Sea has been in place since September 2013, which is applied to protect harbour porpoise from underwater noise from pile driving activities. The concept requires *inter alia* that in the defined breeding area at the sensitive time (May to end of August), sound that seems to cause disturbance (>140 dB SEL) is only allowed in 1% of this area and that at any other time throughout the year not more than 10% of the area can be ensonifed with such sound levels.

The SWG welcomed the study and **stressed** the importance of sound mitigation measures. In the discussion it was noted that the study also considered that all noise mitigation measures have an impact on the operations design and work schedule, as the systems have to be applied prior to pile driving or require special technical features of the installation barge. Minimising the duration of the installation of the noise mitigation system is one of the major challenges when striving to achieve an application of a noise mitigation system that is economically feasible. With respect to the Baltic Sea, the SWG **strongly encouraged** the relevant governments in the area to apply appropriate measures to protect the highly endangered harbour porpoise subpopulation of the Baltic proper from negative effects of underwater noise through pile driving and other anthropogenic activities. These measures should be especially applied within and around existing marine protected areas and should be included in management plans.

In recognising the pervasive nature of underwater sound in the marine environment and the inherent difficulties in assessing the behavioural impacts that such inputs may cause, the SWG **agreed** that increased efforts should be made to avoid, minimise and mitigate the adverse effects of anthropogenic noise on cetaceans. In particular the SWG **recommended** that Governments should promote and facilitate the adoption of noise-reducing technologies by industry, including shipping, exploration for fossil fuels and pile-driving. The SWG also **encouraged** the completion of appropriate assessments for marine activities to help ensure harm is not caused to cetaceans, including giving consideration to the development of noise exposure limits as, for example, used in Germany with respect to pile driving. The SWG **encouraged** industry (and other noise producers such as the military) to release data about its noise generating activities (both completed and, where possible, planned), including but not limited to activity, location, source characteristics, duration, in order that the cumulative implications for cetaceans of all activities can be assessed.

[12]This can be downloaded from *http://www.bfn.de/0314_meeresnatur-schutz-berichte.html.*

The SWG **stressed** the importance of utilising temporal and spatial management of noise generating activities and **encouraged** the identification of sensitive areas in which noise would be strictly managed.

Donovan introduced Nowacek *et al.* (2013), which dealt with a responsible approach to minimising disturbance to cetaceans from seismic surveys. The paper originally arose out of work undertaken by the IUCN Western Gray Whale Advisory Panel to develop a monitoring and mitigation plan for a seismic survey undertaken off Sakhalin Island by the Sakhalin Energy Investment Company (SEIC). The results of that work can be found on the IUCN website. Recognising that individual areas, species and survey types have different characteristics and requirements, the authors identified a number of principles and steps that would have common application even though the final mitigation and monitoring programmes would differ. Fig. 1 below summarises the process developed. Donovan emphasised that this is a feedback process with a primary objective that the monitoring and mitigation plans improve over time. He also stressed that the monitoring component should be seen as an integral part of any programme, not merely an optional extra.

The SWG thanked Donovan for presenting this paper and endorsed the methods described in this and other papers.

9.4 Other anthropogenic sound issues

The SWG received a brief summary of the findings of the 2008 mass stranding of melon-headed whales (*Peponocephala electra*) in north-western Madagascar. At SC/65a, the SWG received an update that an Independent Scientific Review Panel (ISRP) and Workshop had convened in February 2013 to review all the reports and considerable amount of data that had been provided to investigate the cause of the mass stranding. The ISRP report was fully released after SC/65a in September 2013, and the full report and supplementary information can be found on the Commission website[13]. While seismic surveys and other factors were systematically excluded or deemed unlikely by the ISRP, the ISRP found that the use of a 12-kHz Multi-Beam Echosounder System (MBES) to be 'the most plausible and likely behavioural trigger for animals initially entering the lagoon system'. The ISRP also pointed out that this was the 'first known marine mammal mass stranding closely associated with relevant high frequency mapping sonar systems'. All details about how the ISRP arrived at their conclusion can be found in their full report. Given this finding the ISRP highlighted a number of key points, two of which are listed below:

> 'It is important to note, especially for odontocete cetaceans that hear well in the 10-100kHz range where ambient noise is typically quite low, high-power active sonars operating in this range may in fact be more easily audible and have potential effects over larger areas than lower-frequency systems that have more typically been considered in terms of anthropogenic noise threats.
>
> 'The potential for behavioural responses and indirect injury or mortality from the use of similar MBES systems should be considered in future environmental assessments, operational planning, and regulatory decisions.'

The SWG **recommended** that this process could serve as a model for investigating the cause of mass stranding in other areas. In discussion it was noted that the environmental impact assessment process and exploration plans are restarting in northwest Madagascar, and hopefully the findings in the

[13]*http://www.iwc.int/2008-mass-stranding-in-madagascar.*

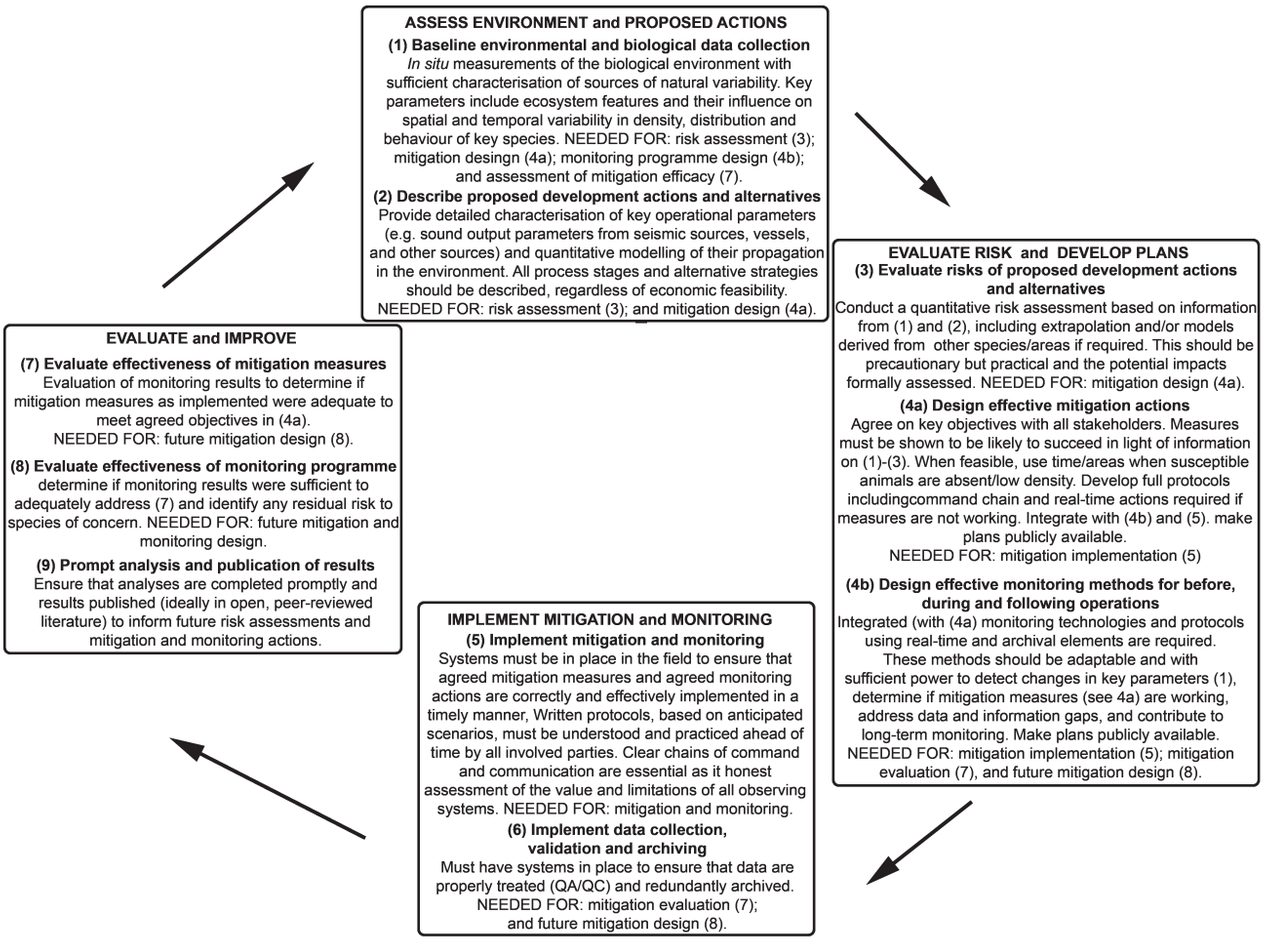

Fig.1. A practical roadmap for planning, executing, evaluating and improving the design of a responsible seismic survey. The numbers in parentheses throughout the figure refer to other elements with the figure.

report may guide these processes to incorporate effective mitigation and monitoring related to MBES and other sound sources. The SWG drew attention to the fact that this is a new sound source associated with cetacean mass strandings and **recommended** that high power MBES (or similar) be considered in addition to military sonars as possible threats to cetacean populations. The SWG thanked the Government of Madagascar, the US government, the Commission, and participating parties, for their support in the investigation of this mass stranding event.

There is considerable concern about the impacts of frequent naval exercises and intense oil or gas survey activities on a threatened population of Cuvier's beaked whales in the Mediterranean. Di Sciara presented the work of the Scientific Committee of the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS), on the location of critical habitats of Cuvier's beaked whales in the Mediterranean in order to support appropriate mitigation measures. The ACCOBAMS Committee developed a map of 'areas of special concern for beaked whales' – based on a combination of modelled beaked whale habitat and locations of all known mass stranding events, surrounded by a 50n.mile buffer zone – showing areas that naval exercises involving sonar use should avoid. Although formal adoption of the map was strongly opposed by some Parties to ACCOBAMS during their last meeting in Tangier, November 2013, a resolution was adopted agreeing, *inter alia*, that 'the concept of areas of special concern in which noise would be mitigated should be enhanced'.

The SWG **commended** the ACCOBAMS Scientific Committee for addressing the conservation of Cuvier's beaked whales in the Mediterranean through the identification of the species' critical habitat, and **recommended** that efforts to map Cuvier's beaked whales habitat in the Mediterranean should be continued and improved, in order to provide well documented, scientifically-sound and updated information to agencies and producers of underwater sound that could adversely impact beaked whales.

10. IMPACTS OF CLIMATE CHANGE ON CETACEANS

10.1 Progress on climate change

An overview of Committee work on climate change and a summary of recent relevant publications were provided in SC/65b/E12. The Committee has been seeking to address the impact of climate disruption on cetaceans for over two decades, with the first Workshop on climate change held in 1993. The major conclusions from that first Workshop were that cetaceans would be adversely affected by increasing water temperature and that the most important impact was likely to be mediated via changes in prey distribution. The Workshop report also noted that current climate change models have limitations in their predictive capabilities. Because of that, and insufficient data on cetacean responses to climate change, it was concluded that considerable further research would be required to accurately predict impacts on cetaceans. A key recommendation of the first Workshop was that the Committee and Commission consider ways in which to facilitate such research.

Over the following years, further emerging threats to cetaceans were identified and, in 1998, the effects of habitat degradation were identified as a priority area for research leading to a Workshop on the subject in 2005.

In 2007, the Scientific Committee held a second climate change Workshop, spurred by growing concern over the rate of global environmental change. Interest and research efforts were focused on disruptive impacts on ecosystems and difficulties in accurately predicting climate change response at the species level in order to design effective mitigation mechanisms. From this Workshop came general recommendations for: (1) elaborating more accurate models; (2) quantifying levels of uncertainty; and (3) developing further research to better understand the link between climate and cetacean distribution. The second climate change Workshop also recommended that work continue on: (1) single species effects, with regional contrasts; (2) comparisons of three trophic levels within the same region; and (3) studies of distribution shifts – especially where sufficient data are available to detect a change in distribution, in order to investigate whether this is attributable to climate change.

The third Scientific Committee climate change Workshop, held in Vienna in 2010, focused on small cetaceans and raised particular concerns for the smaller non-pelagic cetacean species with habitats restricted through the presence of physical barriers, e.g. riverine species and populations residing in bays or coves. Among the key outcomes were the call for a global review on restricted habitats, and the recommendation that a list of priority species be drafted in the context of the IUCN Red List, to assess the relative vulnerability and resilience of species to climate change. SC/65b/E12 noted some relevant and potentially helpful efforts in this area that have been developed and published recently including the following.

- Doney *et al.* (2012) discussed impacts of climate change on marine ecosystems, and considered how species might adapt (e.g. shifts in ranges as species align their distributions to match their physiological tolerances under changing environmental conditions), and also the impact on ecosystem structure and dynamics.
- Lambert *et al.* (2014) recognised limitations of current scientific understanding of cetaceans, when attempting to model future distribution under climate change scenarios.
- Poloczanska *et al.* (2013) examined the impact of climate change on marine life, compiling a database of 1,735 marine biological changes from the literature.

SC/65b/E12 also noted that the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report is due in 2014, and the September 2013 summary for policy makers (IPCC 2013) predicted:

- oceans will continue to warm, with heat extending to the deep ocean, affecting circulation patterns;
- decreases in Arctic sea ice cover, Northern Hemisphere spring snow cover, and global glacier volume;
- global mean sea level will continue to rise at a rate very likely to exceed the rate of the past four decades; and
- changes in climate will cause an increase in the rate of CO_2 production and ocean acidification.

During discussion, an informal poll was taken and it was noted that approximately 50% of SWG members are currently engaged in or indirectly working on issues related to climate change. A member of the SWG noted that the ACCOBAMS Expert Workshop on the Impact of Climate Change on Cetaceans of the Mediterranean and Black Seas (to be held in Monaco on 11 June 2014) will help identify gaps in knowledge and propose new initiatives for that region. In addition, the SWG indicated that other bodies have considered the issue of climate change and conservation, including the April 2014 Workshop in Costa Rica organised by the Convention for Migratory Species. The SWG **agreed** that an intersessional steering group should meet (possibly at the International Marine Conservation Congress meeting to be held 14-18 August 2014 in Glasgow, Scotland[14]) to develop a plan for climate change work by the Scientific Committee over the next few years.

10.2 Other climate change information

Information on a recently published review of the distribution of endemic cetaceans in relation to hydrocarbon development and commercial shipping in the Arctic (Reeves *et al.*, 2014) was presented to the SWG. The article provided range maps for the three cetacean species endemic to the Arctic – bowhead whale (*Balaena mysticetus*), beluga whale (*Delphinapterus leucas*) and narwhal (*Monodon monoceros*) – and used these maps together with charts of ship traffic patterns and of oil and gas lease areas and structures (e.g. platforms, drilling sites) to form a broad-scale understanding of the potential impacts of climate-related expansion of industrial activity on arctic whale populations. The results showed extensive overlap between areas inhabited by the whales and areas of increasing interest for shipping and hydrocarbon exploration and development. Among points of emphasis were: (1) there is little reliable baseline information (e.g. numbers, trends, health) on some species in some areas (e.g. Okhotsk vs Bering-Chukchi-Beaufort bowhead whales; Svalbard/Frans Josef Land narwhals); (2) the nature and degree of threats are likely to vary by species, region and time, with great uncertainty regarding the relative sensitivity and potential for adaptation of the different species; (3) understanding of cause-effect relationships, impact thresholds (dose-response) and how, *inter alia,* to measure and assess risk and mitigation effectiveness is improving but still far from sufficient; and (4) although significant progress is being made in the search for ways to define, quantify and assess cumulative impacts, much more development and testing of applicable methodologies is needed.

10.2.1 Arctic impacts Workshop

Rosa provided a summary of the Workshop on Impacts of Increased Marine Activities on Cetaceans in the Arctic to the SWG. During IWC/62, the Commission agreed that the Arctic was a region that required the development of measures to prevent the possibility of a tragedy similar to the Deepwater Horizon oil spill. As a result, the Commission requested that the Committee develop an agenda for a Workshop on Anthropogenic Impacts on Cetaceans in the Arctic Ocean. The Commission requested the Workshop to consider all the growing anthropogenic uses arising from increased access to the Arctic, rather than just limiting research to oil and gas.

The Workshop was held in Anchorage, Alaska on 6-7 March 2014 with participation from academia, communities, government, non-governmental organisations, international governmental organisations, industry, and environmental organisations. Recognising that the Arctic is changing quickly (the 'new normal') and retreating Arctic sea ice will provide access for shipping, tourism, oil and gas, and

[14] *http://www.conbio.org/mini-sites/immc-2014.*

other industries, this Workshop was focused on shipping and oil and gas activities specific to their potential impacts on cetaceans, their populations, and the ecosystem on which they depend. The Workshop facilitated an open dialogue amongst stakeholders on a number of relevant aspects of the issue, including: current and past research conducted; implementation of management measures; knowledge gaps and concerns; and information the Commission can provide to assist managers in preparing for these impacts.

Panels presented information on shipping, oil and gas-related activities, and indigenous issues.

The speakers provided insights and recommendations in each session, which will be included in the draft report that is planned for completion in mid-summer 2014.

The second day of the Workshop was spent in breakout groups addressing specific themes and questions. The first was 'actual and potential threats, filling knowledge gaps and collaborative studies' and the second was 'monitoring and mitigation, guidelines/principles and a collaborative model for the Arctic'. Participants identified lists of general, monitoring and mitigation issues with respect to increased marine activities in the Arctic on cetaceans, then identified the following general types of roles that the Commission could play in helping address the impacts of increased marine activities in the Arctic on cetaceans. These roles included; building a stronger communication network between a variety of groups and organisations; facilitating trans-boundary cooperation in assessment and mitigation of risks; contributing to efforts to set research priorities for the Arctic; strengthening Commission cooperation/collaboration and gaining observer status with both the Arctic Council and the IMO; ensuring that various industry sectors have better understanding of risks to whale populations and whale-hunting people as a result of their activities; supporting efforts to convince or require industry to contribute cetacean, acoustic and other environmental data to a common database and make their information publicly available via the Commission or another conduit; and further promoting incorporation of the concerns and interests of subsistence communities as well as traditional knowledge in decision-making processes

Finally, the Workshop Steering Committee is finalising recommendations for the Commission to consider, which cover issues such as the following.

(1) Building stronger links with other important international organisations (e.g. the Arctic Council, IMO), range states, local authorities and industry;
(2) Sharing the expertise of the Committee with those organisations by participating in relevant working groups of those organisations (e.g. Arctic Council's Arctic Monitoring and Assessment Programme) and by inviting their participation in relevant Scientific Committee and Conservation Committee activities;
(3) Providing easily accessible advice on such matters as:
    (a) summary of knowledge of cetacean population status, distribution and movements, density, critical habitat;
    (b) risks by species and/or region based on expected timelines of human activities;
    (c) providing advice on appropriate methods for cetacean status assessment, risk modelling, monitoring strategies; mitigation methods, and ways to assess their effectiveness;
    (d) baseline data collection and case studies;
    (e) mapping of cetacean hotspots (in time and space) and known/projected human activities; and
    (f) traditional knowledge including information from subsistence hunting.
(4) Promoting stakeholder participation (especially indigenous communities and industry) in Commission work.
(5) Promoting the Commission's successful international whale disentanglement training effort and perhaps extend this to training in other issues (e.g. monitoring).
(6) Raising awareness among industry of the cultural aspects of aboriginal subsistence whaling and concerns of hunters.
(7) Facilitating data sharing and provide information for mediation.
(8) Recommending to member nations that they adopt the IMO's Polar Code.
(9) Developing mechanisms to provide advice and support to industry including responding to specific requests for advice on mitigation approaches and good practice.

The SWG **commended** the Workshop participants for their work and looked forward to the final report expected in mid-summer 2014. The SWG **reiterated** two of its recommendations (see Item 7.2) that the Commission pursue stronger links with other important international organisations (e.g. the Arctic Council, IMO), range states, local authorities and industry and that Commission members enhance the collection of baseline data related to health assessments, prey, and habitat of cetaceans for an improved capacity for impacts assessment and monitoring recovery in the event of a spill, a change in baselines due to climate change, or other habitat alterations.

11. HABITAT-RELATED ISSUES

11.1 Cetaceans and marine debris

11.1.1 Update on planning for the 2nd Marine Debris Workshop

Simmonds noted that the first IWC Workshop on marine debris, which was led by the Committee, sought to better define and understand the adverse impacts of marine debris on cetaceans (IWC, 2014b). A second marine debris Workshop – which has been developed through the Conservation Committee and was endorsed by the Commission - will:

(1) explore how the Commission can engage with the existing international and regional mitigation efforts concerning the management of marine debris;
(2) determine how best to ensure those efforts are informed by the growing understanding of the cetacean specific impacts of marine debris; and
(3) advise on how best the Commission can lead/engage with action in regions where marine debris has the greatest potential impacts on cetacean populations.

The Workshop will also consider the role of a Conservation Management Plan (CMP) to address this threat and further identify research needs and gaps. A steering committee and a conveners group have been established for this second Workshop. The list of invited participants is now in the process of being finalised and recommendations from the SWG were welcomed. The Workshop will be held in Hawaii in the first week of August 2014. The SWG welcomed this update on the upcoming second marine debris Workshop.

11.1.2 New information on marine debris impacts on cetaceans

SC/65b/E02 presented information collated on rates of marine debris ingestion and associated mortality rates, as well as recommendations regarding reporting debris interactions to the Commission. Ingestion of debris has been documented

in 48 (56% of) cetacean species, with rates of ingestion in necropsied stranded carcasses as high as 74% in some areas. Significant geographic, inter- and intra-specific variability was found in interaction rates. Prevalence of debris ingestion was found to be relatively high in some regions but there were insufficient data to link this with rates of pathology, though limited data on mortality rates were available. The authors found that debris ingestion-induced mortality rates of 0-10% have been documented in stranded animals where a cause of death could be determined, suggesting that debris could be a significant conservation threat to some populations. However, the variation in prevalence of debris ingestion and rates of debris ingestion-induced mortality between species and regions points to the need for improved global data collection; data on ingestion and mortality rates is far from comprehensive, geographically, temporally or across species. A key recommendation of the first IWC Workshop on marine debris was that information on rates of debris interactions should be reported annually by country to the Commission. SC/65b/E02 made recommendations for information that should be included in such reporting.

The SWG thanked the authors for providing the information and noted that there was a need to develop monitoring tools to quantify the relevance of marine debris ingestion to the incidence of strandings and mortality, with the ultimate aim of extrapolation to cetacean mortality rates. The SWG **agreed** that information on marine debris ingestion, such as that summarised in SC/65b/E02, should be included in national Progress Reports submitted to the Commission, and pointed out that the SC/65b/E02 table headings included might be easily added to the online form for Progress Reports. The marine debris fields suggested for inclusion in progress reports for strandings would include:

(1) total number of carcasses per species and region where a full necropsy was conducted (including examination of stomach contents);
(2) number of these in which ingestion of debris was detected;
(3) number of carcasses per species and region where a definitive cause of death was determined;
(4) number of mortalities attributed to debris;
(5) number with pathology attributed to debris; and
(6) a comments field – for example to include an assessment of the degree of confidence that pathology/mortality was caused by debris and information on the type and quantity of debris.

With respect to entanglement/bycatch data it was recommended that a field could be added where authors can submit evidence that the gear was being actively fished or constituted 'ghost' gear at the time of entanglement.

It was noted that passive ingestion of debris (as well as sediments) during strandings should be distinguished from cases of marine debris ingestion by free-swimming cetaceans that might be directly related to morbidity and mortality. The SWG also **recommended** discussions with the *ad hoc* Progress Report group and Secretariat information technology staff with the aim of adding agreed fields for inclusion of such records in the online submissions portal.

SC/65b/E10 described a plan for the analyses of the quantity and distribution of marine debris in German waters, as well as an assessment of marine debris impacts on marine mammals. Data from aerial surveys for harbour porpoises conducted regularly since 2002 in national waters, during which sightings of marine debris have been recorded, will be evaluated. Spatio-temporal distribution patterns of floating marine debris will be investigated and origins of debris identified using a drift model. An extensive database on stranded and bycaught marine mammals (harbour porpoises, harbour and grey seals) collected along the coasts of Schleswig-Holstein since 1990 will also be assessed to compile data on findings of marine debris in marine mammals that have been documented during necropsies. Additionally, faeces of the three marine mammal species will be examined for micro debris to determine uptake of microplastics by these top predator species.

In discussion, the SWG suggested that particular categories of marine debris could be identified as part of the program, and methods developed to distinguish between them. In the thousands of US stranding records, such information is only available in the 'comments' field, and development of a more effective, efficient reporting scheme is needed. The SWG suggested that the inclusion of microplastics documented inside cells would be a valuable addition to documentation of material inside the gut. In response to questions about the ability to detect debris under different weather conditions, the author stated that the program would only attempt to document floating marine debris in sea states at or less than Beaufort 1, as detection of smaller items in rough conditions was difficult or impossible and that under such conditions it was possible to reliably detect items only as small as a cardboard juice carton.

Summaries of SC/65b/SP02-SP05 and Isoda *et al.* (2014) were presented to the SWG (see Item 3 for statements on these papers). During the 2013 JARPN II offshore survey, debris was detected in stomachs of 33 sei whales (*Balaenoptera borealis*) among 100 sampled individuals. Debris was also detected in the stomachs of three among 28 Bryde's whales (*Balaenoptera edeni*). No debris was detected for three common minke and one sperm whale examined (SC/65b/SP02). During the 2013 JARPN II coastal survey, debris was detected in the stomach of one among 34 and nine among 58 common minke whales from the Sanriku and Kushiro catches, respectively (SC/65b/SP03-SP04). No ingested debris was detected for Antarctic minke whales during the 2013/14 JARPA II survey (SC/65b/SP05). Plastic was the most abundant type of debris and size of ingested material was less than 15cm in most cases. No obvious signs of illness that may have been caused by debris ingestion were detected by observation of external appearance and gross anatomy of the internal organs.

Information on marine debris collected during the JARPA and JARPAII surveys, for the period of 1987/88 to 2010/11 was reported in Isoda *et al.* (2014). Marine debris on the sea surface was recorded during the sighting surveys. The highest density index (DI: number of marine debris objects observed per 100n.miles) was recorded in Area V (DI: 0.15), and Area IV (DI: 0.12). The stomachs of a total of 10,041 Antarctic minke whales, 16 dwarf minke whales and 16 fin whales were examined for debris. A total of 70 pieces of marine debris and objects other than prey were found in the stomachs of Antarctic minke whales, including feather, stone, wood, plastic and others. The proportionate occurrence of marine debris in the fore and main stomachs per 100 Antarctic minke whales examined was estimated at 0.35%. No debris was observed in the stomachs of 16 dwarf minke whale and a feather was observed in the stomach of one fin whale. Entanglement was observed in only four cases for Antarctic minke whales. Given the low indices, the effect of marine debris on whales in the Antarctic is expected to be limited at the present time. This study provided the first comprehensive observations of marine debris found on the sea surface, inside the stomachs of whales, and in entanglements of whales in the Antarctic.

Some members of the SWG noted that it was concerning that, during some surveys, a high number of whales had some form of marine debris in their stomachs.

11.2 Other habitat-related issues

Rosenbaum *et al.* (2014) provided information on the movement of Southern Hemisphere humpback whale (*Megaptera novaeangliae*) Breeding Stock B and its overlap with anthropogenic activities in the South Atlantic Ocean. Humpback whales are managed by the Commission as primary populations that breed in the tropics and migrate to feeding areas around the sub-Antarctic and Antarctic waters. There is little information on individual movements within breeding areas or migratory connections to feeding grounds. This paper sought to better understand humpback whale habitat use and movements at breeding areas off West Africa, and during the annual migration to Antarctic feeding areas. It also assessed potential overlap between whale habitat and anthropogenic activities. Argos satellite-monitored radio tags were used to collect data on 13 animals off Gabon, a primary humpback whale breeding area. Habitat use was quantified for three cohorts of whales and a state-space model was used to determine transitions in the movement behaviour of individuals. A spatial metric of overlap was developed between whale habitat and models of cumulative human activities, including oil platforms, toxicants, and shipping. Strong heterogeneity in movement behaviour over time was detected that is consistent with previous genetic evidence of multiple populations in the region. Breeding areas for humpback whales in the eastern Atlantic were extensive and extended north of Gabon late in the breeding season. Also observed, for the first time, was direct migration between West Africa and sub-Antarctic feeding areas. Potential overlap of whale habitat with human activities was the highest in exclusive economic zones close to shore, particularly in areas used by both individual whales and the hydrocarbon industry. Specifically, whales from the north and central cohorts were in close proximity to oil platforms totalling 41.4% of the time they were tracked. Whales overlapped with the different anthropogenic activities during each stage of their migration, and the lowest relative potential impact (RPI) values were only recorded when whales migrated considerable distances offshore or to sub-Antarctic feeding areas. The extent of overlap with anthropogenic activities makes it difficult to implement effective mitigation measures over their entire range. Further research into the potential effects of industrial activities on recovering whales in biologically important habitats and during migration is needed to produce the most effective mitigation strategies, and inform relevant national and regional policies.

Rosenbaum presented information on the assessment of vessel strike risk for large cetaceans in the Bering Strait region. Reducing risk requires either reducing the probability of a vessel-whale encounter (in time or space), reducing the probability of a lethal strike by slowing vessels down, or a combination of the two. Ground-based Automatic Identification System (AIS) data (provided by Marine Exchange of Alaska) was used to describe different vessel routes. Then, using data on cetacean habitat use and satellite telemetry data for bowhead and gray whales provided by Citta *et al.* (2012) and Heide-Jorgensen *et al.* (2012), inferences were made about when and where bowhead and gray whales are likely be at risk from maritime traffic, particularly as the number of vessels increase, and shipping windows expand. The following three questions were addressed: (1) do whales and vessels overlap in time; (2) do whales and vessels overlap in space; and (3) are vessel speeds conducive to minimising lethal strikes? The types of ship traffic were broken down, showing where overlap occurs with large cetacean tagging data. The conclusions were that significant overlap does occur, these interactions are likely to increase and this is an area of key concern.

SC/65b/SH19 presented preliminary information on the association of satellite-tracked whales with anthropogenic activities. Three satellite tagged Arabian Sea humpback whales exhibited spatial and temporal overlap with shipping traffic, oil and gas activity and planned fast ferry routes along the coast of Oman. All three whales tracked in this study passed through the main approach channels to the major ports at either Salalah and/or Duqm. The extent of interaction between whales and industrial activities will be examined in subsequent analyses (Rosenbaum *et al.*, 2014).

The SWG thanked the authors of the papers for presenting their findings and encouraged the continuation of similar work.

12. CONSERVATION MANAGEMENT PLAN

The SWG reviewed the process and procedures for the establishment of CMPs for species and noted the three current CMPs. The current CMPs are single species with multiple threats that require international coordination. The concept for threat-based CMPs recommended at SC/65a would be to focus on a single threat requiring international coordination and affecting multiple species or large habitats. The role of the SWG would be to evaluate and contribute to both species-based and threats-based CMPs. The SWG **reiterated** its recommendation last year for a review of the template and criteria and then consideration of the options of a threat-based approach. The SWG **recommended** that marine debris be the focus of a first threat-based CMP.

13. WORK PLAN

Rowles noted that, following discussions at SC/65a, the SWG was starting a new approach at this year's meeting to develop strategic work plans in five focus areas. The SWG would develop a two-four year work plan and two-year budget in order to efficiently pursue the aims of the SWG with regard to environmental issues potentially impacting cetaceans. Coordinators and focus areas include:

(1) pollution impacts (Ailsa Hall and Gina Ylitalo);
(2) effects of anthropogenic sound (Jason Gedamke and Rob Williams);
(3) Arctic issues (Robert Suydam, Peter Thomas and Cheryl Rosa);
(4) Cetacean Emerging and Resurging Diseases (CERD) (Cheryl Rosa and Teri Rowles); and
(5) climate change and marine debris (Mark Simmonds and Robert Suydam).

The SWG had topic leads with interested SWG members develop specific work plans for the next two years. These work plans were then presented to and reviewed by the entire committee and priorities were made for the next two years. Some projects received lower priorities for the immediate operational period and were delayed for future years given the workload of the SWG, the recent work on that topic, the need for and availability of new information, and the costs. The SWG **agreed** to these agenda items for its work plan for SC/66a and SC/66b (see Table 1). In addition the SWG reviewed multiple budget requests and recommended funding for Pollution 2020+, a CERD pre-meeting, a climate change intersessional steering group meeting, and an intersessional meeting on investigations of mortality events and mass strandings.

Table 1
Work plan for the next two meetings.

Topic	Subtopic 1	Subtopic 2	SC/66a	SC/66b
SOCER Pollution			Pacific	Polar
	Pollution 2020	Refine consequence model	X	X
		Contaminant prioritisation	X	
		In utero transfer analyses and modelling		X
	Oil spill impacts	Planning oil spill Workshop		X
		Update on cetaceans and oil exposure	X	X
		Other oil spill related issues	X	X
	Contaminant threat assessment	Focus sessions on regional trends and status of POPs in cetaceans	X	
		Data integration and mapping		X
	Marine debris			
		Report from the 2nd Workshop	X	
		Progress on marine debris reporting	X	X
		Other marine debris information	X	X
CERD/mortality events	CERD	Data input and website management	X	
		Progress on enhanced communications: maintain email lists and provide monthly updates on disease issues	X	X
		Pre-meeting to plan next steps for CERD (one day)	X	
		Other disease related issues	X	X
	Strandings and mortality events	Planning and hosting intersessional Workshop on mortality events and mass strandings (in conjunction with biennial SMM)	Planning-finalise agenda	Receive report
		New information on strandings and mortality events	X	X
Effects of anthropogenic sound	Soundscape mapping	Determine next steps and priorities for soundscape mapping	X	X
		Progress in soundscape mapping	X	X
	Masking	Planning for masking-focused meeting	X	
		Focus sessions on masking		X
	Stress Workshop	Planning stress and sound Workshop		X
	Mitigation and monitoring	Focus sessions to review MMO effectiveness		X
	Other sound related issues		X	X
Climate change	Planning	Report from intersessional steering committee meeting	X	

14. REVIEW AND ADOPT REPORT

The report was adopted at 18:44 on 20 May 2014. The SWG thanked the Chairs for their efficient guidance and the Chairs thanked the rapporteurs for their dedication and hard work and the SWG for their participation and discussion.

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Appendix 1

AGENDA

1. Introductions
2. Election of Chair
3. Adoption of Agenda
4. Appointment of rapporteurs
5. Review of available documents
6. State of the Cetacean Environment Report (SOCER)
7. Pollution
   - 7.1 Pollution 2020+
   - 7.2 Oil spill impacts
     - 7.2.1 Update on Deepwater Horizon oil spill
     - 7.2.2 Other oil spill information
   - 7.3 Other pollution information
8. Cetacean Emerging and Resurging Diseases (CERD) and mortality events
   - 8.1 Update from the CERD intersessional group
   - 8.2 CERD website and database
   - 8.3 Strandings and mortality events
   - 8.4 Other health-related activities
9. Effects of anthropogenic sound on cetaceans and approaches to mitigate these effects
   - 9.1 IWC/IQOE Workshop report
   - 9.2 New information on the effects of anthropogenic sound
   - 9.3 Update on new tools, approaches or efficacy of mitigation of effects of anthropogenic sound on cetaceans
   - 9.4 Other anthropogenic sound issues
10. Impacts of climate change on cetaceans
    - 10.1 Progress on climate change
    - 10.2 Other climate change information
11. Habitat-related issues
    - 11.1 Cetaceans and marine debris
      - 11.1.1 Update on planning for the 2nd Marine Debris Workshop
      - 11.1.2 New information on marine debris impacts on cetaceans
    - 11.2 Other habitat-related issues
12. Conservation Management Plans
13. Work plan
14. Review and adopt Report

Appendix 2

PRIORITISATION OF REGIONS FOR FURTHER DEVELOPMENT OF PREDICTIVE SOUND FIELD MAPPING TECHNIQUES

The report from the Workshop on Predicting Soundfields (SC/65b/Rep03) noted that while further understanding the potential effects of anthropogenic noise on cetaceans was an important contextual framework for the Workshop, the technical focus of the Workshop was almost exclusively on the methodology behind quantifying (through measurements and modelling) anthropogenic noise. The assessment of potential impacts as well as the designation of priority areas for mapping product development was determined to be best left to management bodies like the IWC.

To support further development of these tools, the IWC Scientific Committee was requested to consider its management needs and designate high priority areas where the next steps in this work could be conducted.

It was suggested first and foremost that the areas are prioritised due to:

(1) high cetacean distribution and density or of biological importance to cetaceans; and
(2) concern over noise conditions including both where:
- there is an existing overlap with activities that produce noise; and
- future development or environmental pressures are poised to change noise conditions.

In addition to expanding the application of soundscape mapping techniques to additional high priority areas globally, in order refine modelling techniques and assist in interpretation of their results, the Workshop report also recommends that targeted case studies be conducted. These case studies would assess model output uncertainty, model sensitivity to varying inputs, and comparison of predicted sound levels with empirical data. This work would likely focus on a smaller area within priority region(s) where high quality data currently exist (e.g. the list of seven data needs in the Workshop report, including acoustic records and information on anthropogenic noise sources and their distribution) and where preliminary noise map products are already available.

In order to advance towards two primary long-term goals that guided the Workshop (further developing, and increasing the global application of, sound mapping techniques) it is recommended that the following studies be conducted, in line with Workshop recommendations.

(1) In a high priority region where limited or no sound mapping products exist, preliminary regional to ocean basin scale mapping products should be produced. Baseline status and trend analyses should be conducted in these regions, and where there is limited collection of acoustic data, efforts to obtain this data should be expanded.
(2) In a region(s) with high quality data to support high resolution predictive sound mapping, case studies should be conducted quantifying uncertainty in predicted sound levels, model sensitivity to varying input parameters, and ideally, verification or comparison of model results with empirical data.

The regions outlined in the Table opposite were assessed for their suitability for each of these studies.

The highest priority regions for these next steps should be those with currently high, or high projected levels of increase of anthropogenic sound levels for the purposes of producing predicted and/or empirically measured soundfield maps due to human activities. It is also important to note the value of identifying places where animal density is high but anthropogenic noise levels are expected to be low. Given the obligations to identify Important Marine Mammal Areas, Ecologically or Biologically Significant Areas, Marine Mammal Protected Areas, Sanctuaries, etc., prioritisation of areas that are both important to marine mammals and have low levels of introduced anthropogenic noise, would ultimately be important to map to highlight the contrast with high noise level regions, and emphasise the need for conservation of this acoustic habitat. Consideration should also be given to those types of MPAs/BIAs mentioned above that overlap with Offshore Biologically Important Areas (21 areas across ocean basins above) for marine mammals in relation to exclusion of Navy low-frequency sonar.

Other potential candidate areas for soundscape mapping consideration are the southwestern Indian Ocean and the northern Indian Ocean/Arabian Sea. These may be generally characterised as less developed and may have less ship traffic than other regions. In both regions, there is likely expansion of E&P exploration and production, and possible increases in ship traffic and coastal development. Some areas in both regions have some baseline assessments of cetaceans, indicating diversity hotspots or BIAs.

An alternative could be to prioritise areas where cetacean density surface models and soundfield predictions are available for in-depth scenario testing. Such areas could include the US EEZ, given recent investment in NOAA's CetSound products (*http://www.cetsound.noaa.gov*), or Canada's Pacific coast, where a number of studies have integrated soundfield mapping, cetacean density and identification of candidate Quiet MPAs (Erbe *et al.*, 2012; Erbe *et al.*, 2014; Williams *et al.*, 2014).

The sub-committee also wish to specifically note our strong support of the Workshop recommendation for a modelling framework that allows for flexibility in use, and in investigation and comparison of alternate scenarios. This will be an essential element in any predictive sound modelling tools intended to address regions with changing human use and patterns of activity, or environmental conditions, and will allow managers to assess different potential management scenarios.

Finally, as an overarching theme, we also note the value in bringing together wide ranging group of international Workshop attendees, where discussion amongst them allows for finding areas of convergence between the varying regional approaches to the issue. Visualisation tools designed in this manner, and standardisation in approach, will therefore have a higher utility across a wide range of governmental and non-governmental management bodies. We recommend continued international collaboration on the issue of anthropogenic noise, and planning of additional Workshops and meetings with wide ranging government agencies and organisations or projects (e.g. International Quiet Ocean Experiment) that are working to address this issue.

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Williams, R., Clark, C.W., Ponirakis, D. and Ashe, E. 2014. Acoustic quality of critical habitats for three threatened whale populations. *Anim. Conserv.* 17: 174-85.

Region	Current level of anthropogenic noise	Likely future level of anthropogenic noise	Baseline information available	Existing sound mapping products	Potential suitability for Study 1 or 2
Arctic	Low generally (with seasonal peaks in oil and gas exploration)	Increasing to high	Low	Limited	1
Southern Ocean Sanctuary	Low	Remaining relatively low	Low	No	N/A but see text below
South Atlantic	Variable between low to high (some well-studied whale populations may provide contrast in exposure)	Increase in some areas	Low - some areas have initial assessments of cetaceans indicating diversity hotspots or BIAs	No	1
Mediterranean	High in deep water environment	High	High	Yes	2
North Sea	High in shallow water environment	Anthropogenic noise likely to remain high	High	Yes	2
Gulf of Mexico	High	High	High	Yes	2

Appendix 3

POLLUTION 2020 WORK PLAN

Oil spills – exposure and impacts

(1) Refine the physiologically based toxicokinetic model (PBTK model for estimating uptake, metabolism and potential effects based on contaminant ingestion rather than measured blubber concentrations) and estimate exposure and excretion routes and rates for polycyclic aromatic hydrocarbons (PAHs).
(2) Review the toxicological literature to improve understanding of the potential impacts of dispersants
(3) Organise a Workshop on the impacts of oil spills on cetaceans. This would come with lessons learned from the Deep Water Horizon spill, would include: determining exposure and effects of oil on mammals in general and on cetaceans in particular; guidelines for assessing impact including the effect of oil spill response activities, in situ burning and dispersants. It would look at the various risk areas including the Arctic, the Gulf of Mexico and the North Sea and would possibly develop recommendations that might be included in Conservation Management Plans for specific species or areas.

Aims 1 and 2 above are ongoing and will be completed within the next 12 months. It is anticipated the Workshop would occur in 2017.

Refinement of the individual based population effects model

(1) Release the web version of the individual based model, publish this updated framework and approach with two example populations: humpback whale and killer whale (in conjunction with co-authors and custodians of appropriate data).
(2) Contaminants of concern in cetaceans – The questionnaire will be circulated to experts in the field to identify which contaminants are of highest priority and should be focused on in future modelling efforts. The list includes for example, the POPs, current use pesticides, flame retardants, PAHs, TBT, pharmaceuticals, plasticisers etc.
(3) Carry out a literature review and database for dose-response relationships of the priority chemicals as identified in 1) above. Which compounds have enough data on dose-response relationships that can be used for future modelling efforts?
(4) One of the areas of uncertainty in the individual based model is the amount of POPs transferred from the female to the foetus in utero. A dataset of paired samples exists at the Marine Mammal Center in Sausalito, collected from harbour porpoise on the west coast of the US so these samples will be analysed for a suite of POPs allowing the in utero transfer proportion estimate to be updated. Once completed the data will be incorporated into the model.

Pollutant information for conservation and management plans and risk assessment

(1) Map, by ocean basin, changes in measured POP blubber concentrations over time for key species. The first step would be data discovery, what data are available.

Appendix 4

STATE OF THE CETACEAN ENVIRONMENT REPORT (SOCER) 2014

Editors: M. Stachowitsch*, E.C.M. Parsons+ and N.A. Rose¥

INTRODUCTION

Several Resolutions of the International Whaling Commission, including Resolutions 1997-7 (IWC, 1998) and 1998-5 (IWC, 1999), directed the Scientific Committee (SC) to provide regular updates on environmental matters that affect cetaceans. Resolution 2000-7 (IWC, 2001) welcomed the concept of the State of the Cetacean Environment Report (SOCER) and requested the annual submission of this report to the Commission. The first full SOCER (Stachowitsch *et al.*, 2003) was submitted in 2003 and subsequent editions initiated and continued a cycle of focusing on the following regions: Mediterranean and Black Seas, Atlantic Ocean, Pacific Ocean, Indian Ocean, Arctic and Antarctic Seas. Each SOCER also includes a Global section addressing the newest information that applies generally to the cetacean environment. The 2014 SOCER focuses on the **Atlantic Ocean**, summarising key papers and articles published from *ca.* 2012 through 2014 to date.

ATLANTIC OCEAN

General

WORLD'S FIRST LARGE MARINE ECOSYSTEM LEGAL FRAMEWORK

One trend in improving the state of the oceans is attempting to incorporate ever larger regions into conservation and management schemes. Angola, Namibia and South Africa have signed the Benguela Current Convention, which aims to promote the conservation and sustainable use of the Benguela Current Large Marine Ecosystem, one of the richest ecosystems on earth. This Southern Atlantic cold-water current flows northward along the west coast of Africa. This cross-national agreement was supported by the United Nations Development Programme and the Global Environment Facility. Such large-scale approaches have the potential to provide the greatest benefits, including for highly migratory species such as cetaceans.

(SOURCE: News. 2013. *Mar. Pollut. Bull.* 71: 3).

DREDGING OPERATIONS LINKED FOR THE FIRST TIME TO BEHAVIOURAL CHANGES IN A DOLPHIN POPULATION

This study is the first to conclusively link dredging operations to a measurable behavioural response in a marine predator. The bottlenose dolphin population along the north-eastern coast of Scotland has experienced a range expansion, whereby Aberdeen Harbour has progressively become a foraging area. Nonetheless, higher intensities of dredging have caused the dolphins to spend less time in the harbour, even though there was already a high baseline level of anthropogenic disturbance there. As opposed to the habituation to some other stressors, the lack of any change in tolerance to dredging might be explained by the irregular nature of the disturbance. Currently 1,481 dredging vessels are operating worldwide, a capacity increase of 75% since 2000: this reflects the need to accommodate rising levels of shipping and offshore energy exploitation in cetacean management.

(SOURCE: Pirotta, E., Laesser, B.E., Hardaker, A., Riddoch, N., Marcoux, M. and Lusseau, D. 2013. Dredging displaces bottlenose dolphins from an urbanised foraging patch. *Mar. Pollut. Bull.* 74: 396-402).

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LINK BETWEEN DECREASING PREY, DECREASING BODY CONDITION AND DECREASING REPRODUCTIVE RATE IN BALEEN WHALES

An analysis on the effect of linkages between prey availability, body condition and reproductive rates was conducted for North Atlantic fin whales. As prey abundance declined, blubber thickness declined, and pregnancy rates in breeding age females similarly declined, suggesting a link between food availability and reproductive rate. This study has important repercussions for the impacts of a variety of stressors such a prey decline due to overfishing, climate change or pollution, or disruption of feeding behaviour by disturbance from noise-producing activities or boat traffic, which could ultimately lead to a decline in reproductive rates and therefore effect the recovery of baleen whale populations. This study gives important evidence to a link that had been previously been postulated.

(SOURCE: Williams, R., Víkingsson, G.A., Gislason, A., Lockyer, C., New, L., Thomas, L. and Hammond, P.S. 2013. Evidence for density-dependent changes in body condition and pregnancy rate of North Atlantic fin whales over four decades of varying environmental conditions. *ICES J Mar. Sci.* 70: 1,273-1,280).

Habitat degradation

General

WATER QUALITY IN EUROPEAN WATERS ASSESSED BY REMOTE SENSING

Determining water quality is important for marine ecosystems, their inhabitants, and the human population. In Europe, the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD) have been approved, the goal being to achieve a 'good' surface water status by 2015. This study used satellite imagery to develop a tool to better estimate the sea surface chlorophyll-*a* within coastal waters of Spain from 2005-10. This approach helped estimate this parameter with a frequency 40 times higher when compared to field sampling and revealed that the water body showed a high quality status. The authors consider this to be a powerful tool to efficiently evaluate waters within the EEZs of European countries.

(SOURCE: Novoa, S., Chust, G., Sagarminaga, Y., Revilla, M., Borja, A. and Franco, J. 2012. Water quality assessment using satellite-derived chlorophyll-*a* within the European directives, in the southeastern Bay of Biscay. *Mar. Pollut. Bull.* 64: 739-750).

DECREASED HARBOUR PORPOISE ABUNDANCE AROUND WIND FARM SHOWS SLIGHT RECOVERY OVER TIME

The Nysted Offshore Wind Farm was built in the Danish western Baltic Sea in 2001, and at the time was the largest offshore wind farm in the world, with 72 2.3MW turbines. The impact of the wind farm on harbour porpoises was investigated by examining distribution via acoustic monitoring over a 10-year period. Researchers found that the 'results show that [harbour porpoise] echolocation activity declined in Nysted Offshore Wind Farm after the baseline in 2001-2…and has not fully recovered yet', but the impact of the wind farm on porpoises 'is gradually diminishing', with an increase in numbers, from 11% of the baseline level immediately after construction to 29% of the baseline 10 years later, which they attribute to habituation, reduced fishing effort in the wind farm area, and possibly an artificial reef effect of the turbine platforms.

(SOURCE: Teilmann, J. and Carstensen, J. 2012. Negative long term effects on harbour porpoises from a large scale offshore wind farm in the Baltic – evidence of slow recovery. *Environ. Res. Ltrs.* 7: doi:10.1088/1748-9326/7/4/045101).

Fisheries interactions

BOTTLENOSE DOLPHINS INTERACT WITH FISHERY GEAR IN FLORIDA

Most of the fishery-related bottlenose dolphin strandings in Florida involved hook and line gear (as opposed to trap pot gear and fishing nets). Total fishery gear cases increased over time (1997-2009). Adult male individuals had a greater number of interactions than expected, related to their higher tendency to engage in unnatural foraging behaviours such as depredation and scavenging. These behaviours are probably reinforced due to the overlap between popular recreational fishing spots and prime feeding habitat for dolphins. Such studies are crucial for improving conservation and management efforts.

(SOURCE: Adimey, N.M., Hudak, C.A., Powell, J.R., Bassos-Hull, K., Foley, A., Farmer, N.A., White, L. and Minch, K. 2014. Fishery gear interactions from stranded bottlenose dolphins, Florida manatees and sea turtles in Florida, USA. *Mar. Pollut. Bull.* 80: *http://dx.doi.org/10.1016/j.marpolbul.2014.02.008*).

Marine debris

MICROPLASTICS ABUNDANT IN THE ATLANTIC

Microplastics represent marine debris at the smallest scale, either the degradation products of large plastic items or the small 'plastic pellets' that provide the raw material for producing plastic items. An examination of 125 beaches on three islands in the North Atlantic Canary current revealed enormous concentrations, reaching 100g of plastic per litre of sediment. These beaches are in highly protected natural areas, demonstrating that this material is brought from distant coasts and the open ocean. All microplastics on shorelines spent time in coastal and open water habitats, and evidence is mounting that these particles and the toxic compounds that adhere to them are taken up by marine organisms, including those at the top of the food chain such as cetaceans.

(SOURCE: Baztan, J., Carrasco, A., Chouinard, O., Cleaud, M., Gabaldon, J.E., Huck, T., Jaffrès, L., Jorgensen, B., Miguelez, A., Paillard, C. and Vanderlinden, J.P. 2014. Protected areas in the Atlantic facing the hazards of micro-plastic pollution: First diagnosis of three islands in the Canary Current. *Mar. Pollut. Bull.* 80: 302-311).

COMPUTER-GENERATED MAPPING TOOLS IMPROVE REMOVAL OF DERELICT FISHING GEAR

Lost and discarded fishing gear poses a threat to marine habitats and their inhabitants, including cetaceans. Removal of such gear has become a major management issue. In Biscayne National Park, Florida, lobster trap debris 'hot spot' maps were created that combine remotely sensed data on habitat type and depth with previous locations of debris collection. This GIS-based approach effectively reduced the search area by 95%. An expanded system incorporating water currents, locations of known fishing effort and distance from port could further improve such efforts and would be a promising approach elsewhere where the relationship between fishing effort, debris occurrence and entanglement risk have been established.

(SOURCE: Martens, J. and Huntington, B.E. 2012. Creating a GIS-based model of marine debris 'hot spots' to improve efficiency of a lobster trap debris removal program. *Mar. Pollut. Bull.* 64: 949-955).

RIVERINE INPUT OF LITTER INTO THE NORTH SEA: CASE STUDY THAMES RIVER

The input of litter into the sea by rivers is considered to be a major source of marine debris. The Port Authority of London, for example removes about 250 tons of debris and rubbish each year from the Thames – a major input route into the North Sea – using purpose-built vessels and special debris collectors. This study deployed various types of bottom nets to collect submerged debris. Most was plastic and amounts were highest near sewage treatment works. Many items were sanitary products not designed to be disposed via lavatories, calling for a change in consumer behaviour and for applying pressure on manufacturers of such products to improve their biodegradability. The results underline that, beyond visible debris floating on the surface, consideration must also be given to submerged items reaching the sea via rivers.

(SOURCE: Morritt, D., Stefanoudis, P.V., Pearce, D., Crimmen, O.A., and Clark, P.F. 2014. Plastic in the Thames: A river runs through it. *Mar. Pollut. Bull.* 78: 196-200).

SOUTH ATLANTIC OCEAN 'GARBAGE PATCH' DETECTED

Plastic and other marine debris have been recognised as a severe marine pollution problem, and the IWC has recently highlighted the ingestion and entanglement threat posed to cetaceans by marine litter. This study demonstrated that floating debris is accumulating along the margins of the South Atlantic Gyre as far south as 34-35°S. Almost all the litter (97%) was composed of plastic, and in most cases litter far outnumbered floating seaweeds. The author speculate there are even higher densities of litter in the core of the gyre.

(SOURCE: Ryan, P.G. 2014. Litter survey detects the South Atlantic 'garbage patch'. *Mar. Pollut. Bull.* 79: 220-224).

Ship strikes

RULES TO REDUCE COLLISIONS WITH RIGHT WHALES ALONG US ATLANTIC COAST MADE PERMANENT

The US National Oceanic and Atmospheric Administration (NOAA) has taken steps to permanently implement the temporary rules (expiration date December 2013) governing ship traffic in areas containing North Atlantic right whales along the Atlantic coast of the United States. This Ship Strike Rule specifies reduced speeds (10 knots or less) of vessels longer than 65 feet during certain times of the year in 10 so-called Seasonal Management Areas (SMAs) between Maine and Florida. These rules have significantly reduced collisions between ships and whales since 2008. Compliance has been good, although three large commercial vessels were fined for violations in late 2011. One study reported a decrease in large whale vessel-strike mortalities from 2.0 per year from 2000-06 to 0.33 from 2007-12, whereby the number decreased within SMAs and increased outside them. The 450 right whales in the Northwest Atlantic are among the most endangered animals in the world. The authors suggest increasing the spatial and temporal extent of SMAs in the mid-Atlantic because the current ones encompass only 36% of historical right whale vessel-strike mortalities.

(SOURCE: News. 2013. *Mar. Pollut. Bull.* 72: 4-5; News. 2012. *Mar. Pollut. Bull.* 64: 460; van der Hoop, J.M., Vanderlaan, A.S.M., Cole, T.V.N., Henry, A.G., Hall, L, Mase-Guthrie, B., Wimmer, T. and Moore, M.J. 2014. *Conservation Letters.* Vessel strikes to large whales before and after the 2008 Ship Strike Rule. doi: 10.1111/conl.12105).

Chemical pollution

PERFLUORINATED COMPOUNDS IN BOTTLENOSE DOLPHINS

Perfluorinated compounds (PFCs) are used as surface coatings and are a focus of interest in pollution studies due to their persistence, bioaccumulation and global distribution. The blood plasma of bottlenose dolphin populations from two US southeast Atlantic sites was examined. Dolphins from the Charleston, South Carolina, site had some of the highest PFC levels reported in marine mammals (same order of magnitude as occupationally exposed humans). Importantly, the highest values were found in juveniles (significantly higher than in adult males and females). Such high levels during rapid growth and development may involve greater health risks and are probably due to PFC transfer from the mother by milk and by prey consumed during early years. This class of pollutants is known to contain endocrine disruptors, tumour promoters and immunosuppressors.

(SOURCE: Fair, P.A., Houde, M., Hulsey, T.C., Bossart, G.D., Adams, J., Balthis, L. and Muir, D.C. 2012. Assessment of perfluorinated compounds (PFCs) in plasma of bottlenose dolphins from two southeast US estuarine areas: Relationship with age, sex and geographic locations. *Mar. Pollut. Bull.* 64: 66-74).

HIGH PERSISTENT ORGANIC POLLUTANT LEVELS IN EAST ATLANTIC COMMON DOLPHINS

Blubber samples were analysed for POPs from 42 female short-beaked common dolphins that were taken as bycatch between 1992 and 2006 by fisheries operating off the southwest coast of the UK. At least 1,000 common dolphins are taken as bycatch each year here. Seventy-two percent of the examined individuals had PCB concentrations above an established toxicity threshold (17 mg kg^{-1} lipid weight), and the dolphins from UK waters 'represented the upper end of the concentrations reported' in the literature. These elevated PCB levels are a cause for concern regarding potential risk of death due to infectious diseases. The levels are expected to be even higher in males, which cannot offload such contaminants to their offspring as breeding females do.

(SOURCE: Law, R.J., Bersuder, P., Barry, J., Barber, J., Deaville, R., Barnett, J. and Jepson, P.D. 2013. Organochlorine pesticides and chlorobiphenyls in the blubber of bycaught female common dolphins from England and Wales from 1992-2006. *Mar. Pollut. Bull.* 69 (1-2): 238-242).

BAN OF TRIBUTYLTIN HAS PROVEN TO BE EFFECTIVE IN UK WATERS

Tributyltin (TBT) is a toxic compound used as an additive to antifouling paints for boat hulls. After EU and IMO initiatives, it was banned in 2003 (with complete prohibition on ship hulls phased in through 2008 due to painting intervals). This study shows that: (1) the TBT concentrations have declined in harbour porpoises; and (2) the percentage of porpoises in which TBT was detected has declined (from 100% in the 1990s to 4.3% in 2009). The authors conclude that 'the ban has proven to be effective in reducing inputs to the seas from vessels'. Similar trends have been documented in other 'legacy' pollutants such as organochlorine pesticides and certain flame retardants, but not for PCBs (due to continuing diffuse inputs and the large reservoir already present in the environment).

(SOURCE: Law, R.J., Bolam, T., James, D., Barry, J., Deaville, R., Reid, R.J., Penrose, R. and Jepson, P.D. 2012. Butyltin compounds in liver of harbour porpoises (*Phocoena phocoena*) from the UK prior to and following the ban on the use of tributyltin in antifouling paints (1992-2005 and 2009). *Mar. Pollut. Bull.* 64: 2,576-2,580).

POLLUTANT LEVELS IN HUMPBACK WHALES ACROSS THE ATLANTIC INDICATE SOURCES AND TIMING OF INPUTS

The levels of persistent organic pollutants (POPs) were examined in two eastern North Atlantic humpback whale populations (Cape Verde and Ireland) and compared with a western North Atlantic (Gulf of Maine) population. The PCB concentrations were below the estimated threshold toxicity value. The ratio of DDT to its breakdown product DDE indicates more recent DDT inputs for the eastern North Atlantic sites. The DDT: PCB ratios from the eastern North Atlantic individuals indicate that agricultural sources of these pollutants are more important than industrial sources. The results show the potential for POPs as tracers to help clarify unresolved aspects of population structure in humpback whales in the North Atlantic. The low POP concentrations suggest that they are an unlikely factor in the poor recovery of humpback whales in Cape Verde.

(SOURCE: Ryan, C., McHugh, B., Boyle, B., McGovern, E., Bérubé, M., Lopez-Suarez, P., Elfes, C.T., Boyd, D.T., Ylitalo, G.M., Van Blaricom, G.R., Clapham, P.J., Robbins, J., Palsbøll, P.J. and O'Connor, J. 2013. Levels of persistent organic pollutants in eastern North Atlantic humpback whales. *Endang. Species Res.* 22: 213-223).

DDT LEVELS DECLINING

The analysis of the pesticide DDT and its breakdown products (DDD and DDE) in thousands of bivalve samples taken from coastal water of the United States revealed that average concentrations were declining along both the West and East Coast. The highest values in Atlantic waters were in Delaware and the Hudson/Raritan Estuary; in the Gulf of Mexico in Alabama and northwestern Florida. Values are declining with an environmental half-life between 10 and 14 years and are expected to drop to below 10% of today's concentrations by 2050. This indicates that this pollutant is slowly disappearing from environments where no new production or inputs occur. Unfortunately, the use of this pesticide is not banned worldwide. This pollutant is subject to bioaccumulation and is therefore found in relatively high amounts in top marine predators such as cetaceans.

(SOURCE: Sericano, J.L., Wade, T.L., Sweet, S.T., Ramirez, J., and Lauenstein, G.G. 2014. Temporal trends and spatial distribution of DDT in bivalves from the coastal marine environments of the continental United States, 1986-2009. *Mar. Pollut. Bull.* 80: in press. *http://dx.doi.org/10.1016/j.marpolbul.2013.12.049*).

Disease and mortality events

General

CAUSE OF DEATH IN ONE-THIRD OF STRANDED CETACEANS ON THE CANARY ISLANDS IS ANTHROPOGENIC

An examination of 233 stranded cetaceans from 19 species in the Canary Islands, Northeast Atlantic, revealed that the cause of death in one-third of the cases was anthropogenic. The most common causes of death were fishery interactions (bycatch), ship collisions (particularly in sperm whales), atypical mass strandings linked to naval exercises (beaked whales), and ingestion or entrapment by marine debris. The most important non-anthropogenic causes of death were starvation and a range of infectious and non-infectious diseases. This highlights the many threats facing cetaceans and provides valuable input for cetacean conservation and management efforts here.

(SOURCE: Arbelo, M., Los Monteros, A.E,. Herráez, P., Andrada, M., Sierra, E., Rodríguez, F., Jepson, P.D. and Fernández, A. 2013. Pathology and causes of death of stranded cetaceans in the Canary Islands (1999-2005). *Dis. Aquat. Org.* 103: 87-99, doi: 10.3354/dao02558).

Oil spills

DEEPWATER HORIZON SPILL IMPACTS DOLPHIN HEALTH

Bottlenose dolphins in Barataria Bay, Louisiana, are showing several disease conditions that are uncommon and consistent with petroleum hydrocarbon exposure. This bay in the Gulf of Mexico received heavy and prolonged oiling related to the *Deepwater Horizon* incident. The 29 dolphins examined showed evidence of adrenal toxicity and were five times more likely to have moderate to severe lung disease. Almost half of the animals were given a guarded or worse prognosis, with 17% of these not expected to survive. A comparable but unexposed population in Sarasota Bay, Florida, showed a significantly lower prevalence and severity of symptoms. Mortalities in Barataria Bay are considered to be part of an ongoing Unusual Mortality Event (UME) covering the northern Gulf of Mexico and encompassing 1,051 cetacean strandings since early November 2013.

(SOURCE: Schwacke, L.H., Smith, C.R., Townsend, F.I., Wells, R.S., Hart, L.B., Balmer, B.C., Collier, T.K., De Guise, S., Fry, M.M., Guillette, L.J., Jr., Lamb, S.V., Lane, S.M., McFee, W.E., Place, N.J., Tumlin, M.C., Ylitalo, G.M., Zolman, E.S. and Rowles, T.K. 2014. Health of common bottlenose dolphins (*Tursiops truncatus*) in Barataria Bay, Louisiana, following the *Deepwater Horizon* oil spill. *Environ. Sci. Tech.* 48: 93-103).

Disease

NOVEL MORBILLIVIRUS IN SOUTH ATLANTIC DOLPHIN

Although major morbillivirus outbreaks and mortalities have been reported in cetaceans from the Northern Hemisphere,

only one fatal case, in a bottlenose dolphin, has been reported in the Southern Hemisphere (southwest Pacific Ocean). This is the first reported case in the South Atlantic, affecting the coastal and estuarine Guiana dolphin. The stranded female calf contained a novel strain of morbillivirus. Accordingly, morbillivirus infection is extant in Guiana dolphins in Brazil and dolphin calves are susceptible.

(SOURCE: Groch, K.R., Colosio, A.C., Marcondes, M.C.C., Zucca, D., Díaz-Delgado, J., Niemeyer, C., Marigo, J., Brandão, P.E., Fernández, A. and Catão-Dias, J.L. 2014. Novel cetacean morbillivirus in Guiana dolphin, Brazil. *Emerg. Infect. Dis*. 20: 511-513).

BRUCELLA INFECTION FOUND IN HARBOUR PORPOISE STRANDED ON BELGIAN COAST

The bacterium *Brucella ceti* was found in a stranded adult female harbour porpoise on the Belgian coast. The necropsy revealed the bacterium in multiple organs, a recent pregnancy and the possibility of a spontaneous abortion. *Brucella* is known to cause abortions in terrestrial animals and could therefore also affect reproduction in cetaceans. The results also point to potential vertical and horizontal transmission to new-borns. The authors also emphasise the health risk posed to humans of contracting this disease by handling infected cetaceans in the framework of, e.g. strandings, bycatches, rehabilitation centres.

(SOURCE: Jauniaux, T.P., Brenez, C., Fretin, D., Godfroid, J., Haelters, J., Jacques, T., Kerckhof, F., Mast, J., Sarlet, M. and Coignoul, F.L. 2010. *Brucella ceti* infection in harbor porpoise (*Phocoena phocoena*). *Emerg. Infect. Dis.*16: 1,966-1,968).

MORBILLIVIRUS IN AN ATLANTIC DOLPHIN CLOSELY RELATED TO VIRUS IN MEDITERRANEAN DOLPHINS

A morbillivirus detected in a live-stranded juvenile bottlenose dolphin in the Canary Islands, eastern North Atlantic Ocean, is nearly identical to the morbillivirus reported in striped dolphins in the Mediterranean Sea. This supports the hypothesis that transmission occurs between species and shows that the dolphin populations in the Mediterranean and Atlantic are in contact through the Strait of Gibraltar. This information could help clarify the infectious source(s) of the die-off of bottlenose dolphins along the east coast of the US in 2013.

(SOURCE: Sierra, E., Zucca, D., Arbelo, M., García-Álvarez, N., Andrada, M., Déniz, S. and Fernández, A. 2014. Fatal systemic morbillivirus infection in bottlenose dolphin, Canary Islands, Spain. *Emerg. Infect. Dis.* 20 (2) *http://dx.doi.org/10.3201/eid2002.131463doi*).

Climate change

ANOMALOUS GRAY WHALE SIGHTINGS IN THE ATLANTIC AND MEDITERRANEAN REFLECT CHANGES IN ARCTIC

The reduction in seasonal sea ice coverage in the Arctic has resulted in an expansion of the distribution of gray whales. Observations of a gray whale in the Mediterranean Sea in 2010 and one off Namibia in 2013 (the first record of a gray whale in the Southern Hemisphere) could be harbingers of the future if reductions in sea ice continue and the northwest and northeast passages become ice-free.

(SOURCES: Elwen, S.H. and Gridley, T. 2013. Gray whale (*Eschrichtius robustus*) sighting in Namibia (SE Atlantic) – first record for Southern Hemisphere. Paper SC/65a/BRG30 presented to the Scientific Committee of the International Whaling Commission; Scheinin, A.P., Kerem, D., MacLeod, C.D., Gazo, M., Chicote, C.A., and Castellote, M. 2011. Gray whale (*Eschrichtius robustus*) in the Mediterranean Sea: anomalous even or early sign of climate-driven distribution change? *Mar. Biodiver. Rec.* 4, e28).

POSSIBLE IMPACTS OF CLIMATE CHANGE FOR UK WATERS

Temperatures in UK waters show an overall upward trend. Changes in primary production are expected throughout UK waters, with southern waters becoming 10% more productive (e.g. the English Channel) and northern regions (e.g. central and northern North Sea) becoming 20% less productive. Shifts of cetacean species have been reported, with various species of dolphins (including white-beaked dolphins, Atlantic white-sided dolphins, short-beaked common dolphins and striped dolphins) moving northwards, and novel stranding of warmer water species being reported for the first time (such as Blainville's beaked whale), suggesting a temperature-change-linked shift for a variety of cetacean species.

(SOURCE: Marine Climate Change Impacts Partnership. 2014. *Report Card 2013*. Marine Climate Change Impacts Partnership. *In*: Evans, P.G.H. and Bjørge, A. 2013. Impacts of climate change on marine mammals. Marine Climate Change Impacts Partnership: Science Review. Available from: *http://www.mccip.org.uk/media/13291/2013arc_backingpapers_15_marm.pdf*).

REDUCTION OF OCEAN CIRCULATION IN NORTH ATLANTIC COULD LEAD TO COOLING

Although the Marine Climate Change Impacts Partnership described warming of the waters in the North Atlantic, another study determined that the Atlantic Meridional Overturning Circulation (AMOC) decreased 10-15% since 2004. This study analysed data from floating sensor arrays in the North Atlantic over an eight-year period. If the AMOC is strong, more heat is transferred into the surface waters of the North Atlantic; if weak, less heat is transferred. It was also suggested that the AMOC may have actually declined by 20% or more. Although climate change is likely a factor in weakening ocean circulation, it was suggested that the change is more dramatic than would be expected by climate change alone and that other factors may be involved.

(SOURCE: Robson, J., Hodson, D., Hawkins, E. and Sutton, R. 2014. Atlantic overturning in decline? *Nature Geoscience* 7: 2-3; Smeed, D.A., McCarthy, G.D., Cunningham, S.A., Frajka-Williams, E., Rayner, D., Johns, W.E., Meinen, C.S., Baringer, M.O., Moat, B.I., Duchez, A. and Bryden, H.L. 2013. Observed decline of the Atlantic Meridional Overturning Circulation 2004 to 2012. *Ocean Sci.* 10: 1,619-1,645).

Noise impacts

CANARY ISLANDS: NO MASS STRANDINGS SINCE SONAR BAN

The Canary Islands has been a hotspot for mass strandings, particularly of beaked whales. These strandings have been attributed to naval exercises, specifically those involving high-intensity sonar. No mass strandings have been reported since the Spanish government imposed a moratorium on naval exercises in these waters in 2004. This demonstrates that prompt political action can result in conservation success for whales and dolphins.

(SOURCE: Fernandez, A., Arbelo, M., and Martin, V. 2013. No mass strandings since sonar ban. *Nature Corres.* 497: 317).

SUBSTANTIAL DISTURBANCE OF GERMAN HARBOUR PORPOISE STOCK POSSIBLE DURING WIND FARM CONSTRUCTION

Aerial surveys in the German North Sea investigated harbour porpoise abundance and seasonal changes in distribution. Porpoises moved into German waters in the spring, became more abundant in the early part of the summer and then apparently move out of German waters in the autumn. The surveys found that there were specific areas where porpoises aggregated, or 'hotspots', in the spring and summer. This distribution was compared with proposed and existing sites for wind farms. The authors proposed that wind farm licences should not be granted for one of the hotspot areas (Sylt Outer Reef) and construction should not occur during the spring for a second (Borkum Reef Ground). Assuming that porpoises were disturbed within 20km of a construction site, it was estimated that as much as '39% of the harbour porpoise stock in the German EEZ could be affected during construction'.

(SOURCE: 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).

MILITARY EXERCISES RESPONSIBLE FOR COMMON DOLPHIN MASS STRANDING IN SOUTHWEST ENGLAND

On 9 June 2008, short-beaked common dolphins mass-stranded in Falmouth Bay, Cornwall; at least 26 died. They were well fed, had no signs of algal toxin exposure and had low pollutant levels in tissues. However, five animals had microscopic haemorrhages in the ear. Several potential causes of the stranding were excluded, including 'infectious disease, gas/fat embolism, boat strike, bycatch, predator attack, foraging unusually close to shore, chemical or algal toxin exposure, abnormal weather/climatic conditions, and high-intensity acoustic inputs from seismic airgun arrays or natural sources (e.g. earthquakes).' There was, however, a naval exercise on the morning of the mass stranding. The authors suggested that the initial naval exercise drove the pelagic dolphins into the enclosed waters of Falmouth Bay, and then subsequent helicopter activity caused them to strand. The authors concluded 'naval activity to be the most probable cause of the Falmouth Bay [mass stranding event]'.

(SOURCE: Jepson, P.D., Deaville, R., Acevedo-Whitehouse, K., Barnett, J., Brownlow, A., Brownell, R.L., Jr., Clare, F.C., Davison, N., Law, R.J., Loveridge, J., Macgregor, S.K., Morris, S., Murphy, S., Penrose, R., Perkins, M.W., Pinn, E., Seibel, H., Siebert, U., Sierra, E., Simpson, V., Tasker, M.L., Tregenza, N., Cunningham, A.A. and Fernández, A. 2013. What caused the UK's largest common dolphin (*Delphinus delphis*) mass stranding event? *PLoS ONE* 8(4): e60953. doi:10.1371/journal.pone.0060953).

ACOUSTIC BEHAVIOURAL RESPONSES OF BOTTLENOSE DOLPHINS TO SHIPPING IN THE SADO ESTUARY, PORTUGAL

The Sado Estuary, Portugal, has a particularly high level of boat traffic. The group size and acoustic and visual behaviour of common bottlenose dolphins resident in this area was monitored and correlated with the presence or absence of vessels within a 1km radius of dolphin groups. Overall, mean call rates decreased significantly in the presence of boats. Production of creaks (fast click trains) was significantly lower in the presence of ferry boats. Significant differences in dolphin whistle minimum, maximum, and start frequencies were also observed, suggesting vessel traffic is having an impact on communication within this small dolphin population.

(SOURCE: Luís, A.R., Couchinho, M.N. and Santos, M.E. 2014. Changes in the acoustic behavior of resident bottlenose dolphins near operating vessels. *Mar. Mamm. Sci.* 30(4): 1,417-1,426).

NEW ATTEMPT TO TACKLE UNDERWATER NOISE IN A COASTAL NORTH ATLANTIC CASE STUDY

Underwater noise levels have been increasing worldwide and are a recognised threat for cetaceans. This study characterised the noise levels at two sites in Moray Firth, Scotland, an important marine mammal habitat (Special Area of Conservation). It established a pre-development baseline and presented ship noise monitoring methods. These relied partially on shore-based time-lapse footage and on the ship-tracking Automatic Identification System (AIS). By tying the results to EU Marine Strategy Framework Directive indicators, this study shows a way forward in how international regulations can best address the anthropogenic noise issue.

(SOURCE: Merchant, N.D., Pirotta, E., Barton, T.R., and Thompson, P.M. 2014. Monitoring ship noise to assess the impact of coastal developments on marine animals. *Mar. Pollut. Bull.* 78: 85-95).

KILLER WHALE RESPONSE THRESHOLDS TO SONAR LOWER THAN PREDICTED BY US NAVY MITIGATION MEASURES

Killer whale groups in Norway were exposed to experimentally-controlled military sonar at 1-2 kHz and 6-7 kHz, with the source level increasing and the sonar source in increasing proximity, to determine the threshold at which behavioural changes occurred. Responses occurred between 94 and 164 dB re 1 µPa SPL. These response thresholds did not seem to be influenced by sonar frequency or prior exposure to sonar. The mean response threshold was 142±15dB (SD) re 1 µPa SPL. The researchers concluded that the 'dose-response functions indicate that some killer whales started to avoid sonar at received [sound levels] below thresholds assumed by the US Navy'. Moreover, the 'predicted extent of habitat over which avoidance reactions occur…was large enough to raise concerns about biological consequences to the whales'.

(SOURCE: Miller, P.J.O., Antunes, R.N., Wensveen, P.J., Samarra, F.I.P., Alves, A.C De Carvalho., Tyack, P.L., Kvadsheim, P.H., Kleivane, L., Lam, F.P.A., Ainslie, M.A. and Thomas, L. 2014. Dose-response relationships for the onset of avoidance of sonar by free-ranging killer whales. *J. Acoust. Soc. Amer.* 135: 975).

DECREASE IN KILLER WHALE ABUNDANCE LINKED TO NAVAL SONAR WHEN PREY ABUNDANCE IS LOW

Monitoring with visual and passive acoustic surveys was conducted before, during and after a naval exercise in Norway and the effect noted on killer whales. Although the main factor that affected killer whale presence was the availability of herring (the whales' main prey species), when herring presence was low, naval sonar activity had a negative impact on killer whale presence.

(SOURCE: Sanna Kuningas, S., Kvadsheim, P.H., Lam, F.P.A. and Miller, P.J.O. 2013. Killer whale presence in relation to naval sonar activity and prey abundance in northern Norway. *ICES J. Mar. Sci.* 70:1,287-1,293).

GLOBAL

General

WHALE-WATCHING DISTURBANCE ESTIMATED TO CAUSE SUBSTANTIAL DECREASES IN WHALE ENERGY INTAKE

Considerable effort is being made to answer how short-term behavioural disturbance in marine mammals, including cetaceans, translates into impacts at the population level. The authors analysed interactions of northern minke whales with whale-watching vessels, combined with a stepwise modelling approach, to estimate energy budgets and the loss of energy intake because normal foraging and diving behaviour ceases or is altered. Whale-watching vessel presence resulted in an estimated overall decrease in energy intake of 42%, due to a decrease in feeding behaviour.

(SOURCE: Christiansen, F., Rasmussen, M.H. and Lusseau, D. 2013. Inferring activity budgets in wild animals to estimate the consequences of disturbances. *Behav. Ecol.* 24: 1,415-1,425).

HABITAT DEGRADATION AND HUNTING OF LARGE SPECIES ASSOCIATED WITH MAMMAL EXTINCTION RISK

A review of IUCN Red Listed mammal species to determine what common factors were associated with endangerment determined that 'large and widely distributed mammals are affected by combinations of direct exploitation and threats associated with increasing landscape modification that go from logging to intense human land-use.' On the other hand, 'small, narrowly distributed species are affected by intensifying levels of landscape modification but are not directly exploited.' Unsurprisingly the most endangered species were exposed to the greatest number of threats and it was suggested that 'extinction risk is associated with the accumulation of external threats.' Habitat loss and degradation were strongly associated with mammal extinction risk, and for large, widely distributed species (e.g. cetaceans), hunting was an additional factor that increased extinction risk.

(SOURCE: González-Suárez, M. and Revilla, E. 2014. Generalised drivers in the mammalian endangerment process. *PLoS ONE* 9(2): e90292. doi:10.1371/journal.pone.0090292).

YANGTZE FINLESS PORPOISE POPULATION RAPIDLY DECLINING

The most recent survey conducted in 2012 in the Yangtze River and two adjoining lakes in China showed that the population of this endangered species – the only freshwater finless porpoise in the world – has declined to a mere 1,000 individuals. Compared with the 2006 survey, this represents an unsustainable 13.7% rate of annual decline. The species is projected to become extinct as early as 2025. This decline is attributed to human disturbance such as increasing shipping traffic and newly discovered illegal fishing practices, including traps that could affect the porpoises. This trend could be exacerbated by the drastic shrinking of many Yangtze River Basin lakes: from 1950 to 2010, the central and lower reaches of the Yangtze lost approximately two-thirds of their lakes due to increased land reclamation for agriculture and industrial development. Moreover, 32 individuals were found dead in early 2012 in Dongting and Poyang lakes, from electro-fishing, boat propellers, food shortages and poison. The recent extinction of the baiji in the same waters is a wake-up call to take immediate and urgent action. The reputation and reason for existence of national and international cetacean conservation and management organisations, including the IWC, is at stake – as is the conscience and responsibility of humankind toward nature in general.

(SOURCES: News. 2013. *Mar. Pollut. Bull.* 71: 3; News. 2012. *Mar. Pollut. Bull.* 64: 460; News. 2012. *Mar. Pollut. Bull.* 64: 1,081).

VAST QUANTITIES OF DUMPED MILITARY ORDNANCE POSE AN INCREASING THREAT

European countries have dumped more than 1 million tons of munitions in the Irish Sea, 168,000 tons in Danish waters, and 300,000 tons in the North Sea. After World War II, the USA and European countries dumped another 300,000 tons of conventional and chemical munitions into the sea. An estimated 150 individual dump sites spread from Iceland to Gibraltar. In the US, more than 400 dump sites are located in the Pacific, Atlantic and Gulf of Mexico. The integrity of this military ordnance, especially of incendiary and chemical weapons, has been compromised after decades in seawater. With our increasing use of the ocean bed for fishing, sand and gravel extraction, offshore oil and wind energy production, diving and so on – coupled with the further deterioration and leakage of toxic substances – this material poses an increasing threat to marine and human life.

(SOURCE: Morton, B. 2013. Bombs away! *Mar. Pollut. Bull.* 73: 1-2).

THE GLOBAL STATE OF THE OCEANS

A special issue of *Marine Pollution Bulletin* was devoted to a synthesis of two workshops held by the International Programme on the State of the Ocean (IPSO; *http://www.stateoftheocean.org*) in partnership with the International Union for Conservation of Nature (IUCN; *http://www.iucn.org*). The verdict: '[H]uman activities have led to intense multiple stressors acting together in many marine ecosystems. Most notably these are arising from overexploitation of biotic resources, climate change effects forming the so-called 'deadly trio' (ocean warming, acidification and hypoxia/anoxia) and pollution.' The authors call for a 'rapid adoption of a holistic approach to sustainable management of all activities that impinge on marine ecosystems.' With regard to marine fisheries, several solutions are presented, including addressing the weaknesses and gaps in ocean governance via United Nations General Assembly resolutions. The most ambitious and promising approach is a structural overhaul of the system. This would include creating a new global infrastructure to coordinate, ensure consistency and accountability, and supervise, sanction and enforce. One step would be to create a U.N. Department for Oceans and Law of the Sea, and to negotiate a new agreement under UNCLOS to protect and preserve marine life in areas beyond national jurisdictions.

(SOURCE: Rogers, A.D. (ed.) 2013. The global state of the ocean: interactions between stresses, impacts and some potential solutions. Synthesis papers from the International Programme on the State of the Ocean 2011 and 2012 workshops. *Mar. Pollut. Bull.* 74: 491-551).

Habitat degradation

General

POLLUTION WITH FAECAL PATHOGENS INCREASING IN COASTAL WATERS

Much of the world's human population and our domesticated animals live along coastlines. Parasites, bacteria and viruses that are shed in the faeces of humans and animals enter coastal waters through sewage, storm-drains and as run-off. This is making contamination of coastal waters with terrestrially-derived faecal pathogens a chronic and increasingly global pollution problem. This threat is expected to increase as natural coastal habitats become degraded or replaced by human infrastructure. Climate change is also expected to exacerbate this problem, calling for reducing our 'faecal footprint'. This type of contamination has adverse effects on marine wildlife, including marine mammals.

(SOURCE: Shapiro, K. 2012. Climate and coastal habitat change: A recipe for a dirtier ocean. *Mar. Pollut. Bull.* 64: 1,079-1,080).

Marine debris

MARINE DEBRIS: PERVASIVE IN THE SEA AND DOMINATING THE LITERATURE ON MARINE POLLUTION

Marine debris is such an intensifying threat that it is coming to dominate the publications in the field of marine pollution. A review of the literature as it pertains to cetaceans reveals that ingestion of debris has been documented in 48 (56% of) species. Rates of ingestion peaked at 31% in some populations. Debris-induced mortality rates of up to 22% of stranded animals were documented. Plastic constituted most of the debris ingested. There is a high prevalence of debris interactions, and the authors call upon cetacean stranding networks to collect and publish such data on a species level.

(SOURCE: Baulch, S. and Perry, C. 2014. Evaluating the impacts of marine debris on cetaceans. *Mar. Pollut. Bull.* 80: in press. *http://dx.doi.org/10.1016/j.marpolbul.2013.12.050*).

NEW APPROACHES TO DETECTING LOST FISHING GEAR

Derelict fishing gear (DFG) poses a threat to marine ecosystems (and safe navigation). It is a key item in the cetacean entanglement problem and requires a multi-disciplinary approach. A special journal issue was devoted to the early, at-sea detection of such gear, the goal being pre-emptive removal. Three disciplines are addressed: oceanography, remote sensing and marine debris. The main conclusions drawn in these disciplines are that: (1) DFG concentrations can be modelled, substantially reducing the search area and improving at-sea detection efficiency; (2) the only known attempt to use unmanned aircraft systems, whose instruments can detect DFG poorly visible to the human eye, proved to be unsuccessful but provided information for future attempts; and (3) marine debris removal is much less costly than the long-term impacts of ghost fishing.

(SOURCE: McElwee, L., Morishige, C. and Donohue, M. (eds.) 2012. At-sea detection of derelict fishing gear. *Mar. Pollut. Bull.* 65: 1-75).

Ship strikes

NEW METHOD TO HELP DETECT SHIP STRIKES AS THE CAUSE OF DEATH IN CETACEANS

Recording the number of cetacean deaths due to non-natural causes is an important task at the IWC, and ship strikes are a key recognised threat. Examinations of 13 stranded

cetaceans with sharp trauma from ship strikes showed that muscle samples from elsewhere on the carcass (i.e. not at the injury site) also revealed a series of relevant microscopic changes. This histopathological approach provides additional criteria to help determine ship strikes as the cause of death in animals that are in an advanced stage of decomposition or where access to the entire animal is limited.

(SOURCE: Sierra, E., Fernández, A., Espinosa de los Monteros, A., Arbelo, M., Díaz-Delgado, J., Andrada, M. and Herráez, P. 2014. Histopathological muscle findings may be essential for a definitive diagnosis of suspected sharp trauma associated with ship strikes in stranded cetaceans. *PLoS One* 9 (2): 1-8: e88780).

Chemical pollution

SPERM WHALES USED TO INDICATE GLOBAL LEAD POLLUTION

Heavy metals, including lead, are a key marine pollutant. Sperm whales were used as an indicator species to assess oceanic lead pollution globally. They are suitable because they are distributed worldwide, long-lived and positioned at the end of the food chain, where higher concentrations are expected due to bioaccumulation. Three hundred and thirty-seven (337) skin biopsies were collected from animals around the world, including 35 from the Atlantic. Lead concentrations in skin reflect recent exposure because the half-life of lead in soft tissues is only a few weeks or months. This was the first global toxicological dataset for lead in a marine mammal and confirmed that lead is widely distributed, with hotspots in some regions (e.g. Papua New Guinea, Bahamas, Australia). The authors expect lead concentrations in other organs to be higher than that found in skin.

(SOURCE: Savery, L.C., Wise, S.S., Falank, C., Wise, J., Gianios, C., Jr., Douglas Thompson, W., Perkins, C., Zheng, T., Zhu, C. and Wise, J.P., Sr. 2014. Global assessment of oceanic lead pollution using sperm whales (*Physeter macrocephalus*) as an indicator species. *Mar. Pollut. Bull.* 79: 236-244).

WHALE EARPLUG REVEALS LIFETIME HISTORY OF CONTAMINANT EXPOSURE

In a new approach, an earplug taken from a blue whale killed by a ship strike off Santa Barbara, California, revealed information about the lifetime profiles (i.e. from birth to death) of exposure to organic contaminants (pesticides and flame retardants) and mercury. There was a transfer of contaminants to this whale from its mother early in life and two distinct pulses of mercury contamination. The recognition that earplugs chronologically archive pollutant and hormone levels provides a new approach to measuring environmental stress. In this case, hormone levels revealed a doubling of stress over the animal's lifetime and enabled determination of the time to sexual maturity. Combined with similar studies on earplugs of museum samples, this increases the feasibility of accurately assessing anthropogenic impacts on scales ranging from an individual whale to the marine ecosystem.

(SOURCE: Trumble, S.J., Robinson, E.M., Berman-Kowalewski, M., Potter, C.W., and Usenko, S. 2013. Blue whale earplug reveals lifetime contaminant exposure and hormone profiles. *PNAS* 110: 16,922-16,926).

Disease and mortality events

Direct exploitation

HUMAN CONSUMPTION OF CETACEANS

Based on 900 sources of information, the authors of this study determined that people from at least 114 countries have consumed one or more of at least 87 marine mammal species. These include less well-known species such as the pygmy beaked whale, south Asian river dolphin, narwhal, Chilean dolphin, long-finned pilot whale and Burmeister's porpoise. Overall the historical review reveals an increase in the exploitation of small cetaceans, particularly coastal and estuarine species. Many are caught in conjunction with fishing activities, whereby 'non-targeted-deliberate' acquisition is cause for serious concern. A greater understanding of the underlying motivations is required to design and implement more effective conservation measures, especially because most takes are in countries with little or no assessment of marine mammal populations.

(SOURCE: News. 2012. *Mar. Pollut. Bull.* 64: 459-461; Robards, M.D. and Reeves, R.R. 2011. The global extent of marine mammal consumption by humans: 1970-2009. *Biol. Conserv.* 144: 2,770-2,786).

Stress

THE SUBLETHAL EFFECTS OF CAPTURE

A review of marine bycatch papers determined that there were many possible sublethal effects of capture (i.e. bycatch), even if animals are released alive. These include physiological disturbance, behavioural impairment, injury, reflex impairment, and effects on reproduction (such as miscarriages in dolphins), feeding, and growth for animals that survived a fisheries interaction. Some of these sublethal impacts could be short-term (e.g. acute stress response) or could be long-term or even delayed sublethal outcomes (e.g. reduction in growth or reproduction) and are thus 'directly fitness-relevant and could have had population-level effects'. The authors called for more research into the effects of capture stress on reproduction in particular. They note that to date the sublethal effects of bycatch have mostly been ignored, but they could have major conservation and management repercussions. This could certainly be the case for cetaceans that were captured either accidentally (in active and ghost fishing gear) or deliberately (for research purposes).

(SOURCE: Wilson, S.M., Raby, G.D., Burnett, N.J., Hinch, S.G. and Cooke, S.J. 2014. Looking beyond the mortality of bycatch: sublethal effects of incidental capture on marine animals. *Biol. Conserv.* 171: 61-72).

Climate change

CLIMATE CHANGE PREDICTIONS FOR THE OCEANS

The most recent 2014 International Panel for Climate Change (IPCC) report deals with foreseen effects of climate change and allocates a level of confidence to the predictions therein. Many of the predictions are related to the ocean environment. The authors note that 'Responding to climate-related risks involves decision-making in a changing world, with continuing uncertainty about the severity and timing of climate change', cautioning policy makers that decisions need to be made urgently even when many scientific factors remain uncertain.

(SOURCE: Field, F.B. Barros, V.R., Bokken, D.J., Mach, K.J., Mastandrea, M.D., Eren Bilir, T., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastandrea, P.R., White, L.L. 2014. *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. International Panel on Climate Change, Geneva).

UPWELLING CEASED IN WEDDELL SEA POLYNYA DUE TO CLIMATE CHANGE

The Weddell Sea polynya, an area of open water the size of New Zealand, is formed by relatively warm salty water being pushed to the surface when passing over a ridge. It keeps the Weddell Sea ice free. Normally, after emitting heat, this upwelling water sinks to become a major source of Antarctic bottom water, and this movement is a major contribution to oceanic circulation. However, the polynya has recently been covered by a layer of low-density freshwater from melting glaciers and increased precipitation. The cessation of this upwelling has reduced the transport of heat, salt and ocean water towards Antarctica, and will greatly impact ocean circulation as well as Antarctic productivity, a major habitat for Southern Hemisphere cetaceans.

(SOURCE: de Lavergne, C., Palter, J.B., Galbraith, E.D., Bernardello, R. and Marinov, I. 2014. Cessation of deep convection in the open Southern Ocean under anthropogenic climate change *Nat. Clim. Change* doi:10.1038/nclimate2132).

Noise impacts

SEISMIC SURVEY PLAYBACKS LEAD TO ABNORMAL DEVELOPMENT IN LARVAE

The impacts of underwater noise on cetaceans continues to be investigated, but noise impacts on prey and keystone species are less well understood. Recordings of seismic survey pulses were played back to scallop larvae (a component of zooplankton). Larvae exposed to these pulses exhibited significant developmental delays and half (46%) developed body abnormalities. The larvae were exposed to received levels of 160dB re 1µPa (rms). Accordingly, considering the source levels of seismic survey arrays, the zone of impact for such larvae could be 'over hundreds of km-squared assuming spherical spreading of sound' around a seismic survey source. This study suggests that the impact of seismic surveys could extend to ecosystem productivity and larger components of marine ecosystems other than just cetaceans.

(SOURCE: Aguilar De Soto, N. Delorme, N., Atkins, J., Howard, S., Williams, J. and Johnson, M. 2013. Anthropogenic noise causes body malformations and delays development in marine larvae. *Scient. Reps* 3: 2831; doi:10.1038/srep02831).

CUVIER'S BEAKED WHALES RESPOND TO MID-FREQUENCY NAVAL SONAR AT LEVELS MUCH LOWER THAN ASSUMED

Two tagged Cuvier's beaked whales were exposed to playbacks of mid-frequency active naval sonar. The sound source started at 160dB re 1µPa when whales were 3.4-9.5km away, and the source was 'ramped up' by 3dB every 25 seconds to 210dB re 1µPa. The whales began to respond at received levels of 89 dB re 1µPa (rms) by ceasing to beat their tail flukes. One animal stopped echolocating, ceased foraging, and swam rapidly away from the source at a received level of 98 dB re 1µPa (rms). The avoidance response lasted for 1.6 hours. The other whale initiated a similar response at a received level of 127 dB re 1µPa (rms), and this response lasted for 1.7 hours, with an unusually deep dive profile lasting 7.6 hours after exposure. The authors noted that 'current US management practices assume that significant behaviour disruption almost never occurs at exposure levels this low'; therefore, significant impacts to beaked whales could occur at levels lower than previously thought, making current US mitigation guidelines for mid-frequency active sonar ineffective at preventing impacts to whales.

(SOURCE: DeRuiter, S.L., Southall, B.L., Calambokidis, J., Zimmer, W.M.X, Sadykova, D., Falcone, E.A., Friedlaender, A.S., Joseph, J.E., Moretti, D., Schorr, G.S., Thomas, L. and Tyack, P.L. 2013. First direct measurements of behavioural responses by Cuvier's beaked whales to mid-frequency active sonar. *Biol. Lett.* 9(4): 20130223).

SEISMIC SURVEYS CAN ALTER THE BEHAVIOUR OF FISH AND INVERTEBRATES

Air guns used in seismic surveys are a major source of anthropogenic noise and are known to affect cetaceans. Experiments involving two species of schooling fish (trevally and pink snapper) and southern reef squid revealed that fish and invertebrates also react to this type of noise. The fish, for example, moved to the bottom and swam faster in more tight groups. The squid showed similar behaviour: alarm responses and changes in swimming patterns and vertical position. Accordingly, consideration should be given not only to the direct effect of air guns on cetaceans, but also indirect effects on their potential prey. The corresponding mitigation techniques need to be developed before beginning a seismic survey.

(SOURCE: Fewtrell, J.L. and McCauley, R.D. 2012. Impact of air gun noise on the behaviour of marine fish and squid. *Mar. Pollut. Bull.* 64: 984-993).

FIRST STUDY TO SHOW THAT BALEEN WHALES REACT TO SONAR NOISE

Tagged blue whales in the Southern California Bight showed behavioural responses to mid-frequency (1-10kHz) sonar sound. Although the sound levels produced in the experiments were orders of magnitude below some military systems, the blue whales responded by stopping feeding, increasing swimming speed, and travelling away from the sound source. This is the first study to show that baleen whales respond to this type of mid-frequency sound, which is known to cause mass strandings of deep-diving toothed whales.

(SOURCE: Goldbogen, J.A., Southall, B.L., DeRuiter, S.L., Calambokidis, J., Friedlaender, A.S., Hazen, E.L., Falcone, E.A., Schorr, G.S., Douglas, A., Moretti, D.J., Kyburg, C., McKenna, M.F. and Tyack, P.L. 2013. Blue whales respond to simulated mid-frequency military sonar. *Proc. Roy. Soc. B*.280: 20130657. http://dx.doi.org/10.1098/rsbl.2013.022378).

INTERNATIONAL MARITIME ORGANIZATION ISSUES NEW GUIDELINES FOR SHIPPING NOISE

The International Maritime Organization (IMO) recently adopted guidelines to reduce underwater noise from commercial ships – the impact of such noise on cetaceans was a major motivation for these guidelines. Although these guidelines are voluntary, their development is a major step forward in recognising and mitigating underwater noise produced by shipping. They: recognise that shipping noise can have short- and long-term impacts on marine species, especially on cetaceans and other marine mammals; call for monitoring and measurement of shipping noise; note analytical models that could be used to determine effective quieting measures; provide guidance for designing quieter ships; provide further guidance for reducing noise emissions from existing ships, especially by minimising cavitation from ship propellers; and provide advice on shipboard operations that could minimise shipping noise production, e.g. polishing ship propellers to smooth the surface and remove fouling organisms.

(SOURCE: International Maritime Organization's Code on Noise Levels on Board Ships, 2014 edition, available for purchase at *http://www.imo.org/Publications/Documents/Newsletters%20and%20Mailers/Mailers/I817E.PDF*).

HOW TO TELL IF BUBBLE LESIONS IN STRANDED CETACEANS ARE FROM SONAR/DECOMPRESSION OR DECOMPOSITION

Gas bubble lesions and emboli have been identified as signs of possible sonar exposure or rapid decompression (e.g. being brought to the surface rapidly after being caught in deep-water nets) in cetacean carcasses. However, it is difficult to tell whether bubbles seen in the tissues of stranded carcasses are from decomposition or emboli/decompression. A review of bubble presence found more gas bubbles in tissues of animals that had rapidly decompressed (due to bycatch) compared to stranded animals. Another analysis of gas in bubbles of test animals found that emboli- and decompression-associated bubbles have similar gas compositions (70-80% nitrogen and 20-30% carbon dioxide). Moreover, bubbles associated with decomposition contain hydrogen, which could be used as an indicator of decomposition-associated bubbles. These are useful diagnostic tools for detecting sources of cetacean mortality from anthropogenic activities.

(SOURCES: de Quirós, Y.B., González-Díaz, O., Møllerløkken, A., Brubakk, A.O., Hjelde, A., Saavedra, P. and Fernández, A. 2013. Differentiation at autopsy between in vivo gas embolism and putrefaction using gas composition analysis. *Inter. J. Legal Med.* 127: 437-445; de Quirós, Y.B., Seewald, J.S., Sylva, S.P., Greer, B., Niemeyer, M., Bogomolni, A.L. and Moore, M.J. 2013. Compositional discrimination of decompression and decomposition gas bubbles in bycaught seals and dolphins. *PLoS ONE* 8(12): e83994. doi:10.1371/journal.pone.0083994).

ACKNOWLEDGMENTS

The editors once again thank David Janiger for providing his database of recently published marine mammal papers and for supplying pdf copies of difficult-to-obtain papers. Antonio Fernandez Rodriguez, Fabian Ritter and David Weller sent us relevant literature or made connections to important sources. The editors are especially grateful to the Government of Austria and the Animal Welfare Institute for

providing support for SOCER preparation, as requested by Resolution 2000-7 (IWC, 2001). We also thank the IWC for allotting funds for preparing SOCER 2014.

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GLOSSARY OF TERMS

Species glossary

Atlantic white-sided dolphin	*Lagenorhynchus acutus*
Baiji	*Lepotes vexillifer*
Blue whale	*Balaenoptera musculus*
Blainville's beaked whale	*Mesoplodon densirostris*
Burmeister's porpoise	*Phocoena spinipinnis*
Chilean dolphin	*Cephalorhynchus eutropia*
Common bottlenose dolphin	*Tursiops truncatus*
Common dolphin (short-beaked)	*Delphinus delphis*
Cuvier's beaked whale	*Ziphius cavirostris*
Guiana dolphin	*Sotalia guianensis*
Fin whale	*Balaenoptera physalus*
Finless porpoise	*Neophocaena phocaenoides*
Harbour porpoise	*Phocoena phocoena*
Humpback whale	*Megaptera novaeangliae*
Killer whale	*Orcinus orca*
Long-finned pilot whale	*Globicephala melas*
Minke whale (northern)	*Balaenoptera acutorostrata*
North Atlantic right whale	*Eubalaena glacialis*
Pygmy beaked whale	*Mesoplodon peruvianus*
South Asian river dolphin	*Platanista gangetica*
Sperm whale	*Physeter macrocephalus*
Striped dolphin	*Stenella coeruleoalba*
White-beaked dolphin	*Lagenorhynchus albirostris*
Pink snapper	*Pagrus auratus*
Trevally	*Pseudocaranx dentex*
Southern reef squid	*Sepioteuthis australis*

AIS: Automatic Identification System.

AMOC: The Atlantic Meridional Overturning Circulation, a major current in the Atlantic Ocean, characterised by a northward flow of warm, salty water in the upper layers of the Atlantic, and a southward flow of colder water in the deep Atlantic.

Anoxia: Absence of oxygen.

Anthropogenic: Human in origin.

Bioaccumulation: When a pollutant increases in concentration from the environment to the first and subsequent organisms in a food chain.

Bivalve: A class of marine and freshwater molluscs that have laterally compressed bodies enclosed by a shell consisting of two hinged parts.

Chlorophyll-a: A specific form of chlorophyll used in photosynthesis, which absorbs most energy from violet-blue and orange-red light. This photosynthetic pigment is essential for photosynthesis in some marine phytoplankton.

dB: Decibel – a logarithmic measure of sound pressure level.

DDD: The organochlorine dichlorodiphenyldichloroethane, a breakdown product of the pesticide DDT.

DDE: The organochlorine dichlorodiphenyldichloroethylene, a breakdown product of the pesticide DDT.

DDT: The organochlorine pesticide dichlorodiphenyltrichloroethane, which tends to accumulate in the ecosystem and in the blubber and certain internal organs of cetaceans.

Depredation: In ecology, when animals feed on anthropogenically available resources, such as dolphins taking fish on lines or elephants eating crops.

EEZ: Exclusive Economic Zone.

Emboli: Plural of embolus, which is any detached, traveling mass (solid, liquid, or gaseous) in blood vessels that is carried by circulation. Emboli are capable of clogging arteries at a site distant from their point of origin.

Hz: Hertz, a measure of sound frequency (pitch), in wave cycles per second (kHz=1,000 Hertz).

Hypoxia: Low levels or supply of oxygen.

Indicator species: Species that can provide information on ecological changes and give early warning signals regarding ecosystem processes due to their sensitive reactions to them. They can also be called sentinel species.

IMO: International Maritime Organization.

IPCC: International Panel on Climate Change.

Keystone species: A species with a disproportionately large effect on its ecosystem relative to its abundance.

Lipid weight: A basis of measurement whereby concentrations of a substance are compared to the lipid (fat) content of a material.

µPa: Micropascal, a unit of pressure.

Microplastics: Plastic particles 0.3-5mm in diameter, often the result of larger plastic pieces breaking down over time.

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.

MW: Megawatt.

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.

PCBs: 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.

PFCs: Perfluorinated compounds. A class of environmentally persistent molecules with fluorine atoms attached, used in many industrial applications including fire-fighting foams, pesticides and surface coatings.

POPs: Persistent organic pollutants, organic compounds that are resistant to degradation and thus persist in the environment.

Primary production: The synthesis of organic compounds from atmospheric or aqueous carbon dioxide, forming the foundation of any food web.

rms: Root-mean-square. A measurement of sound pressure.

SD: Standard deviation.

SPL: Sound pressure level. A measure of the intensity of sound, in decibels.

South Atlantic Gyre: The subtropical gyre in the South Atlantic Ocean. In the southern portion of the gyre, northwesterly (or southeastward-flowing) winds drive eastward-flowing currents that are difficult to distinguish from the northern boundary of the Antarctic Circumpolar Current. Like other oceanic gyres, it collects vast amounts of floating debris.

TBT: Tributyltin. A toxic chemical commonly used in anti-fouling paints on ship hulls.

Trap pot gear: Submerged, three-dimensional wire or wood devices that permit fishery species to enter, but make escape extremely difficult or impossible.

UNCLOS: United Nations Convention on the Law of the Sea.