Annex K

Report of the Sub-Committee on Environmental Concerns

Members: Hall (Convenor), Aoki, Bironga, Bjørge, Castro, Charlton, Cipriano, Collins, Debrah, Donovan, Fernández, Ferriss, Fiogbe, Frisch-Nwakanma, Fujise, Gallego, Genov, Goetz, Haug, Hernandez Mora, Herr, Holm, Hosoda, Hubbell, Iñíguez, Jimenez, Kitakado, Lang, Leaper, Lee, Lent, Litovka, Lundquist, Mallette, Marcondes, Mattila, Minton, Morita, Moronuki, Naylor, Nelson, New, Nio, Panigada, Parsons, Plön, Punt, Razzaque, Reeves, Reyes Reyes, Ridoux, Ritter, Rojas-Bracho, Rose, Santos, Scheidat, Seyboth, Simmonds, Širović, Slooten, Smith, Stachowitsch, Stockin, Suydam, Suzuki, Svoboda, Tamura, Tarzia, Trejos Lasso, Tiedemann, van de Water, Walløe, Walters, Weinrich, Weller, Yaipen-Llanos, Yasunaga, Zerbini.

1. INTRODUCTION

1.1 Introductory remarks

Hall and Holm welcomed the participants to the Sub-Committee on Environmental Concerns.

1.2 Election of Chair

Hall and Holm were elected as co-Chairs.

1.3 Appointment of Rapporteurs

Genov was appointed as rapporteur.

1.4 Adoption of Agenda

The adopted Agenda is given as Appendix 1.

1.5. Review of available documents

The documents available to the sub-committee were identified as SC/68A/E/01-12; SC/68A/SP/05; Schnitzler *et al.* (2019); Galligan *et al.* (2019); Genov *et al.* (2019); Di Guardo *et al.* (2018); Bernaldo de Quirós *et al.* (2019); Derville *et al.* (2019); Canada (2019); Weilgart (2018); Puig-Lozano *et al.* (2018); Panti *et al.* (2019); and Nelms *et al.* (2019).

2. POLLUTION

2.1 Polychlorinated biphenyls, DDTs and mercury in cetaceans

Tiedeman presented a paper (Schnitzler *et al.*, 2019) which reports polychlorinated biphenyls (PCBs) and other pollutants levels in a single neonate male killer whale (*Orcinus orca*) which stranded on the German island of Sylt in February 2016. The blubber PCB concentrations were very high [∑PCBs, 225mg/kg lipid weight (lw)], greatly exceeding the PCB toxicity thresholds reported for the onset of immunosuppression [9mg/kg lw ΣPCB] and for severe reproductive impairment [41mg/kg lw ΣPCB] reported for marine mammals. Additionally, this individual showed equally high concentrations in p,p'-DDE [226mg/kg lw], PBDEs [5mg/kg lw] and liver mercury levels [1.1 µg/g dry weight dw]. PCB levels in the neonate were similar to those previously reported for adult females. These results suggest a high placental transfer of pollutants from mother to foetus. The neonate was infected with lung worms. No pathologies explaining the cause of death were detected, rendering it possible that the pollutant levels were causative and underscoring that PCB pollution in killer whale neonates may reach fatal levels. Genotyping revealed the neonate belonged to Ecotype I (generalist feeder). It carried the mitochondrial haplotype 35 present in about 16% of the North Atlantic killer whale from or close to the North Sea.

In discussion the importance of these case studies was noted and that the lung worm infection may be indicative of a suppressed immune response, putatively linked to pollutants levels in this individual killer whale.

Holm then presented a paper by Galligan *et al.* (2019). The aim of their study was to examine the relationships between blubber steroid hormones and persistent organic pollutants (POPs), with emphasis on DDTs, in common bottlenose dolphins (*Tursiops truncatus*). Blubber and skin biopsies from free-ranging bottlenose dolphins from St. Andrews Bay, Florida were studied (n=62). This region has elevated concentrations of DDT and similar compounds in the sediment. POPs are lipophilic and their accumulation in blubber is well known but blubber also contains steroid hormones, such as progesterone, testosterone and cortisol that reflect the systemic physiological state of the animal. All individuals demonstrated quantifiable concentrations of DDTs and other POPs. Male and female common bottlenose dolphins exhibited differential POP exposure profiles because females offload significant portions of their POP burden during lactation, while males have no such life history trait. This also means that POP concentrations in males can be considered an estimate of their lifetime exposure.

Using principal component (PC) analysis, it was determined that blubber DDTs primarily loaded to the first PC, explaining more than 80% of the total variance in POP exposure. Most of the other measured compounds loaded primarily to the second PC (chlordanes, PCBs, mirex, hexachlorobenzene (HCB), brominated flame retardants). Of the steroid hormones, testosterone and androstenedione were detected in males. In females, cortisol, progesterone and androstenedione were commonly detected. In males, testosterone was negatively correlated with DDT-metabolites. In females, cortisol was negatively correlated with DDT and most of the other compounds. The negative relationship between POPs and these steroids may be caused by POP-mediated adrenal disruption, affecting androgen and corticosteroid homeostasis. Adrenal hormones play important roles in vertebrate stress physiology, nutrient homeostasis, immune function, and development. Consequently, POP-mediated adrenal disruption could have serious implications for bottlenose dolphin health and fitness.

Following these results, the importance of investigating adrenal lesions and pathologies in stranded animals was emphasised. However, it was noted that this work does not provide evidence of cause and effect as the samples were randomly collected from the population using remote biopsy sampling preventing the authors from controlling for any confounding effects of age.

The sub-committee thanked Tiedeman and Holm for presenting these papers.

Genov *et al.* (2019) reported his findings on POPs in common bottlenose dolphins from the northern Adriatic Sea. The local population inhabiting the Gulf of Trieste has been studied since 2002 using extensive long-term photo-

identification. Between 2011 and 2017, biopsy samples were collected from 32 free-ranging adult dolphins, the largest sample size for live free-ranging animals of this species in Europe. Concentrations of 25 PCB congeners, as well as *p,p'*-DDE and hexachlorobenzene (HCB) were determined in all samples. The authors tested for the effects of sex, parity and social group membership on organochlorine concentrations, thereby integrating information on pollutants with long-term photo-ID records. PCB concentrations were significantly higher in males than in females, and significantly higher in nulliparous females than parous ones, indicating maternal offloading from females to offspring. There were no differences between social groups. PCB concentrations of 87.5% of dolphins exceeded the toxicity threshold for physiological effects in experimental marine mammal studies (9mg/kg lw), while 65.6% exceeded the threshold based on reproductive impairment in ringed seals (41mg/kg lw). *p,p'*-DDE concentrations followed similar patterns with respect to sex, parity and social group membership, but levels were substantially lower than those of PCBs. The mean contribution of *p,p'*-DDE to total DDT was 89.7%, suggesting that *p,p'*-DDE, as the predominant metabolite of total DDT, likely reflect total DDT levels. Table 4 in Genov *et al.* (2019) provides an overview of PCB levels in different populations of common bottlenose dolphins. In the dolphins in the Mediterranean Sea, PCB concentrations tend to decline from west to east, and from north to south, but this is not the case for DDT, which appears to be higher in the east. The high levels of PCBs in this population are of concern particularly in combination with other known or suspected threats to this population.

The sub-committee thanked Genov for his paper and congratulated him on a study involving known individuals whose fate could be tracked and future outcomes related to levels of contaminant exposure combined with other stressors. It was noted that changes in water temperature as a result of climate change could also affect this population of bottlenose dolphin because of their restricted distribution and shallow water habitat.

The findings of the JARPNII Programme of relevance to this sub-committee were presented. Appendix 3 of SC/68A/SP/05 reported the final conclusions of the temporal trends of total mercury (Hg) concentrations in muscle of common minke, sei and Bryde's whales based on JARPN and JARPNII samples for the period 1994-2016 (complete data set). The study took into consideration some analytical recommendations from the IWC SC, in particular the incorporation of the age data into the analyses. Temporal trends were examined using a Multiple Linear Regression (MLR), a Generalized Linear Model (GLM) with standardisation, and a Generalized Additive Model (GAM) analyses. Data from 2015 and 2016 had not been analysed previously. Results of the MLR and GLM with standardisation showed that Hg concentrations in the whales had decreased from 1994 to early 2000's, and that it has stabilised from early 2000's to 2016. All these results were supported by the GAM analyses. The incorporation of age data allowed the detection of more slight changes of Hg levels in marine environment.

Appendix 4 of SC/68A/SP/05 reported the final conclusions of the temporal trends of PCB concentrations in blubber of common minke whales based on JARPNII samples for the period 2000-16 (complete data set). Temporal trends were examined using a Multiple Linear Regression (MLR) based on the complete JARPNII data set. PCB levels were not significantly associated to sampling year for all sub-areas, suggesting that PCB levels in common minke whales in the western North Pacific were stable during 2002 and 2016. These updated analyses confirmed the results presented to the 2016 JARPNII Final Review Workshop.

Appendix 5 of SC/68A/SP/05 reported the final conclusions of the temporal trends of radioisotopes (RIs) I131, Cs134 and Cs137 concentrations in muscle of common minke, sei, Bryde's and sperm whales based on JARPNII samples for the period 2011-16. Temporal trends were examined using a Spearman rank test based on the complete JARPNII data set. Results showed the RIs levels in all whale species examined have been decreasing since 2011. These updated analyses confirmed the results presented to the 2016 JARPNII Final Review Workshop.

The sub-committee thanked Yasunaga for presenting these updated results. In discussion, it was recognised that the POP concentrations reported in this study were on a wet weight basis which may result in bias due to variation in blubber lipid content. This was because initially lipid content was not measured in these samples. However, the plan was to have the lipids in the samples analysed later and unfortunately the stored samples were lost in the Tsunami. In future samples will be analysed for lipids as well as POPs and results reported on a lipid weight basis.

2.2 Mitigation measures for Persistent Organic Pollutants

A summary of potential mitigation measures to reduce the exposure of cetaceans to persistent organic pollutants (POPs) was given by Holm (SC/68A/E/03). Measures to mitigate the exposure risk are, in general, challenging, as many POPs are still in the environment. Restricting the release is also difficult as 20% of the total production volume of PCBs (1.3 million tonnes) were used in open applications such as sealants, plasticisers, paints, coatings, etc. and are released from there to the environment. The forecasted global temperature increase will also result in further, increased volatilisation and eventually mobilisation from primary sources (e.g. production facilities) and secondary sources (e.g. soils, forests, ice, snow pack, melting snow, rivers and estuaries). Measures and mitigation options that would reduce the risk for cetaceans are difficult, but, for example, would include limiting and improving the management of dredging of PCB-laden rivers, estuaries, harbours and ports and limiting mobilisation in marine sediments (Jepson *et al.*, 2016) as well as limiting the abrasive blasting of PCB-containing paints on infrastructures, such as in ports and of bridges. In general, the Strategic Approach to International Chemicals Management (SAICM), a policy framework which fosters the sound management of chemicals, proposed a set of eleven basic elements which should be followed. In conclusion, only: (a) the reduction in the use of hazardous compounds; (b) their management in closed systems (where no substances are exchanged with their surrounding environment); and (c) the application of appropriate destruction technologies for residues, can mitigate the risk of exposure to both human and environmental health.

The sub-committee thanked Holm for her thorough summary of the current mitigation measures and their applicability to cetaceans. The sub-committee then discussed the importance of engaging with current initiatives to control and reduce the input of POPs to the marine environment, particularly the effectiveness of the Stockholm Convention on Persistent Organic Pollutants. Simmonds reiterated the suggestions previously made by Stuart-Smith and Jepson (2017) on this topic and specifically that they had

reported that 'although the Stockholm Convention provides a global framework to address PCBs, there appears to be a systemic shortfall of many parties of the Convention to provide sufficient prioritisation and resources for effective implementation'. They had also noted that a 2015 United Nations Environment Programme assessment estimated that the vast majority of PCB-contaminated equipment and materials, around 14 million tonnes still requires elimination and that some countries, will not achieve the 2025 and 2028 targets of the Stockholm Convention. Stuart-Smith and Jepson called for renewed action to reduce PCB contamination, to prevent some killer whale and other dolphin populations from going extinct.

It was also pointed out that planned large scale developments for some regions of the world (such as the Western Indian Ocean) could result in additional POP inputs and that impacts might not be detected because monitoring was not established, and baseline information was not being collected.

The sub-committee will continue to welcome new information about the effects of POPs on cetaceans and, in addition, agrees to request that the Secretariat considers how best to provide information on the significant threat posed by POPs to some cetacean populations to the relevant international bodies, including (but not limited to) the Stockholm Convention and the United Nations Environment Assembly (UNEA).

Further to the Secretariat's advice, the intersessional group will consider how best to develop this work area. The sub-committee also agreed to request that the Conservation Committee considers how to take this matter forward and the role of the Scientific Committee.

2.3 Update on intersessional progress on the Pollution 2020 initiative

An update on progress within the Pollution 2020 initiative was given by Hall. Three main activities were agreed upon in the SC/67b work plan:

(a) Continue modelling of the effects of contaminants on cetacean populations, including potential addition of the impact of exposure to brominated flame retardants

Hall reported that she had explored the data and dose-response functions available which would allow the potential impacts of exposure to the brominated flame retardants, specifically the polybrominated diphenyl ethers, to be included in the sPOC model for exploring the population consequences of exposure to contaminants in cetaceans (Hall *et al.*, 2018). However, she concluded that at this time there was insufficient data to warrant separate inclusion of the PBDEs in the model. The paucity of data resulted in large uncertainty in the model results, rendering them unsuitable for further inference. In addition, the concentrations of PBDEs in the blubber of marine mammals are highly correlated with the concentrations of PCBs and DDTs which makes it very difficult to disentangle effects due to single compound groups. A more useful approach in future might be to include the effect of mixtures, when suitable dose-response data are available. This approach will therefore be deferred until further results are available.

(b) Data integration and mapping

Hall presented the final version of the Cetacean Contaminant Mapping Tool (SC/68A/E/01). The global contaminants map now includes data on mercury as well as PCBs and DDTs collated from published studies. It will be openly available online and will be linked to the IWC Pollution page of the website within the next few months. Users will be able to select and display regional and decadal data for different cetacean species. The purpose of the map is to allow researchers, conservation managers and other users to determine where contaminant hot spots may be occurring and to determine data gaps. The ability to view decadal summary data is also included. It was noted in discussion that for mercury it is important to also have data on selenium which acts to sequester mercury in these species. This was acknowledged but it was noted that not all studies published selenium concentrations together with their findings on mercury and that the purpose of the map was not to investigate health effects but solely to provide summary data on where information was available and provide generalised decadal trends for a given species.

(c) Estimating the rate of decline in PCBs in cetacean blubber following reductions in environmental concentrations

This task is ongoing and will be completed and the findings reported at SC/68B.

The sub-committee thanked Hall for her work on the Pollution 2020 initiative.

2.4 Afterlife of Pollution 2020 products

The sub-committee discussed how it might continue to update and support the Effects of Pollutants on Cetacean Population (sPOC) model and particularly to update the Contaminant Mapping Tool database. These products will be hosted and supported by the Sea Mammal Research Unit at the University of St Andrews and will be maintained into the future by the IT support staff at the University. However, the database behind the map will not be updated by the University of St Andrews beyond 2018. In discussion it was agreed that this would be carried out by the SOCER team (see Item 6.3) who would summarise and tabulate any new, relevant contaminant data from the publications they review. This would follow the fields and format required for the mapping tool and would be uploaded into the database and appended to the existing data using the web portal with password access.

2.5 Future Pollution initiatives

During discussion it was concluded that, although we have been working on the effects of contaminants on cetaceans for over 30 years, cause and effect relationships are still tentative and uncertain and dose-response data for the species of interest are not available. By the inter sessional correspondence group, it was suggested that a continuation of the Pollution 2020 initiative should be established and named 'Pollution 2025'. The new programme should focus more on cumulative effects, as contaminants were central to many of the case studies highlighted in the Cumulative Effects of Multiple Stressors Workshop held in April 2018 (IWC, 2019). Multidisciplinary studies were needed which should include veterinarians, toxicologists, population biologists and epidemiologists to name a few and the approach should reflect the principles of 'One Health'[1]. It was also suggested that several strandings schemes have now been collecting data on contaminant exposure and disease diagnoses for many years and that a database of metadata relating to what is available globally could assist researchers in identifying collaborations and combinations of data. Metanalyses would improve sample sizes and thus

[1] *https://www.who.int/features/qa/one-health/en/.*

the power to detect effects, recognising the limitations and biases related to data from stranded animals. It was agreed that a small Steering Group work intersessionally to discuss the options for the new Pollution 2025 initiative further and that their findings will be reported to SC/68B.

The sub-committee's interest and work in this area might also be of relevance to the United Nations Decade of Ocean Science for Sustainable Development, which commences in 2021-30 and to the post-2020 Convention on Biodiversity framework. The sub-committee will continue to work with the Secretariat to engage with these Conventions to facilitate relevant knowledge exchange.

Attention: NI (Hall)
The sub-committee agreed that:

(a) the Pollution 2020 initiative is complete, and its findings will be presented at SC/68B. A final report will be submitted to the Commission; and
(b) a small Steering Group should be established intersessionally to discuss the options for a new, multidisciplinary pollution/cumulative effects initiative, named Pollution 2025, further and their findings be reported to SC/68B.

Attention: S
The sub-committee recommended the Secretariat engage with initiatives such as the Stockholm Convention, the Convention on Biological Diversity and the United Nations Environment Assembly to facilitate relevant knowledge exchange.

Attention: CC
The sub-committee also requested that the Conservation Committee considers how to take forward interactions with relevant fora to reduce cetacean exposure to pollutants and the role of the Scientific Committee.

2.6 Other pollution issues

An oral update on the use of heavy fuel oil (HFO) in the Arctic was provided by Hubbell. Since this issue was first considered in Hubbell (2017), several new studies have been published on the impact and behaviour of HFO in Arctic conditions, as well as its effects on cetaceans. (Andrianov and Lukin, 2017; Andrianov *et al.*, 2018) noted persistent changes in behaviour in the southern Herd of White Sea belugas following an HFO spill. Rasmussen-Fritt *et al.* (2018) comprehensively reviewed the behaviour and characteristics of HFO and noted the challenges of responding to a spill in Arctic conditions. Traditional methods of response, such as booms, or in-situ burning were found to be less effective. An experiment by Vergeynst *et al.* (2018) on biodegradation of HFO in Greenlandic found that HFO could interact with mineral particles in glacial runoff to create marine oil snow, which can sink to the sea floor and further persist in coastal waters. The author concluded by notifying the Committee of progress at the International Maritime Organization in the development on a ban of the use of HFO in Arctic waters, which intends, on the basis of an assessment of the impacts, to develop a ban on HFO for use and carriage as fuel by ships in Arctic waters, on an appropriate timescale (International Maritime Organization, 2018a; 2018b). Finally, Hubbell notified the sub-committee of the development of new 'hybrid' fuel blends, designed to comply with a regulatory change in the permitted amount of sulphur content in shipping fuels set to take effect in 2020. These could have properties similar to HFO, but different behaviours or toxicity, and could have both regional and global implications in the event of a spill.

3. DISEASES OF CONCERN

3.1 Infectious diseases

SC/68A/E/11 provides an update on pathogens identified in stranded cetaceans in the Canary Islands. Pathogens were detected in stranded cetaceans. *Brucella* spp. was detected in seven animals from four different species: common bottlenose dolphin (*Tursiops truncatus*) (*n*=2), striped dolphin (*Stenella coeruleoalba*) (*n*=2), Atlantic spotted dolphin (*Stenella frontalis*) (*n*=2) and Blainville's beaked whale (*Mesoplodon densirostris*) (*n*=1). In most cases the brain was the target organ. *Erysipelothrix rhusiopathiae* was detected in the lung, mesenteric lymph node and brain of a common bottlenose dolphin stranded in 2010. Herpes viruses were detected in 36 animals belonging to 11 different species of the Delphiniidae, Kogiidae, and Ziphiidae families. *T. gondii* was exclusively detected in the Atlantic spotted dolphin species (*n*=7), represented by systemic or brain infections. There is an increasing presence of multi-infection by those pathogens in single stranded animals, especially the presence of morbillivirus and herpesvirus, and *Brucella* in one single animal, as well as toxoplasma.

The sub-committee welcomed this information and thanked Fernández. In discussion, it was noted by several participants that mixed infections are common in various locations. Mazzariol reported that within the Mediterranean, *Brucella* occurs particularly in common bottlenose dolphins, while in striped dolphins, toxoplasma appears to be the primary agent and tends to be more severe than in common bottlenose dolphins. Ongoing work involves investigating if the inflammatory response differs between pelagic versus coastal cetaceans. The sub-committee also discussed potential links between specific diseases in relation to pollutant loads. Mazzariol informed the sub-committee of a paper on a fin whale infected with morbillivirus and toxoplasma having very high levels of pollutants (Mazzariol *et al.*, 2012). It was agreed that there is a need to further investigate the relationship of immune response and susceptibility to diseases, in relation to pollutants. Mazzariol also noted that definitive host for *Toxoplasma* is the cat, and it therefore originates from the terrestrial environment. It can infect marine animals even after six months in the marine environment. There does not appear to be a marine cycle for *Toxoplasma.* Other carriers are largely unknown, but the sub-committee understands that studies into the genetic structure of protozoa isolated from cetaceans are underway.

There was also discussion regarding the occurrence of Toxoplasmosis in Hector's dolphins and the most reliable way to diagnose infection. Serology will only give an indication of exposure but no information on when exposure to the pathogen occurred or whether the animal's health was affected.

SC/68A/E/13 which provided information on cetacean strandings in Costa Rica between 2004 and 2019. Marine brucellosis was the main cause of strandings. Seven cetacean species from three different families (Delphinidae, Ziphidae, Physeteridae) showed positive reaction against *Brucella* antigens and *Brucella ceti* was isolated in 70% of stranded striped dolphins (*Stenella coeruleoalba*), with meningoencephalomyelitis, placentitis, endocarditis and osteoarthritis. Due to the high occurrence of this bacterial disease in stranded animals in the Costa Rican Pacific

shores, biosafety measures should be established each time when handling stranded cetaceans in the Eastern Tropical Pacific region.

The sub-committee welcomed this information and noted that these pathogens will be the focus of the sub-committee's work at SC/68B and encouraged further information from this study to be presented.

3.2 Host-pathogen interactions

The paper by Di Guardo *et al.* (2018), presented by Mazzariol, identifies the critical knowledge gaps in our understanding of cetacean host-pathogen interactions. The authors highlight five 'knowledge-deficient areas' (see below). The sub-committee agreed that these areas should be priority areas for future research and suggested that information addressing any of them would be welcome at the SC/68B disease focus session.

Attention: SC

The sub-committee recommends that the focus session on Brucella and Morbillivirus organised for SC/68B be expanded to include Toxoplasmosis and Herpesviruses in cetaceans. The sub-committee would also welcome information that would address some of the knowledge gaps on cetacean host-pathogen interactions identified by Di Guardo et al. (2018) as follows:

- *characterisation of the cell receptors allowing infection;*
- *interaction and effects of chemical pollutants on the expression levels of the aforementioned cell receptors;*
- *pathogenetic evolution of the concerned infections in T helper 1-dominant vs. T helper 2-dominant cetacean individuals;*
- *effects of pregnancy-associated immune status on the infectious potential of specific pathogens; and*
- *usefulness of cetaceans and their pathogens as models for human disease.*

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4. STRANDINGS AND MORTALITY EVENTS

4.1 Update on the IWC Strandins Initiative

4.1.1 Progress report

SC/68A/E/05 provided a progress update for the IWC Strandings Initiative (April 2018-April 2019). Activities of the Strandings Coordinator and Expert panel detailed within the report included an emergency response assistance to Argentina for a common dolphin (*Delphinus delphis*) mass stranding, Golfo Nuevo, Península Valdés, Argentina (SC/68A/E/08), a joint strandings/entanglement training (in conjunction with Human Impacts Coordinator) for Chile and Peru and ongoing engagement with IUCN Wildlife Health Specialist Group (IUCN-WHSG) and CITES to assist in the development of a procedure for transboundary transport of diagnostic specimens for cetacean disease investigations in emergency situations. The Strandings Coordinator presented at 24th ASCOBANS Advisory Committee Meeting (AC24) in Vilnius, Lithuania (September 2018) and is engaging with Asian Marine Mammal Stranding Network (AMMSN) regarding a planned 3-day symposium to be held in Taiwan (September 2019). Further plans of the Strandings Initiative and its collaborating partners include the discussions of a Global Strandings Network, for which an exploratory workshop has been proposed for the World Marine Mammal Conference to be held in Barcelona, Spain (December 2019).

The sub-committee welcomed the update and thanked Stockin for her efforts. In discussion, the sub-committee noted the obstacles related to CITES regulations with respect to transporting samples. Echoing the concerns of the strandings coordinator, regarding the slow progress in resolving the issue of trans-boundary sample transportation and CITES permits, the sub-committee hoped that as discussions with CITES were ongoing, this obstacle, which is crucial in relation to emergency responses, will be resolved soon.

The sub-committee also noted that funding is one of the key challenges in ensuring the effective operation of the IWC Strandings Initiative. The need to liaise and synergise with other international organisations or agreements such as ACCOBAMS and ASCOBANS, particularly in standardising necropsy methods and sampling procedures, was also emphasised, in order to obtain the best possible results and allow useful comparisons. The sub-committee have been concerned with the human health and zoonotic risks from the consumption of aquatic wild meat and the importance of this issue was raised again. The workshop on 'Poorly Documented Takes of Small Cetaceans in Asia' in November 2016 included a debate of this issue. The IWC strandings coordinator will be attending the Asian Marine Mammal Stranding Network Meeting later this year and was asked to report back to this sub-committee on any discussions on this topic.

4.1.2 Training prioritisation matrix

SC/68A/E/04 outlined the procedures and criteria proposed by the Expert Panel the IWC Strandings Initiative to: (i) inform decision-making on training requests; and (ii) outline Strandings Initiative procedures during emergency response requests. A key focus of the Strandings Initiative is to work in collaboration with governments, IGO, NGO and other partners in capacity building/training programmes for emergency response to significant mass and/or unusual mortality events. The training programme under development focuses jointly on strandings response and strandings investigation. Based on Coordinator and Expert Panel capacity, it is anticipated that up to three training workshops may be conducted each year, tailored to requests received from requesting parties. The Strandings Initiative also offers real-time, virtual support and advice to response teams handling live strandings and strandings investigations. Subject to resources, the Strandings Initiative is likely to be able to provide funds and/or mobilise expertise for up to a further three international responses each year. In addition to this, the Strandings Expert Panel (SEP) can respond virtually via the Coordinator. Recognising the likelihood of there being more than three cases of training or emergency support requested per annum and limited resources to provide support, the guidelines by which resources may be prioritised were presented for commentary and endorsement of the Scientific Committee.

The sub-committee thanked Stockin and the SEP for the information provided, and also acknowledged the work of the previous Strandings Coordinator co-Chair, Claire Simeone.

In discussion, the sub-committee debated the training prioritisation matrix. It was emphasised that these are 'guidelines' that need to be flexible, as many different aspects need to be considered in different situations. As such, the matrix will evolve and will be open to new input as new relevant information becomes available. It was also pointed out that the level of training may differ. Capabilities and capacities of requesting countries will always need to be considered, as well as the type of support being requested, while human safety is always of paramount concern.

It was further agreed that synergising with exiting initiatives and activities, such as being undertaken by IFAW, should be attempted whenever possible. The available training materials will also be reviewed, and revised, as clear definitions and instructions are needed for issues such as tissue recovery, dissection protocols or necropsy procedures.

There was additional discussion regarding the nature of the available training materials and whether they could be presented to potential funders to demonstrate the need for support. The strandings coordinator emphasised the bespoke nature of the training needs. Each training session is tailored to the needs of the particular country or region. The sub-committee suggested that the documentation of case studies could be a good way to illustrate the varied nature of the training required in different situations and scenarios. Examples of training materials available to the initiative include the Global Marine Animal Stranding Training Toolkit[2].

In further discussion, the sub-committee noted that rescue and animal welfare are part of this initiative, particularly in situations such as mass strandings. In relation to that, there is a need to carefully consider options of re-floatation versus euthanasia, where decisions will also need to consider the relevant legislation and cultural sensitivities in different countries.

Attention: SC, WKM&WI
The sub-committee recommends that the prioritisation matrix for responding to training requests to the strandings coordinator be adopted and modified in future as necessary.

Attention: SC, CG, S
The sub-committee recommended that, as the Strandings Initiative was entering a new and important critical phase, funding be sought for the continued support of the Strandings Coordinator beyond October 2020. It also encouraged the Secretariat to pursue wider fundraising efforts for Strandings Initiative activities.

4.1.3. Large whale euthanasia

SC/68A/E/02 describes a method for humane termination of suffering in large stranded cetaceans in the Netherlands, which was developed by the cetacean veterinarian Niels van Elk. The course of action in case of the stranding of a large cetacean is under the authority of the Ministry of Agriculture, Nature and Food Quality and is documented in the guidelines for stranded large whales ('Leidraad stranding levende grote walvisachtigen', published 22 December 2017 by the Ministry of Agriculture, Nature and Food Quality[3]). In these guidelines, euthanasia is an option when the termination of suffering is in the best interest of the animal. Euthanasia has to be performed in a manner which prioritises animal welfare and public safety, but also reconciles the emotions of the general public. A method for whales between 6 and 15 meters in length has been devised based on scientific publications, guidelines developed in other countries and trials performed in the Netherlands. The document contains a detailed description of the method, provides a triage criterion for applying this method and outlines the arguments considered for applying this specific method. The method can be summarised as follows: after general sedation, analgesia and local anaesthesia, a hollow pointed needle with 30g of explosives in the tip is inserted into the thoracic cavity, aimed at the heart and large blood vessels. Of the four pre-requisite criteria for carrying out this method, it is particularly essential that the premedication has had a sufficient effect, which needs to be monitored continuously. The rationale behind using a small explosive instead of artillery or chemicals, is that this method provides a suitable combination of effectiveness and appropriate reconciliation of public emotions, since whale strandings in the Netherlands tend to have a high public profile.

The sub-committee noted this new information from the Netherlands, which comes in a timely manner, in light of some of the recent mass strandings, where the experience or capacity to deal with such situations are limited. It was noted that euthanasia for stranded animals is under review in the UK. In discussion, it was also noted that ballistic approaches are successfully used for some of the small cetaceans such as pilot whales but are more limited for large cetaceans such as sperm whales. This information will be referred to the Whale Killing Methods and Welfare Issues Working Group Committee.

4.2 New information on unusual mortality and mass stranding events

SC/68A/E/08 reported on the investigation of a mass stranding of 68 short-beaked common dolphins (*Delphinus delphis*) that occurred in Golfo Nuevo, Península Valdés, Argentina in March 2018. Twenty-one dolphins were refloated, while 47 animals died. Carcasses included all age classes, with a male bias (29 males and 18 females). Most of the adult females were pregnant or lactating. The results do not suggest that the death of the 16 dolphins assessed in this study was due to obvious human effects (e.g. bycatch). All animals were in good body condition and had no external evidence of injuries. Infections by *Morbillivirus*, Influenza A virus, *Sarcocystis* spp., *Toxoplasma gondii*, or *Neospora caninum*, as well domoic acid (DA) toxicity were ruled out as potential aetiologies. Exposure to paralytic shellfish toxins (PSTs) was the only investigated potential cause of death found positive. However, all animals stranded live (47/68 subsequently died) and no carcasses were found floating. This is the first documentation of exposure to PSTs in short-beaked common dolphins from the Argentine Sea but these results are insufficient to assess whether PST exposure played a role in the death of the stranded dolphins. Phytoplankton blooms were first detected in the 1980s. Additional potential hypotheses related to factors known or speculated to cause cetacean mass strandings are currently being explored within the ecological context at the time of the event.

The authors thanked the support of the IWC Strandings Initiative which enabled them to study this event.

In discussion, the sub-committee welcomed this report and reviewed potential causal pathways and the likelihood that PST could cause such a mass stranding. They debated other possible causes such as exposure to an acute acoustic event of anthropogenic origin. Fernández noted that if animals were acutely affected by PST, it would be expected that several animals would die at sea prior to stranding and not live strand. Some of these animals would then be expected to re-float due to putrefaction processes and be found with full stomachs of fish positive to PST. Walløe noted that neurotoxins can also alter behaviour and not cause direct mortality in all animals, although in the case of acute PST toxicity, because it blocks the sodium channels, significant exposure causes respiratory paralysis and death.

[2]*https://darchive.mblwhoilibrary.org/handle/1912/8695.*
[3]*https://www.rijksoverheid.nl/documenten/rapporten/2017/12/22/leidraad-stranding-levende-grote-walvisachtigen.*

Stockin also noted that the cause of stranding and the cause of death may be two separate things. In the context of mass strandings, one or two affected animals may lead to the entire group stranding on shore. Social structure of the species involved therefore plays an important role. The sub-committee agreed that such strandings are often multifactorial and that identifying causal links is extremely challenging. With respect to potential acoustic events, Iñíguez informed the sub-committee that naval exercises are banned around Península Valdés.

SC/68A/E/12, summarised by Iñíguez, reported the stranding records of beaked whales along the Santa Cruz province, Southern Patagonia, Argentina from 1998 to 2019, but also included historical records since 1895. A total of 37 records of beaked whales stranded in the region were documented. These included 27 previously published records (one specimen re-identified through DNA analysis) and 10 new records, involving at least five species in five genera (*Mesoplodon layardii, Ziphius cavirostris, Berardius arnuxii, Hyperoodon planifrons, Tasmacetus shepherdi).* The identification of three unidentified beaked whales is still pending. All strandings involved single individuals. The most frequent species found stranded were strap-toothed whales (*Mesoplodon layardii*, *n*=12), followed by Cuvier's beaked whales (*Ziphius cavirostris*) (*n*=11). Species identities were based on skull morphology, tooth morphology and position in the jaw, morphometric measurements, and mitochondrial control region DNA sequences. There was an increase in the number of strandings between 1998 and 2019 (2 during 1998-2006 *vs* 12 during 2007-19), which was of note because the effort during 1998-2006 was substantially greater (one beach survey per week) than during 2007-19 (one or two beach surveys per year). In the last 20 years, seismic exploration, oil and gas exploitation, military exercises and surveillance have been, and are currently being, carried out in the south-west Atlantic Ocean. Given that Cuvier's beaked whales are known to be very sensitive to noise pollution, additional diagnostic analyses should be carried out on every stranded beaked whale, in order to determine potential acoustic-related trauma. Moreover, information on likely acoustic activities in the area should be investigated to obtain a better understanding of potential causal pathways. Although no complete necropsies were carried out and therefore no conclusion on the cause of death could be made, the co-occurrence of cetacean strandings and acoustic events in this area should be carefully considered. This study complements the information presented in Hevia *et al.* (2012) and provides the first record of Arnoux's beaked whale for the Santa Cruz province, reiterating the importance of the SW Atlantic for multiple beaked whale species.

In discussion, the sub-committee noted the apparent increased stranding rate in recent years, and discussed their implications, as well as potential clues that may indicate exposure to acoustic trauma. During this discussion, Fernández noted that bubbles in the eyes or elsewhere in the body are not diagnostic of acoustic trauma, especially if decomposition processes have already begun, since such bubbles may just be a result of this processes. He emphasised that gas bubbles can be indicative of acoustic trauma only in very freshly stranded animals, and only when the composition of the gas in such bubbles is determined. The sub-committee also discussed the implications of various pathological findings, including parasite infestation in organs such as the kidney. It was noted that even heavy parasite infestations do not necessarily cause strandings or mortality, since these animals appear to survive with high parasite burdens. Brownell noted that climate change may also play a role in increased stranding rates. Iñíguez noted that there has also been an increase in seismic explorations, which should be considered. The sub-committee agreed that beaked whales are particularly vulnerable to acoustic disturbance, and that various potential threats need to be considered, together with changing oceanographic and environmental conditions.

SC/68A/E/10 provides a preliminary report of a new mortality event which occurred in early 2019 in the Golfo de Penas, Southern Chile. A mass mortality event was also reported at this location in 2015, with at least 343 dead whales recorded. All identifiable whales were sei whales (*Balaenoptera borealis*). Further mortalities at this site and time period were recorded in 2016 (*n*=16) and 2017 (*n*=19). In 2019, 27 sei whale carcasses were found in the northern Golfo de Penas, in the areas of San Quintín (*n*=21) and Seno Newman (*n*=6), with a similar estimated time of death. Skin and bone samples were taken to genetically confirm species identification and to complement ongoing population analyses. Average length was 11.5m (range 9.7m-14m), indicating most of the whales were weaning and immature (when compared with Southern Hemisphere whaling data). A few sightings of live sei whales were made, including adults and juveniles recorded at Seno Newman while searching the shoreline. A wider search for strandings in the Golfo de Penas area is currently being undertaken using very high-resolution satellite imagery. These mortality events highlight the Golfo de Penas as an important area for sei whales during the austral summer, stress the need for a better understanding of these events and their likely environmental triggers, raise the alarm of a recurrent event that has been happening (at least) since 2012 with unusual regularity and highlight the need for continuous and systemic monitoring in the area.

The sub-committee welcomed this information. In discussion, potential causes of this event, as well as difficulties associated with responding to it, were addressed. A total of 30 stranded whales were examined and 16 of those were measured. Among them, 63% were immature. The sub-committee noted that obtaining information on length data is a priority. It was pointed out that the waters west of the area affected likely contains large numbers of sei whales. The sub-committee noted that harmful algal blooms may be implicated, but the current evidence is insufficient to confirm that. However, concern was expressed over the existing and expanding aquaculture industry (salmon farming specifically) in this region, which may potentially contribute to the problem through impacts on water quality.

It was further noted that the area in question is extremely remote, difficult to travel across and challenging to work in. Weather conditions also often hamper response attempts. The sub-committee commended the efforts of Chilean researchers to get to some of these very remote strandings locations. The sub-committee agreed that the use of satellite imagery is useful, both for the detection of carcasses and potential early detection of red tides, in order to potentially inform preparedness to such stranding events. Hall informed the sub-committee that ICES also have expertise on the use of satellite imagery and remote sensing to better understand harmful algal blooms. The sub-committee encouraged the Chilean researchers to explore potential other means of obtaining relevant information, possibly through the use of small airplanes or long-distance unmanned aerial aircraft, recognising the challenges that this would bring.

The sub-committee agreed that they would like to see more unusual mortality event reports and findings being brought to the attention of this sub-committee. For example, the Humpback UME, reported to the sub-committee at SC/67a, that has been continuing on the Atlantic coast. A report on this event at SC/68B would be welcome. The sub-committee therefore recommended that the strandings coordinator identify any key events and request those involved to submit a paper for consideration at future Scientific Committee meetings.

The sub-committee also discussed the potential for a future workstream to include compilation of mass stranding events into a database for global hotspot analysis. It was recognised that some background work would need to be carried out to collate the data and that changes to the Annual Progress Reports might be a means of identifying these events on a regular basis. It was agreed that the feasibility of this would be considered in future, following discussion with the working group that are considering modifications to the Annual Reports.

Attention: CG
The sub-committee recommends that any mass stranding or unusual mortality events be reported to the Scientific Committee in the Annual Progress Reports.

Attention: S
The sub-committee recommends that the Strandings Coordinator identify unusual mortality events and request those involved to submit a paper for consideration at future Scientific Committee meetings.

Attention: CG, G
The sub-committee has long recognised the vulnerability of beaked whales to acoustic impacts and recommends, wherever possible, stranding events, especially mass strandings, be thoroughly investigated. The sub-committee can assist through the Strandings Initiative and encourages Contracting Governments to enlist help if required.

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5. NOISE

5.1 Mid-frequency active sonar

Fernández presented the study by Bernaldo de Quirós *et al.* (2019), on the advances in research on the impacts of anti-submarine sonar on beaked whales. It was shown that the best mitigation measure for the effects of mid-frequency active sonar (MFAS) during naval military exercises on beaked whales around the Canary Islands was to ban its use, which has been in effect since 2004. The ban was a result of a non-binding resolution, based on science, issued by the EU Parliament and adopted by the Spanish national government and the regional Canary Islands government. The study recommended the following: (1) a moratorium on the use of MFAS in those regions where atypical mass stranding events (MSEs) continue to occur (e.g. the Mediterranean Sea); (2) continued research in areas with the use of MFAS to determine if sub-lethal impacts on individuals result in population-level impacts; (3) comparative studies on populations of beaked whales in the absence of MFAS; (4) determination of relevant life-history parameters in beaked whales; (5) studies of anatomy, physiology and pathophysiology, to better understand the development of decompression-like sickness in beaked whales; and (6) continued development of new technologies, through interdisciplinary studies and exchanges, to measure physiological responses of free-swimming beaked whales. Fernández pointed out that good science and communication among all stakeholders contributed to the successful mitigation of the problem in the Canary Islands.

The sub-committee thanked Fernández for illustrating how excluding an anthropogenic activity from a particular area can be an effective mitigation option. In discussion, the sub-committee agreed that the case of the Canary Islands and the associated study by Bernaldo de Quirós *et al.* (2019) represents a good example of a simple mitigation measure to reduce the effects of anthropogenic noise. It was stressed that effective mitigation measures might need clear cut bans of use which can also provide protection for other species in the ecosystem. However, it was also agreed that different problems or different areas may require different solutions. It was also pointed out that effects of noise should be considered with other stressors, such as the effects of persistent organic pollutants, as their effects may be synergistic or additive. It is the intention of the sub-committee to focus more on cumulative effects in future. The sub-committee therefore encourages activity exclusion as an effective mitigation approach that could be applied to other regions.

5.2 Update on cooperation with the International Maritime Organization

Smith presented a summary of the workshop 'Quieting Ships to Protect the Marine Environment' (Canada, 2019), which was held in London (UK), in January 2019, hosted by Transport Canada. The workshop was attended by 140 delegates from 24 countries, many of whom were industry representatives and technology experts. The IWC Secretariat also attended. The purpose of the workshop was to identify the state of knowledge on quiet ship technology, provide an opportunity for international collaboration, and exchange research ideas. It addressed a series of issues, including an overview of the impacts of noise on marine life, how noise is propagated and measured, modelling methods, and introduction of new technologies to reduce noise. The workshop also included a detailed review of technologies that could be used, such as propeller design, noise insulation, etc. Key recommendations included:

- recognition that a biological limit for underwater noise levels applicable to all species, in all regions of the world, is challenging to develop and therefore a ship-based limit on underwater noise was recommended;
- that there is a need to ensure that the feasibility of noise mitigation measures also considers the contribution to efforts to improve energy efficiency and reduce Greenhouse Gas (GHG) emissions in line with other IMO work on this issue;
- continue to gather data and in situ measurements of vessels and the noise they emit in order to further the understanding of this issue and its consequences; this also relates to validating modelling measurements, establishing biological limits and the alternative of feasibility-based limits;
- the potential value of explicitly identifying underwater vessel noise as a form of pollution in the relevant maritime and environmental conventions; and
- advancing research on some of the specific technological solutions identified over the course of the workshop and develop a guide for shipbuilders on available technologies.

The workshop concluded that even though underwater noise impacts on marine life have been documented by numerous researchers, there is currently not enough

information to develop a biology-based universal (receiver-type) noise limit for the seas. Ship-based noise limits should therefore be the focus. As a starting point, there should be a goal of a 3dB/decade reduction of global (or at least regional) underwater shipping noise in order to reverse the trend of the past 60 to 80 years. The optimal hull and propeller configuration have a maximum efficiency with trade-offs between cavitation hindrance and energy efficiency. In other words, lower propeller noise (i.e. cavitation) does not automatically give higher efficiency.

In discussion, the participants noted that the noise reduction of 3dB per decade is feasible, and that this is also in line with the goals of reducing greenhouse gas emissions, since speed reductions aimed at reduced consumption would also translate into noise reductions. It was also pointed out that it is important to consider underwater noise alongside the issue of ship strikes. However, the IMO workshop was purely focused on technical noise issues and did not consider operational measures such as speed reduction. The sub-committee also noted that commercial shipping is not the only relevant source of vessel noise impacting cetaceans and that whale- and dolphin-watching activities and recreational boats should also be considered. The sub-committee noted that its own efforts in defining the 3dB target and the subsequent engagement of this issue by the shipping and naval architecture industry should be highlighted.

It was reiterated that consideration within the IMO report, that ship noise should be regarded as a pollutant and should therefore be the subject of legislation, was an important step forward. However, many regions of the world, particularly in the southern hemisphere, had not widely adopted this concept. The development of the Blue Economy (defined by the World Bank as the sustainable use of ocean resources for economic growth, improved livelihoods and jobs and ocean ecosystem health) and activities associated with this policy, such as port construction, in many regions was an issue that needs to be monitored. For example, increases in the number of listening stations outside these new infrastructures could be encouraged.

5.3 New information on noise impacts

Leaper presented the report by Weilgart (2018) which aims to be a comprehensive literature review of the effects of underwater noise on fish and invertebrates. Effects on prey species are important to consider for cetaceans but any consideration of noise thresholds will need to take all taxa and effects across the ecosystem into account. The review covered 115 primary studies of impacts related to the main human-produced underwater noise sources that also impact cetaceans, including shipping, seismic, sonar, pile driving and acoustic deterrents. Within these studies there was evidence of noise impacts on 66 species of fish and 36 species of invertebrates. These included physiological effects, stress responses, and behavioural changes.

Several research gaps were identified which relate to impacts at different trophic levels across the ecosystem and the sub-committee noted that these could be considered when designing studies in relation to impacts of noise on cetaceans. Weilgart (2018) also suggested several management and mitigation recommendations. It was noted that this list is very close to the recommendations that the Scientific Committee has made regarding cetaceans over the last few years. Hence many of the actions needed to address noise impacts on cetaceans are very similar to those for fish and invertebrates.

It was noted that, to gain wider acceptance of the importance of noise pollution for cetaceans, it is important to also stress their potential effects on other trophic levels that human livelihoods depend on.

5.4 Proposed Noise pre-meeting at SC/68B

A number of topics were suggested for the pre-meeting on noise at SC/68B, as follows.

- Review approaches to setting noise thresholds and targets relevant to cetaceans. This would include work within NOAA, OSPAR, HELCOM and TG Noise (European Commission). All of these distinguish between approaches for ambient noise and impulsive noise. The pre-meeting may wish to consider these separately as well.
- Review the SC endorsed target of reducing shipping noise by 3dB in 10 years and 10dB in 30 years with respect to:
  - work on soundscape modelling and noise budgets at different spatial scales; and
  - on noise reduction by individual vessels i.e. assessing how individual noise reductions can contribute to the overall target.
- Communicating and explaining the target.
- Review studies of the contribution of small (recreational, fishing and whale watching) vessels to coastal soundscapes, including: (a) assessments of exposure of coastal populations; and (b) ways to limit exposure through technical or operational measures (e.g. including in whale watching guidelines).
- Collaboration with the Conservation Committee and their work item on noise. The pre-meeting could identify topics where the SC could contribute for specific sources including seismic, sonar, pile driving and ADDs, in addition to shipping noise and work related to IMO.
- Collaboration with IMO MEPC and work on shipping noise.

The intersessional steering group will investigate the option to hold the pre-meeting in London at the IMO. This could allow some participation by IMO Secretariat and other shipping interests.

The sub-committee thanked Leaper and the group for their assistance with this and looked forward to the outcomes from the meeting being reported at SC/68B.

Attention: CG, G
The sub-committee encourages 'activity exclusion' as an effective mitigation approach, particularly to alleviate the effect of noise on cetaceans.

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6. UPDATE ON OTHER STANDING TOPICS AND PREVIOUS RECOMMENDATIONS

6.1 Marine debris

SC/68A/E/11 presented the results of abundance estimation for floating marine debris in the North Pacific Ocean using sighting data taken during the IWC-POWER surveys from 2010 to 2016. During these cruises, several types of marine debris ('fishing gear net', 'long line', 'single fishing float', 'cluster fishing float', 'wood', 'unidentified styrofoam', 'styrofoam others', 'unidentified plastic', 'plastic small', 'plastic medium and large', 'garbage' and 'others') were observed and recorded. A statistical analysis was conducted to estimate the density and distribution of the observed marine debris. Line transect distance sampling methods were used

for estimating the detection function and abundance, and multiple-covariate distance sampling (MCDS) analysis was applied to take environmental covariates into consideration. In addition to the 'design-based' method, a 'model-based' approach was also employed to estimate the spatial distribution of marine debris. The 'plastic small' and 'single fishing float' types of debris were especially abundant. Some of this debris may be attributed to the tsunami event that occurred in Japan in 2011. The model-based method showed that densities of debris were high between 20°-40°N and concentrated around 145°W.

The sub-committee welcomed this information and thanked Kitakado for presenting it. In discussion, the sub-committee noted that linking surface occurrence of marine debris with impacts on cetaceans is extremely difficult and agreed that such studies are important particularly for detecting changes through time. The sub-committee also noted that similar studies have been ongoing elsewhere, for example in the Mediterranean Sea, and that standardisation of methods would be desirable. In addition, distance to coast and distance to ocean fronts or similar oceanographic features, as well as particle size, were suggested as additional potential environmental covariates to be considered in future modelling.

Fernández presented the paper by Puig-Lozano *et al.* (2018) which provides information on foreign body-associated pathology in stranded cetaceans in the Canary Islands between 2000 and 2015, and the potential associated impacts on the health and mortality of cetaceans. A total of 465 stranded cetaceans were included in the study. At least one foreign body was found in 36 out of 465 (7.74%) animals examined, involving 15 different species, including eight out of the nine (80%) species present year-round in the Canary Islands. The Risso's dolphin (*Grampus griseus*) was the species most affected, followed by the sperm whale (*Physeter macrocephalus*), beaked whales and baleen whales. Plastic foreign bodies were the most common item found (80.56%). Foreign bodies were directly associated with death of 13 out of 36 (36.11%) animals. Poor body condition and deep diving behaviour were found to be risk factors for foreign body ingestion, whereas the adult age was a protective factor.

The sub-committee welcomed this information and thanked Fernández for his presentation. The sub-committee agreed that this study is highly valuable, especially due to large sample size. In discussion, Fernández noted that some of the examined animals had chronic injuries in their mouth, possibly indicating difficulties in feeding. It is therefore possible that foreign body ingestion took place towards the end of the animal's life, but this is obviously difficult to confirm.

Mazzariol informed the sub-committee that ACCOBAMS and ASCOBANS are working towards standardising protocols on cetacean pathology, in order to create a common European protocol, which will hopefully also feed into the IWC workshop on marine debris in December 2019.

Simmonds presented Panti *et al.* (2019), which outlines the outcomes of a workshop considering the impact of marine litter on marine mammals, held at the European Cetacean Society's 31st Annual Conference in 2017. The workshop reviewed available information and drew some conclusions that may be helpful to the IWC and its next workshop – these included the desirability of harmonised and standardised protocols for the analysis of marine litter in stranded organisms, encouragement to national strandings networks to collect information and the potential establishment of an international expert network to help better understand the issue.

Simmonds drew the sub-committee's attention to the recently published 'Voluntary guidelines on the marking of fishing gear' by FAO (FAO, 2019). These arose from concerns expressed at the 31st Session of the Committee on Fisheries (COFI) in 2014 about 'ghost fishing' by abandoned, lost or otherwise discarded fishing gear (ALDFG) and were finally endorsed by the 2018 COFI meeting. The sub-committee noted that the late Joanna Toole had been instrumental in the development of the guidelines which: (i) address the purpose and principles, the scope of application and the implementation of a gear marking system and its associated components, including reporting, recovery; (ii) disposal of ALDFG or unwanted fishing gear; and (iii) commercial traceability of fishing gear. The Guidelines also contain special considerations for developing States and small-scale fisheries with a view to capacity development, as well as guidance on conducting a risk-based approach to implementing gear marking systems. FAO intends the guidelines to help states meet their responsibilities under the relevant international law and the specific requirements for gear marking contained in FAO's Code of Conduct for Responsible Fisheries. Gear marking is also relevant to the IWC's work on whale entanglement.

The sub-committee welcomed the advent of the guidelines and encouraged the FAO to promote their uptake and monitor their application over time.

Hall noted that the outcomes of the upcoming marine debris workshop could also support the update of the necropsy best practices that European Cetacean Society and various stranding schemes have been working on, in order to standardise approaches. Mazzariol informed the sub-committee that the aim is to harmonise diagnostic frameworks for specific issues such as bycatch and marine debris, as well as to find a standardised way to determine causes of stranding.

Stachowitsch drew the attention of the sub-committee to the newly published 'Beachcomber's guide to marine debris', authored by himself. The guide provides information on various types of marine debris found on coastlines, as well as the origin of such debris. The sub-committee agreed that this publication is a valuable tool and congratulated Stachowitsch on producing it.

Nelms *et al.* (2019) (presented by Hall) describes a study to investigate the occurrence of microplastics in the whole digestive tracts of 50 individuals from 10 species of stranded cetaceans from around the UK coast and was presented by Hall. Microplastics were ubiquitous with particles detected in all animals. However, the relatively low number per animal (mean=5.5) suggests these particles are transitory. All animals examined were raptorial feeders, using their jaws and teeth alone to catch prey. These species expel seawater through their teeth, so they may be less likely to consume microplastics directly and more likely to indirectly consume them through contaminated prey.

Stomachs were found to contain a greater number of particles than intestines, indicating a potential site of temporary retention. The majority of particles were fibres (84%) and were mainly blue and black (42.5% and 26.4%). Nylon was the most prevalent (60%) polymer type. The relationship between the cause of death category and microplastic abundance was not significantly different. Further research is required to better understand the potential chronic effects of microplastic exposure on animal health.

During discussions on the ingestion of plastics by cetaceans, a study was proposed to compare materials ingested by single, probably sick, sperm or beaked whales

with the materials in the stomachs of sperm and beaked whales that had mass stranded. This comparison may help us better understand the time and types of materials ingested by whales from these two types of stranding events. The best location to undertake this type of project is New Zealand as they have the highest frequency of beaked whale mass stranding events.

The sub-committee **agreed** that limiting the input of marine debris, primarily through reduced production and waste, is key in addressing this issue. The sub-committee welcomed further information on marine debris and its impacts and the report from the workshop to be held in December 2019.

6.2 Climate change

SC/68A/E/07, provides an update to previous overviews on the effects of climate change on cetaceans (Simmonds, 2016). He noted that understanding the mechanisms through which climate change will impact any given population or species is a significant challenge facing those working to conserve and manage wildlife. The IWC has held a series of workshops about climate change (starting in 1996) and has highlighted, among other things, the need to better understand the relationship between cetacean distribution and measurable essential climate variables such as Sea Surface Temperature (SST). Simmonds reported that the literature now includes increasing evidence of cetaceans apparently responding to climate change, also partly due to improved statistical modelling techniques. For example, papers by Víkingsson *et al.* (2015), Nøttestad *et al.* (2015) and Chambault *et al.* (2018) all show changes in cetacean distribution/behaviour linked to environmental changes. In addition, other studies have reported robust predictions. For example, Tulloch *et al.* (2019) found that in the Southern Hemisphere, ocean warming is predicted across all latitudes with the greatest warming between 40°S and 60°S latitude by the end of the 21st century. The authors suggested that the apparent upward trend in Antarctic minke whale (*Balaenoptera bonaerensis*) numbers seen over the last century in the southern hemisphere will slow in the Atlantic/Indian region and reverse in the Pacific over the next 100 years. Ten years ago, Simmonds and Elliott (2009) wrote: 'There is widespread acceptance that climate change generally poses a threat to cetaceans, although the potential for perhaps short-term gain for some more adaptable populations has also been mooted. The need for multinational large scale and long-term work to better understand risks is clear and leadership is coming from appropriate international bodies. However, such bodies will need to give appropriate priority to these endeavours and allocate adequate funding.' They also called for a 'new paradigm' in conservation with swifter and more precautionary actions being taken to manage emerging issues.

In discussion, it was noted that this new paradigm was still needed, more precaution and flexibility is needed to tackle the effects of climate change. For example, some marine protected areas designated to protect cetaceans took one or two decades to be implemented, during which time the animals may have shifted their distribution due to climate change or other factors. It was pointed out that there is especially growing concern for ice-dependent species and those where habitats are limited. To assist in monitoring changes, the IMO's new International Code for Ships Operating in Polar Waters (the Polar Code) could be used to encourage the reporting of unusual or vagrant species sightings. In addition, the Arctic will be the focus of the next International Conference on Marine Mammal Protected Areas where this issue is likely to be discussed further.

Some participants noted that a substantial amount of research is currently ongoing by fisheries scientists, on various species that represent cetacean prey. Studies include not only the effects of temperature changes and the borealisation of fish (adaptation to life in more northerly regions), but also changes in ocean acidity. Some of this research, expected to be published shortly, will likely provide new information relevant to this issue.

Robbins then presented the paper by Derville *et al.* (2019) on humpback whale breeding habitat diversity and adaptability to climate change based on 19 years of survey data from Oceania. Studied breeding sites spanned a thermal range of 22.3 to 27.8°C, which is consistent with other oceanic breeding grounds. Within that range, sites with high whale encounter rates were among the warmest and coolest in Oceania. The most detailed dataset was available from New Caledonia where encounter rates showed a negative relationship to sea surface temperature. This did not appear to be related to the El Niño Southern Oscillation or the Antarctic Oscillation from previous summer, as might be expected if feeding conditions had influenced breeding ground patterns. At other sites in Oceania, physical features such as seabed topography were typically better predictors of humpback whale presence at small scales. Many breeding sites in Oceania are predicted to become unsuitably warm (>28°C) by the end of the 21st century, but modelling suggests the presence of suitable alternative physical habitats in archipelagos and seamounts of southern Oceania. Continued research in Oceania, and particularly at sites along the northern 'thermal edge' (such as American Samoa), may further clarify the acceptable temperature range for breeding grounds and humpback whale responses to climate change.

It was noted in discussion that some species and populations currently experience and are adapted to wide variations in SSTs. For example, the humpback whales in the Arabian sea face a 16°C seasonal change in water temperature. These populations would provide very useful case studies for climate change predictions. The sub-committee also concluded that long-term studies, which are difficult to maintain, are invaluable for climate change impact studies. In addition, effects on the food web, particularly on primary production and effects on higher trophic levels of prey could result in the redistribution of cetaceans.

In conclusion, climate change continues to be an overarching issue that may interact with almost all the stressors of concern to this sub-committee. The sub-committee therefore looks forward to receiving more information on this issue in future.

6.3 State of the Cetacean Environment Report (SOCER)

The State of the Cetacean Environment (SOCER) is the result of a direct request from the Commission and is designed to provide an 'environmental framework/ecosystem health ground-truthing', in order to facilitate the work of the Scientific Committee and inform the decisions of the Commission. Beyond the rotating sequence of regional SOCERs, a 5-year global SOCER compendium was produced in 2018 and now has a new, dedicated webpage on the IWC website[4].

This was presented as one of several notable products of the Scientific Committee at the 2018 Commission meeting in Brazil. SOCER was affected by the major Scientific Committee budget cutbacks of 2018 and editors

[4] *https://iwc.int/socer-report or https://archive.iwc.int/pages/view.php?ref=7007&k.*

were therefore not able to compile a SOCER for 2019. Nonetheless, based on the two-year Scientific Committee budget, the full funding for a single SOCER would be available for 2020. The SOCER is an important contribution by the sub-committee on Environmental Concerns, and the site has had over 300 hits in its first few months of existence. Moreover, the literature review of SOCER feeds directly into the Pollution 2020 Contaminant Mapping Tool. The next review would be North and South Atlantic for SC/68B.

In discussion, the sub-committee agreed that SOCER is an important aspect of their work. The sub-committee thanked the Secretariat for their continued help in proactively promoting SOCER through online channels and social media.

Attention: SC
The sub-committee agreed that SOCER 2020 should be compiled as planned and that any relevant contaminant data identified would be appended to the Contaminant Mapping Tool database.

6.4 Other related information

6.4.1 Hormones in bowhead and gray whales

SC/68A/E/09 provided an assessment of reproductive hormones in the baleen of bowhead whales and in serum from gray whales off Chukotka (Russia). The mean testosterone and progesterone levels in the gray whale samples were extremely low, probably because the animals were immature. Hormone concentrations in the bowhead whale baleen found in Chukchi Sea was almost twice those of a female harvested in the Bering Sea. Of most interest were the hormone profiles of an animal of undetermined sex. Considering the approximate growth rate of the baleen, the level of progesterone was extremely low during the first two years, but a slight increase was observed at the age of about seven years, suggesting the onset of puberty in the animal. Testosterone levels were also variable, with notable increases at age nine years, associated with the onset of maturity. Of some note were the high levels of testosterone at the age of 1-3 months. A high testosterone level immediately after birth may be explained by intrauterine exposure to a high level of androgens from the pregnant female, which can affect the levels in the young. This is the first report from Russia on the analysis of testosterone and progesterone levels in the Bowhead whale baleens, an analysis that follow changes in hormone levels during the animal's life to be investigated.

The sub-committee welcomed this information and the unusual finding of high testosterone in calves during the first few months of life which will be further investigated in future.

6.5 Progress on previous recommendations

The sub-committee reviewed progress on the recommendations from SC/67b that were directed towards them.

*(1) Attention: SC - The sub-committee **agreed** that the Pollution 2020 initiative should be completed and presented at SC/68A. The sub-committee also **encouraged** a paper be presented at SC/68A summarising the potential mitigation measures for reducing exposure of cetaceans to polychlorinated biphenyls (PCBs) in particular and persistent organic pollutants (POPs) in general.*

- The Pollution 2020 reports to the sub-committee and the Commission will be considered next year. The paper on POP mitigation measures was delivered this year.

*(2) Attention: CG-A, SC - The sub-committee continued to highlight the need to estimate the risk and impact of oil spills, particularly to cetaceans in the Arctic. The collection of baseline data for cetaceans, including standardisation of measures, is **encouraged**.*

- The sub-committee received an update on heavy fuel oils this year.

*(3) Attention: CG-A, SC - The sub-committee **encouraged** research on the effects of dispersants or dispersed oil to the Arctic ecosystem and for it to be brought forward to future meetings of the Scientific Committee.*

- This work is ongoing.

*(4) Attention: CG-R, SC - The sub-committee **reiterated** the Cumulative Effects workshop recommendation that consideration needs to be given to 'developing a widely applicable approach for providing precautionary advice for populations in which cumulative effects are of concern. For those where there is immediate concern, where possible, action should be taken to mitigate any recognisable adverse effects'.*

- This will be taken forward in the Pollution 2025 initiative.

*(5) Attention: CG-R, SC - The sub-committee **endorsed** the results stemming from the workshop (sponsored by the 32nd Conference of the European Cetacean Society in La Spezia, Italy, in April 2018) entitled 'Towards understanding the overlap of selected threats and Important Marine Mammal Areas (IMMAs) across the Mediterranean Sea' and **recommended** that such an effort – aimed at overlaying different sources of threat and pressure on existing Important Marine Mammal Areas (IMMAs) – be continued and carried out in more detail in the other marine regions where IMMAs have already been identified. The sub-committee offered its assistance in such assessments.*

- A report from the 'Joint IWC-IUCN-ACCOBAMS workshop to evaluate how the data and process used to identify Important Marine Mammal Areas (IMMAs) can assist the IWC to identify areas of high risk for ship strike' was considered by the HIM sub-committee.

*(6) Attention: SC, S - The sub-committee also **recommended** that the Strandings Initiative Steering Committee and Expert Panel, with the support of the Secretariat, should explore the best ways to gather information on strandings events and what basic data about these events should be recorded, focusing on what is useful for the sub-committee and the Commission. A phased approach to this, starting with an initial pilot project, would assist in this endeavor.*

- This is ongoing and may be taken forward through the National Progress Reports.

*(7) Attention: SC - The sub-committee **agreed** that the criteria for allocating Scientific Committee funds for emergency responses should be developed by the Steering Committee and the Expert Panel. It also noted that the rescue and welfare aspect of live strandings will be addressed by the Strandings Initiative but this aspect is not within the purview of the Scientific Committee.*

- This was presented to the sub-committee this year.

*(8) Attention: SC - The sub-committee welcomed the international efforts addressing the effects of anthropogenic noise on cetaceans and **encouraged***

expanded international coordination regarding assessment and protection of cetacean acoustic habitat quality.
- This work is ongoing and interactions with the IMO MEPC are continuing.

(9) Attention: CG-A, SC - The sub-committee recognised the commonalities identified among the concurrent efforts of multiple international bodies to develop national guidance on noise strategies, and ***encouraged*** *continuing to identify synergies and develop priorities for actions to reduce exposure of cetaceans to anthropogenic noise.*
- This work is ongoing.

(10) Attention: SC - The sub-committee welcomed and ***drew attention*** *to the Convention on Migratory Species Family Guidelines on Environmental Impact Assessments for Marine Noise-Generating Activities[5], noting that these guidelines will help improve global standards for environmental impact assessments.*
- There is an upcoming meeting of the Conference of the parties next year in Gandhinagar, India (15-22 February 2020). The sub-committee recommends establishing liaison with the CMS to identify issues of mutual interests.

(11) Attention: C-A, CG-A, SC - The sub-committee ***drew attention*** *to the fact that climate change remains a threat that interacts with other threats and stressors impacting cetacean populations.*
- This work is ongoing.

(12) Attention: S, SC - The sub-committee ***agreed*** *to hold a focused session next year (SC/68A) on our understanding of the pathology and epidemiology of morbillivirus and Brucella and the potential for identifying and understanding cumulative effects of exposure to other immunosuppressive stressors in cetaceans.*
- This focus session has been expanded to include other pathogens of concern, toxoplasma and herpesvirus and will be held at SC/68B next year.

7. WORK PLAN FOR 2019-20

The sub-committee agreed that the work plan summarised in Appendix 2 should be adopted, with the caveat that emerging issues should be dealt with and a recognition that priorities may change if particular topics require attention because of developments during the year including receiving specific requests from the Commission. The intersessional groups (steering and correspondence) are given in Annex T.

Hall announced that she was stepping down as Chair and the sub-committee thanked Hall for her excellent work as Chair and wished her well for the future.

8. ADOPTION OF REPORT

The report was adopted at 14:00 on 17 May 2019.

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Appendix 1

AGENDA

1. Introduction
   - 1.1 Introductory remarks
   - 1.2 Election of Chair
   - 1.3 Appointment of Rapporteurs
   - 1.4 Adoption of Agenda
   - 1.5 Review of available documents
2. Pollution
   - 2.1 Polychlorinated biphenyls, DDTs and mercury in cetaceans
   - 2.2 Mitigation measures for Persistent Organic Pollutants
   - 2.3 Update on intersessional progress on the Pollution 2020 initiative
   - 2.4 Afterlife of Pollution 2020 products
   - 2.5 Future Pollution initiatives
   - 2.6 Other pollution issues
3. Diseases of concern
   - 3.1 Infectious diseases
   - 3.2 Host-pathogen interactions
4. Strandings and mortality events
   - 4.1 Update on the IWC Strandings Initiative
     - 4.1.1 Progress report
     - 4.1.2 Training prioritisation matrix
     - 4.1.3 Large whale euthanasia
   - 4.2 New information on unusual mortality and mass stranding events
5. Noise
   - 5.1 Mid-frequency active sonar
   - 5.2 Update on cooperation with the International Maritime Organization
   - 5.3 New information on noise impacts
   - 5.4 Noise pre-meeting at SC/68B
6. Update on other standing topics and previous recommendations
   - 6.1 Marine debris
   - 6.2 Climate change
   - 6.3 State of the Cetacean Environment Report (SOCER)
   - 6.4 Other related information
     - 6.4.1 Hormones in bowhead and gray whales
   - 6.5 Progress on previous recommendations
7. Work plan for 2019-20

Appendix 2

WORK PLAN

The work plan has three long-standing items: pollution, diseases of concern and strandings, two items that are dealt with on a cyclic basis: noise, marine debris. Cumulative effects are now included in the new Pollution 2025 initiative. Emerging issues will be added as required. Overarching these topics are SOCER and climate change.

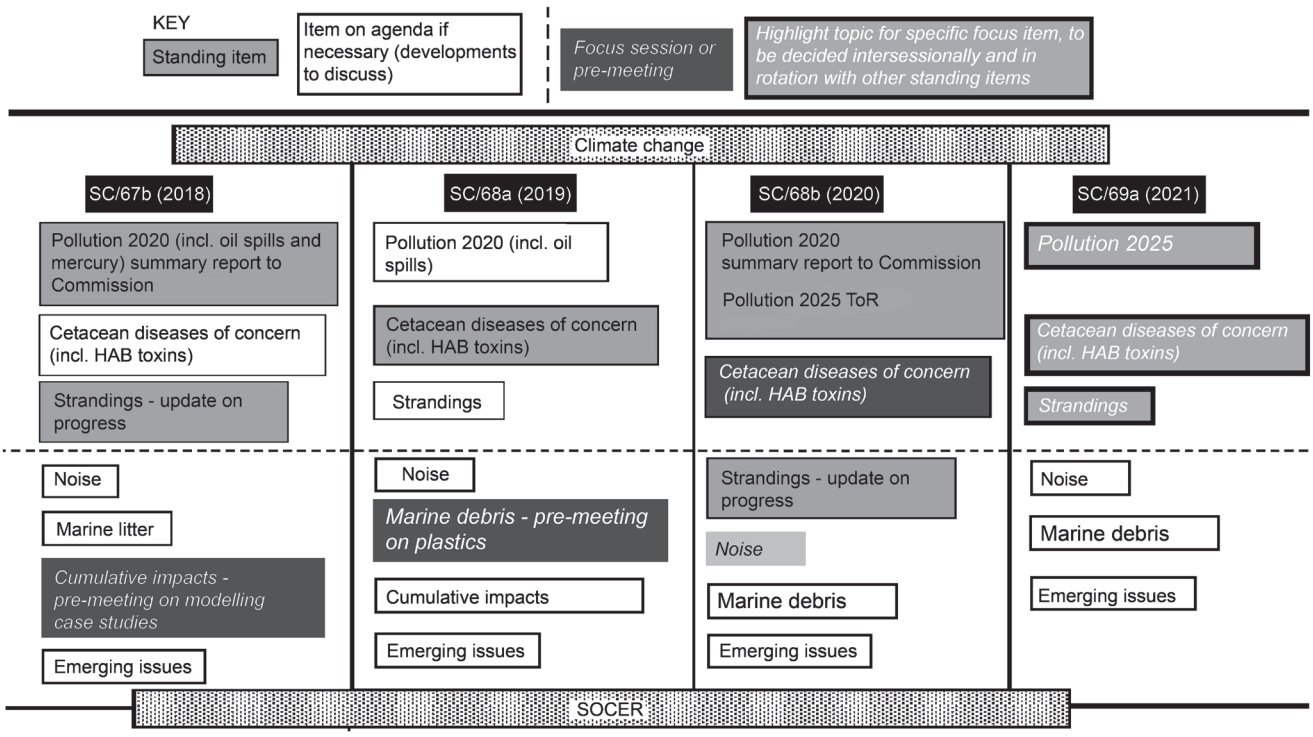

Table 1
Work plan towards 2021.

Topic	Intersessional 2019/20	2020 Annual Meeting (SC/68B)	Intersessional 2020/21	2021 Annual Meeting (SC/69A)
Marine debris	Hold workshop (Organiser: Simmonds)	Workshop report	-	-
Strandings Initiative	Respond to emergency requests, carry out training, synergise protocols with other IGOs (Strandings Coordinator: Stockin)	Report on activities and progress	Respond to emergency requests, carry out training, synergise protocols with other IGOs	Report on activities and progress
Pollution 2020	Complete tasks and produce report (Organiser: Hall)	Report on completion of Pollution 2020 and produce report for Commission	-	-
Pollution 2025	Draft Terms of Reference for Pollution 2025 (i) take into account the pollution work conduced to date; (ii) likely future key pollution issues including but not limited to POPs and marine debris; (iii) how pollution concerns interact with the range of factors that may act cumulatively and synergistically to affect cetacean health and survival; and (iv) recommend work plan. (Organiser: Holm)	Report on Terms of Reference and recommended work plan	-	-
Diseases of Concern	Identify and invite IPs for infectious disease focus session (Organiser: Stimmelmayr)	Hold focus session and report recommendations to sub-committee	-	-
SOCER	Atlantic Ocean focus (SOCER team)	SOCER report	-	-
Noise	Plan pre-meeting, compile relevant documents, Identify and invite IPs, conduct pre-meeting (Organisers: Leaper, Cholewiak)	Pre-meeting recommendations	-	-

INTERSESSIONAL GROUPS

See Annex T for a full list of intersessional groups.