Report of the Scientific Committee

Bled, Slovenia, 24 April-6 May 2018

Annex K
Report of the Sub-Committee on Environmental Concerns

**This report is presented as it was at SC/67b.
There may be further editorial changes (e.g. updated references, tables, figures)
made before publication.**

International Whaling Commission
Bled, Slovenia, 2018

Annex K

Report of the Sub-Committee on Environmental Concerns

Members: Hall (Convenor), Al Harthi, Al Jabri, Aoki, Atkinson, Avila, Baba, Bell, Bickham, Bjørge, Brierley, Brownell, Burkhardt, Buss, Castro, Cerchio, Cholewiak, Cipriano, Collins, Cosentino, Dalla Rosa, de Freitas, DeMaster, Di Tullio, Domit, Doniol-Valcroze, Donovan, Double, Elwen, Ferguson, Ferriss, Fortuna, Frey, Fruet, Gallego, Galletti-Vernazzani, Genov, George, Gonzalez, Gulland, Haug, Hielscher, Holm, Hubbell, Iñíguez, Inoue, Jacob, Kim, Kitakado, Lang, Langerock, Leaper, Leslie, Litovka, Luna, Lundquist, Mallette, Marcondes, Mattila, Mazzariol, Minton, Murase, Mwabili, Natoli, Nelson, New, Palka, Panigada, Parsons, Phillips, Porter, Reeves, R., Reeves, S., Reyes Reyes, Ridoux, Ritter, Rodriguez-Fonseca, Rojas Bracho, Rose, Rowles, Ryeng, Safonova, Sampaio, Santos, Scheidat, Scordino, Scott, Sequeira, Simmonds, Sironi, Širovič, Slooten, Slugina, Smith, Stachowitsch, Stack, Stimmelmayr, Stockin, Suydam, Svoboda, Tamura, Tarzia, Taylor, Thomas, Torres, Trejos Lasso, Urbán, Víkingsson, Wade, Weinrich, Weller, Williams, Willson, Wilson, Yaipen-Llanos, Yasokawa, Yasunaga, Ylitalo, Zerbini.

1. INTRODUCTION

1.1 Introductory remarks
Hall welcomed the participants to the Sub-Committee on Environmental Concerns.

1.2 Election of Chair
Hall was elected as Chair.

1.3 Appointment of Rapporteurs
Cholewiak, Noren, and Ylitalo were appointed as rapporteurs.

1.4 Adoption of Agenda
The adopted agenda is given as Appendix 1.

1.5. Review of available documents
The documents available to the SC were identified as SC/67b/E01-02; SC/67b/E03rev1; SC/67b/E04-06; SC/67b/E07rev1; SC/67b/E08-11; SC/67b/E13; SC/67b/E15-16; SC/67b/CMP04; SC/67b/CMP13; SC/67b/HIM06; SC/67b/AWMP03; Cholewiak *et al*. (in press); Hall *et al*. (2018); IMO (2018); Prideaux (2017); Taffi *et al*. (2014); Van Opzeeland and Boebel (2018).

2. POLLUTION

2.1 Review on intersessional progress on the Pollution 2020 initiative
An update on progress within the Pollution 2020 initiative was given by Hall. Following the work plan agreed upon at SC/67b, there have been three main activities:

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

The individual based model to investigate the effects of pollutants on cetacean populations (SPOC) has been finalised. A peer-reviewed paper detailing the model and applying it to a number of case studies has been published in *Environmental Pollution* (Hall *et al*., 2018) and the model's R code is available through the repository associated with the paper. The web-based, user-friendly version is now available through the Sea Mammal Research Unit, University of St Andrews server (*http://www.smru.st-andrews.ac.uk/reports/*) and a link will be added to the IWC webpages on the Chemical Pollution page.

The model estimates the effect of exposure to pollutants (currently the polychlorinated biphenyls or PCBs) by integrating tissue concentration-response relationships (using data obtained from published toxicological studies) with information on blubber pollutant levels in cetaceans. The model then modifies the probability of calf survival, and mortality following exposure to a pathogen, for a given population or species. Adding the additional option to investigate the effect of exposure to the brominated flame retardants (or polybrominated diphenyl ethers, PBDEs) on calf survival or reproduction into the model has been difficult. The tissue-related concentration-response functions needed are not available for these compounds. Most studies do not report the tissue concentrations, only to oral dose to which the animals have been exposed. In addition, these chemicals do not occur in isolation but will always be found in combination with the other persistent organic pollutants. Therefore, including the effect of exposure to the PBDEs in a model separately from these other contaminants is unrealistic. However, data from a study published recently by Desforges *et al*. (2017) in which the effects of a mixture of persistent organic pollutants (POPs), extracted from killer whale blubber, on immune function *in vitro* are available. These data, and the relationship between the immune function assay and blubber concentrations of

POPs can easily be included in the model. This will therefore be implemented as an option in the web-based version of the model and will be reported at SC/68a.

(b) Data integration and mapping
The contaminant mapping tool presented at SC/67b has been completed and the data on concentrations of PCBs and DDTs in key species for which long-term datasets have been published in the peer reviewed literature, have been included. Additional data published recently and collated by the State of the Cetacean Environment Report (item 6) will be incorporated during the intersessional period. Data on mercury concentrations in cetacean tissues has also been obtained from the papers reviewed in SC/67b/E08 and will be included in the mapping tool that will shortly be available on the web, through the Sea Mammal Research Unit and IWC websites.

(c) Estimating the rate of decline in PCBs in cetacean blubber following reductions in environmental concentrations
A computational model of PCB bioaccumulation in the Adriatic food web has been developed by Taffi *et al*. (2014) following biomass flows in predator-prey relationships at the various trophic levels. This model also investigated the effect that bioremediation measures, i.e. enhancement of the microbial pollutant degradation pathways, may have on the bioaccumulation of these compounds. The authors developed models that integrate bioaccumulation at the ecosystem level with genome-scale metabolic models of pollutant degrading bacteria. Whilst the bioremediation measures proposed may only be applicable to limited regions, the concept of investigating the rate of decline in blubber PCB concentrations in top predators, due to declines in inputs as a result of various mitigation measures, not just bioremediation, could be addressed using this approach. The applicability of the Taffi *et al*. (2014) model for estimating how long it would take before a decline in blubber PCB contaminants is detectable in cetaceans will be therefore be explored further during the intersessional period and the findings will be reported at SC/68a.

The sub-committee thanked Hall for presenting this update and commended her on the work that has been completed for the Pollution 2020 initiative.

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.*

2.2 Report on mercury in cetaceans
SC/67b/E08, a review of mercury in cetaceans, was carried out in response to Resolution 2016-4, 'Resolution on Minamata Convention'. The paper highlights the continued global exposure and potential effect of mercury on cetaceans. The fate and transportation of this element in the marine environment is driven by anthropogenic atmospheric and aquatic sources, as well as through natural geogenic inputs, with coastal areas and species being more vulnerable to mercury contamination than the open ocean. Inorganic mercury is converted to the more toxic form of methylmercury following chemical reactions in relation to various biological factors in the marine environment (King *et al*., 2001). Bioaccumulation of the methylated form occurs because it is more efficiently assimilated into tissues but only relatively slowly eliminated (Evans *et al*., 2016). A very wide range of studies have reported mercury concentrations in the tissues of cetaceans and these will be incorporated into the Pollution 2020 contaminant mapping tool during the intersessional period. The main target organ is the liver but mercury has also been reported in many other tissues (Savery *et al*., 2013; Stavros *et al*., 2007; 2008; Trumble *et al*., 2017).

Marine mammals are capable of detoxifying methylmercury and reducing their burden through the demethylation of methylmercury in the liver (Caurant *et al*., 1996; Wagemann *et al*., 1998) and its subsequent binding to selenium to form insoluble and toxicologically inert mercuric selenide or tiemmannite crystals that accumulate in the liver. However, under certain circumstances, when animals are experiencing other metabolic stressors, this mercuric selenide may cause adverse effects.

In a relatively recent review of the research needs related to mercury biogeochemistry, Sonke *et al*. (2013) concluded 'mercury exposure to humans and wildlife are likely to persist unless drastic emission reductions are put in place'. Since then, the Minamata Convention (*http://www.mercuryconvention.org/*) has been ratified by 91 countries and came into force in August 2017. Its provisions include 'a ban on new mercury mines, the phasing-out of existing ones, the reduction and eventual cessation of mercury use in many products and processes, control measures on emissions to air and on releases to land and water, and the regulation of the informal sector of artisanal and small-scale gold mining which use mercury in the extraction process'. The aim of the Convention is to control the anthropogenic releases of mercury throughout its lifecycle thereby reducing global emissions and exposure to both wildlife and humans. Continued monitoring of mercury in cetaceans is therefore required to determine whether these new measures reduce the uptake and impact of mercury on cetaceans in future.

The sub-committee commended Hall for the thorough review of mercury and acknowledged that the summary of information is quite extensive and useful.

SC/67b/E06 reported total mercury concentrations in river dolphins (*Inia* and *Sotalia*) in the Amazon and Orinoco river basins. Mercury was analysed in the tissue of animals found floating dead (n=19), stranded (n=4 and captured for the

attachment of satellite transmitters (*n*=15) in the Arauca and Orinoco rivers (Colombia and Venezuela border), Amazonas river (Colombia and Peru border) and Itenez or Guapore river in Bolivia. The mercury concentration ranges were reported for *I. g. humboldtiana, I. g. geoffrensis, I. g. boliviensis*, and *Sotalia fluviatilis*. As they are top predators, mercury concentrations biomagnify in these dolphins, which would explain the pattern of concentrations found.

SC/67b/E09 reported on mercury concentrations in wild humpback whales (*Megaptera novaeangliae*) sampled in the Colombian Pacific and the Antarctic Peninsula. The G stock of humpback whales undertakes one of the longest cetacean migrations, from the Antarctic Peninsula (feeding area) to the Southeast Pacific (in Ecuador and Colombia), where their breeding and calving areas are located. These whales are exposed to several pollutants, including mercury, which has been previously reported in the Antarctic Ocean. Skin and blubber samples from G stock humpback whales in the Antarctic Peninsula (2015, *n*=15) and in the Colombian Pacific (Chocó Province, 2015, *n*=14; 2016, *n*=42) were collected. Significant differences between levels in different tissue types from the same individual were found, with higher total mercury concentrations found in skin compared to blubber. Furthermore, concentrations of total mercury were significantly higher in Antarctic skin and blubber samples compared to skin and blubber samples from the Colombian Pacific. However, no significant differences in total mercury levels between females and males were found. Although humpback whales are not top predators in the Antarctic trophic ecosystem, this study provides new insights into mercury bioaccumulation in Antarctic meso-predators. The authors suggested that whales detoxify total mercury during migration. In order to further evaluate the mercury exposure and its impacts on cetaceans, future research should focus on assessing mercury concentrations in target tissues as well as investigating the degree of maternal transfer to the offspring.

Additional information on mercury levels and other environmental contaminants measured in tissues of cetaceans from coastal waters of the Chukchi Peninsula was reported in SC/67b/E03. Organs and tissues of necropsied gray and beluga whales were collected after aboriginal whaling and landing by Chukotka Natives over 10 seasons. In addition, more than 20 biopsy blubber samples from belugas from the White Sea were analysed for persistent organochlorine pesticides. In 2017, about 300 baleen samples from bowhead whales, as well as 10 blood and 10 stomach content samples of gray whales, were collected, which are currently being analysed as part of a hormone and prey study. Higher levels of arsenic and cadmium were measured in whale kidney samples but levels did not vary by age or sex. Lead and mercury were found in lower concentrations in the tested tissues and organs in the Mechigmensky Bay whales.

Chukotka Natives consume the intestines and meat of whales and walruses. The concentrations of arsenic, cadmium, mercury, and lead measured in the muscle and blubber samples of gray and beluga whales did not exceed the maximum permissible levels (MPL) recommended as part of the Russian State Sanitary, Epidemiological and Hygienic Requirements. Cadmium concentrations exceeded the MPL only twice in liver samples from one malodorous male gray whale collected in 2008 (58.5% above MPL) and in the liver of a non-malodorous female gray whale collected in 2015 (15% above MPL) out of 89 samples analysed. The MPL for lead was exceeded in three liver and kidney samples collected from malodorous whales in 2008, ranging from 2 to 4 times above the MPL. The toxic element concentrations in two beluga samples from the western Bering Sea were lower than the MPLs. The multiple excess concentrations of cadmium and lead in liver and kidney could be related to the malodorous or so-called 'stinky' gray whale phenomenon, the tainted flesh from which is not fit for consumption, but this relationship should be further studied. However, the authors concluded that the concentrations of lead and cadmium in the most valuable whale products (meat and blubber) of all studied animals, including the 'stinky' gray whales, were below the MPLs for the heavy metals analysed.

The sub-committee thanked the authors for their valuable contribution to our knowledge of mercury in cetaceans but noted the lack of standardisation of reporting units for mercury concentrations in tissues. The sub-committee therefore **encourages** researchers to report these concentrations on both wet and dry weight bases. Preferred tissues for mercury analysis was also discussed. Although mercury analyses are typically conducted on kidney and liver of stranded cetaceans, this is not always possible in carcasses that are in poor condition. In live animals, skin and blubber from biopsy samples are easily collected and these tissues have been analysed for mercury. The sub-committee also noted that mercury levels could be compared across tissues in fresh stranded animals to determine how concentrations vary among matrices and that nutritional status could influence where mercury is deposited in the body. Future studies that examine the relationships between methylmercury and total mercury among tissues in cetaceans were also suggested.

Attention: CG-R
*The sub-committee **recommended** the continued monitoring of mercury in cetaceans, as this is required in order to assess the medium- and long-term impact of the Minamata Convention.*

2.3 Impact of heavy fuel oils on cetaceans

Information was presented in SC/67a/E03 last year on heavy fuel oil and the potential impacts of this petroleum product on Arctic cetaceans. Heavy fuel oil is not readily broken down in the environment and thus a heavy fuel oil spill could pose an environmental concern in many regions of the world due to the high viscosity and chemical composition of the spilled oil. In addition, heavy fuel oil poses a substantial threat to the Arctic environment because it is extremely difficult to recover once spilled and impacts associated with mitigation measures (e.g., dispersant use, *in situ* burning) are of concern.

Recent studies have reported on the various effects (physiological and behavioural) of petroleum and petroleum-related compounds on certain species of marine mammals such as bottlenose dolphins from the northern Gulf of Mexico after

the *Deepwater Horizon* oil, (Schwacke et *al*., 2013; Venn-Watson *et al*., 2013; Lane *et al*., 2015), oiled ice seals from the Bering Straits of the U.S. (Stimmelmayr *et al*.. 2018), and belugas from the White Sea (Andrianov *et al*., 2018) and St. Lawrence Estuary (Poirier *et al*., 2018). Although the effects of heavy fuel oil on selected marine species (e.g., amphipods, fish, seabirds) have been reported (Alonso-Alvarez *et al*., 2007; Brown *et al*., 2017; Incardona *et al*., 2012), little information is available on heavy fuel oil exposure and potential effects in cetaceans. As was noted at SC/67a, the collection of baseline data for cetaceans in the Arctic, including standardisation of measures between bowhead whales and belugas, is necessary with increased vessel traffic and oil industry activities expected in the region in the near future.

The sub-committee discussed differences between oil spills and heavy fuel oil exposure as well as relationships between oil exposure and disease. It is important to note that the compounds from typical oil spills are different from the compounds in heavy fuel oil. This heavy fuel oil (bunker fuel) is added to the marine fuel for vessels and is more toxic.

Attention: CG-A, SC
The sub-committee:
(a) ***reiterated*** *the need to estimate the risk and impact of oil spills, particularly to cetaceans in the Arctic;*
(b) ***noted*** *that heavy fuel oil could pose an environmental threat in many regions due to its high viscosity and chemical composition;*
(c) ***noted*** *that heavy fuel oil poses a special threat in the Arctic due to difficulties in recovery and potential impacts of some recovery measures (e.g. dispersant use and in situ burning); and*
(d) ***encouraged*** *the collection of baseline data for cetaceans, including standardisation of measures.*

2.4 Other pollution issues

In addition, the effects of dispersants or dispersed oil to the Arctic ecosystem is not well known. To address this need, the Coastal Response Research Center (CRRC) in the U.S. coordinated a discussion among scientists with dispersant research expertise, as well as those with Arctic expertise, to determine the state-of-science regarding dispersants or dispersed oil, as it applies to Arctic waters. The ecotoxicity and sublethal impacts section of the report has been approved and will be posted later this year at *https://crrc.unh.edu/dispersant_science*.

The sub-committee thanked all the participants for the updates provided on pollution. During discussion, it was noted that the Pollution 2020 initiative will be completed next year (SC/68a) and recognised the need to begin planning for future direction of pollution issues related to cetaceans in sub-committee. An intersessional email group has been established to make progress on this task.

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.*

3. CUMULATIVE EFFECTS

A pre-meeting workshop on the cumulative effects of multiple stressors in cetaceans was held on 23rd and 24th April 2018 in Bled, Slovenia. This topic is important to IWC through its concern about the effect of environmental change on cetaceans and follows on from an IWC workshop on Habitat Degradation that was hosted by the University of Siena in 2004 (IWC, 2006).

The objectives of the workshop were: (1) to summarise the methods available for assessing cumulative effects of multiple stressors on cetaceans (both individual and population); (2) to discuss and review those methods and frameworks; (3) to identify case studies on specific species and populations (identifying their pros and cons) to which the frameworks or components of the frameworks could be applied; (4) develop criteria required for robust case studies; (5) to recommend the means and ways of progressing this work and communicating the importance of recognising the potential impact of multiple stressors to a wider audience.

This is a subject of concern across many areas within marine mammal science and the findings of a recent report on 'Approaches to Understanding the Cumulative Effects of Stressors on Marine Mammals', recently published by the US National Academies of Science, Engineering and Medicine (National Academies, 2017), was presented at the workshop. There is clearly growing recognition that the effect of single stressors cannot be understood without considering other major stressors and the nature of any interactions among those stressors. Studies to date have focused on effects of noise, and some toxins and contaminants on marine mammals, generally investigating the additive effects of various stressors of major concern. There is growing recognition that there are many stressors affecting cetaceans at both the individual and population levels. Scientific progress in this field has focussed on one of a hierarchy of responses to a stressor, across multiple levels of biological organisation; from the cell and the nature of molecular interactions to the ecosystem and the nature of trophic interactions. However, the conclusion is that it cannot be assumed that effects are additive. For example, a meta-analyses of hundreds of factorial studies on effects of multiple stressors on marine systems concluded that there are few situations where effects of multiple stressors are simply additive and assuming additivity may lead to an underestimate or overestimate of the cumulative impact. This is because interactions between stressors often results in an antagonistic (reduced combined) or a synergistic (enhanced combined) effect.

A framework for studying multiple stressors, as outlined in the National Academies report (National Academies, 2017, Population Consequences of Multiple Stressors (PCOMS)) incorporating effects on multiple individuals and their combined effect on populations, was outlined. In addition, other studies that could assist in investigating cumulative effects, including epidemiological case-control and individual or agent based modelling (IBM) studies, were discussed. Comparisons with research and similar modelling approaches of common interest within the Ecosystem Modelling sub-committee (namely IBM energetic models and modelling the effects of long-term environmental change on cetacean populations) were also discussed and their potential for adaptation to the questions relevant to understanding cumulative effects, were explored.

A number of case studies that could be used, particularly in the PCOMs frameworks or could add information and understanding to some of the components of the framework (e.g. how to assess health and the relationships between health and changes in vital rates) were discussed. Participants presented a summary on; (1) the study species; (2) the region, stocks or populations of interest; (3) trends in abundance and/or distribution; (4) information on vital rates; (5) the different impacts/stressors (natural and anthropogenic) that these animals are facing; (6) what is known (if anything) about the stressors, their individual/population level effects and their interactions. The four cases studies highlighted were bottlenose dolphins in the Gulf of Mexico and the East coast of Scotland, beluga whales in the Cook Inlet, Southern Resident Killer whales and sperm whales in the Gulf of Mexico. The workshop then expanded on these cases and produced a table of potentially beneficial case study species and populations where research on multiple stressors and the nature of their interactions, could be carried out.

The Workshop put forward a number of recommendations:

Recognising the ongoing interest in the IWC on the impact of cumulative effects on cetaceans and that there is considerable uncertainty and the need to provide assessments and management advice with current state of knowledge, the workshop recommended that:

- methods to assess health be developed across species and populations for which similar data sources are available;
- ongoing need to develop biomarkers for use in the field, particularly using 'omics approaches and new technologies, recognising that new techniques need to be applicable to free-swimming cetaceans Methods for investigating interactions should be developed, including in vitro studies;
- case studies be further developed, particularly how stressors interact to affect health and how that relates to vital rates;
- the key data gaps in assessing the nature of the interactions between stressors be addressed, focussing primarily on those that may act through the same pathways;
- primary focus should be on populations for which it is believed there is most chance of success i.e. those for which good information is available on both cetaceans and potential stressors over a reasonable time period, recognising that overall there are few cetacean populations studied with sufficiently broad sampling programmes covering sufficiently long time frames;
- nevertheless, 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;
- to develop ways of communicating current knowledge about multiple stressors and their potential for cumulative impacts to a wider audience particularly conservation managers and policy makers, and other stakeholders;
- explore ways of progressing cumulative effects studies in conjunction with other similar initiatives, recognising that implementing these long-term, complex studies is expensive; and
- monitor the progress of cumulative effects studies in the Environmental Concerns sub-committee.

The sub-committee welcomed the information and **agreed** with the conclusions of the cumulative effects pre-meeting. It was also noted that as long as there is some uncertainty in the cumulative effects and how to mitigate them, it may be prudent to follow a precautionary approach.

SC/67b/HIM06 reported on a workshop entitled 'Towards understanding the overlap of selected threats and Important Marine Mammal Areas (IMMAs) across the Mediterranean Sea', held on 7 April 2018 in La Spezia, Italy, within the framework of the 32nd Conference of the European Cetacean Society. The workshop was organised jointly by the IUCN Joint Species Survival Commission/World Commission on Protected Areas (SSC/WCPA) Marine Mammal Protected Areas Task Force (the 'Task Force') and by the Agreement on Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS). The workshop provided the opportunity to support the ongoing effort to map specific threats to cetaceans in the ACCOBAMS area by overlaying the Mediterranean IMMAs with the available area-explicit information on shipping and seismic surveys, thereby giving preliminary indications of new Cetacean Critical Habitats in the ACCOBAMS area and facilitating the implementation of conservation actions at the regional level. By way of example, three case study areas containing IMMAs - the Alborán Sea, the Northwest Mediterranean and the Strait of Sicily – were discussed during the workshop, where the overlap between IMMAs and ship traffic (suggesting the potential of ship strikes) and seismic survey blocks (with the potential of impacting noise production) appeared to be of special concern for marine mammals, and for fin, sperm and Cuvier's beaked whales in particular. The workshop suggested that the overlay between marine mammal habitat and pressures deriving from shipping and noise – possibly starting from the above listed case study areas – should be addressed in greater detail by the Task Force's regional expert working group and by the ACCOBAMS Scientific Committee, in order to recommend relevant conservation and

mitigation measures. An important caution was emphasised by participants, that outside the IMMAs there might be similar, or indeed, other problems and pressures on marine mammals.

The sub-committee welcomed information on this effort to identify and address cumulative effects in the Mediterranean Sea.

Attention: G
*The sub-committee further **encouraged** additional efforts to identify the relevant threats in each of the Important Marine Mammal Areas, in order manage the cumulative effects.*

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'.*

*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.*

4. STRANDINGS AND MORTALITY EVENTS

4.1 Update on the IWC Strandings Initiative

As established during SC/66a and 66b, the Commission endorsed the recommendations of the Whale Killing Methods and Welfare Issues Working Group (WKM&WI WG) and the Scientific Committee that the initiative on Strandings, including the establishment of a Stranding Expert Panel (SEP) and Coordinator post, should progress.

An Intersessional Steering Group (ISG) on Strandings was tasked during SC/66b with selecting the SEP members, overseeing its first meeting (including the development of the budget), and working with the Secretariat as appropriate. Nominations were solicited, taking into consideration the Terms of Reference recommended during SC/66b that the SEP should include representation and areas of expertise from: (1) regional experts in stranding response; (2) diverse agencies and organisations; and (3) multi-disciplinary expertise. Selection of Expert Panellists was achieved through an online voting process. While under-representation was overcome during the SC/67a for Asia, this was not done for the African nations. The ISG proposed governance structure for the IWC Initiative on Strandings which included a Stranding Coordinator position description was agreed at SC/67a (SC/67a/E06).

Following agreement with the Commission, the ISG will be substituted by a Steering Group. This Group would guide and assist the work of the SEP and coordinate work on strandings amongst the SEP, Scientific Committee, WKM&WI WG and Commission. This work will include the: (a) development of an initial budget and review of subsequent budgets proposed by the SEP for recommendation to the Commission; (b) appointment of Panel Members (with advice from the Chair and Co-convenor) to ensure appropriate turnover of membership and continuity; (c) provision for communication amongst the SEP, Scientific Committee, WKM&WI WG and Commission. Membership of the Steering Committee will include balanced representation from both the Scientific Committee and the WKM&WI WG. The Scientific Committee Chair (or his/her appointee) and the WKM&WI WG Chair (or his/her appointee) and the Chair of the Conservation Committee (or his/her appointee) will be permanent members. The Secretariat, Stranding Coordinator and Chair of the SEP will be *ex officio* members. The Steering Committee will be asked to select a Chair.

The SEP met virtually in July 2017, electing a Chair (Dr. Sandro Mazzariol - Italy), who will serve for the next 3 years, revising the Terms of Reference (ToR). The revised terms of Reference and *modus operandi* for the SEP are given in detail in the Strandings Initiative Progress Report, in Appendix 2. The ToR may be reviewed by the SEP and suggestions for modifications submitted to the Scientific Committee and the Steering Committee.

The Secretariat, in consultation with the ISG and the SEP appointed Karen Stockin (New Zealand) for a one year 0.5 FTE position as the Stranding Coordinator. The Coordinator is a member of, and provides support to, the SEP. This support will include: contacting the SEP for guidance on strandings events for which advice has been requested; the development of quarterly reports of activities for the SEP members; and development of an annual report for submission to the Steering Committee, Scientific Committee, WKM&WI WG and Commission. These reports will also be made available on the IWC website.

Two sub-committees related to training and emergency response were established. These groups discussed protocols and best-practice, as well as a prioritisation system in order to efficiently use limited funding. Concerning this relevant issue, both sub-committees agreed upon a semi-flexible system to guide discussion. Both sub-committees prioritise IWC SEP support to the locations (Africa, Middle East and Asia, Central and South America) that lack an already established stranding network with existing expertise and facilities. Specific criteria are: (a) for onsite training, regions where emergencies has been already occurred are welcome, in particular those involving threatened species; (b) for onsite emergency response and intervention, the (sub)committee would like to prioritise those events representing most concern

to species conservation and/or compromised animal welfare (i.e. threatened species, diseases of concern, mass strandings, unusual stranding events and oil spills; live stranding for which significant welfare concerns exist). The degree of financial support will be evaluated against these criteria. Reports from the SEP meetings and details of the governance structure are given in Appendix 2.

The sub-committee welcomed the appointment of the Stranding Coordinator and the excellent progress that has been made in the Strandings Initiative, and **agreed** that this work should continue with the support of the sub-committee.

The sub-committee discussed the budget for the strandings initiative, as well as the need to identify priorities for expenditure related to the emergency fund and the contribution to this from the scientific committee. The first emergency stranding response to a mass stranding event in Argentina has essentially expended the currently available budget. There was extensive discussion about how to prioritise responses to future stranding events, recognising that a response could have two components: a rescue response component (in the event of live strandings), and an investigative component, the former being within the purview of the WKM&WI WG. From the investigative perspective, the stages of the decision-making process should ensure that the interests of the scientific committee are taken into consideration, including: (a) identification of the causal factors responsible for the stranding event; and (b) obtaining new information on the biology and ecology of the species involved that may be obtained from the event. A draft, high level, decision-making tree was provided for the sub-committee as a point of discussion and to guide the steering group and expert panel in constructing their final decision-making tree, bearing in mind the aims and objectives of the sub-committee. It was also noted that, regardless of decision response, tracking mass mortality events provides important information about ocean health. It was acknowledged that standardisation of event reporting will be important, beginning with identifying the information on any particular event that may be of interest to the scientific committee and the Commission.

The sub-committee also discussed communication and commonalities between the efforts of the stranding initiative and other similar initiatives. The sub-committee has compiled a list of stranding networks worldwide, which will serve as a useful resource, and cooperation with other organisations that have similar initiatives will be crucial. Identifying information about stranding events could be achieved through personnel contacts, or actively, through searching news reports, social media, etc. Public engagement will be important (and could also benefit from rescue advice), and utilising crowd-sourcing platforms

The sub-committee also discussed membership on both the expert panel and the steering group. The interim steering committee was comprised primarily of Committee members participating in the intersessional efforts to launch the stranding initiative, but membership will change as the expert panel and steering group are formalised. Currently, there are gaps on the expert panel from certain regions, such as Australia and Africa (other than South Africa), and efforts are underway to identify appropriate candidates. Finally, it was noted that within the Committee, there is also a bycatch 'expert group', and it will be important to clearly distinguish between similar groups conducting separate activities. The sub-committee **agreed** that priority should be given to developing the protocols for diagnostic approaches, including developing a database of laboratories and expertise beyond the Expert Panel that could assist in an emergency and that field protocols should be easily accessible by cell phone in the field.

Attention: C-R, S
*The sub-committee **recommended** that the Commission: (a) endorse the Strandings Initiative governance structure in Annex K, Appendix 2; and (b) endorse the continuation of the Strandings Coordinator position for another two years (until IWC/68) subject to available funding and requests the Secretariat make the necessary arrangements.*

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, focussing 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 endeavour.*

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.*

4.2 New information on unusual mortality events
SC/67b/E14 reported on the first outbreak of cetacean morbillivirus in the South Atlantic Ocean. The outbreak started in November 2017 in Ilha Grande Bay and spread to Sepetiba Bay, Rio de Janeiro, Brazil. At least 263 Guiana dolphins died through February 2018. Reverse transcription polymerase chain reaction analysis confirmed that 48 of 64 tested animals were positive to Guiana Dolphin Cetacean Morbillivirus. Since March 2018, the number of Guiana dolphin mortalities has returned to pre-outbreak levels. The authors suggest that the morbillivirus is a factor affecting the dolphin populations and should be included in all Guiana Dolphin Conservation Plans. In view of the seriousness of the situation the Aquatic Mammal Center, National Center for Research and Conservation of Aquatic Mammals/Chico Mendes Institute for Biodiversity Conservation (CMA/ICMBio) and the Brasilian Ministry of the Environment (MMA) recommended a

number of measures including restrictions on boat anchor areas overlapping boto aggregations; restrictions on fishing activities and net heights; monitoring of illegal fishing; the creation of protected areas and the need for the strandings network to undertake surveillance for cetacean morbillivirus. In January 2018, the Laboratório de Mamíferos Aquáticos/Universidade do Estado do Rio de Janeiro, and CMA/ICMBio, started an intensive monitoring program in Sepetiba Bay, to collect data on the boto population to understand the impact of this atypical mortality on boto population dynamics.

The sub-committee welcomed the information and congratulated the researchers for the response to this outbreak and the quick diagnosis of the etiological agent.

Attention: CG-R Brazil, SC
*The sub-committee commended the impressive rapid and comprehensive response to the cetacean morbillivirus outbreak in Brazilian Guiana dolphins and **encouraged** further work on the longer term impact of the outbreak and the investigation of the occurrence and impact of this disease in cetaceans across different geographical areas.*

*Considering the large number of animals that died during the outbreak (particularly mature females) and the historical high levels of human impacts affecting Guiana dolphins in Rio de Janeiro state, such as bycatch, chemical and noise pollution, the sub-committee **recommended** that immediate actions should be taken to protect affected populations in order to increase the chances of population recoveries. In the weeks following the onset of the cetacean morbillivirus outbreak in Rio de Janeiro, an increase in Guiana dolphins deaths were reported in Sao Paulo and Espirito Santo states. The sub-committee therefore **encouraged** monitoring the virus presence in neighbouring coastal dolphin populations, particularly those in which immunosuppressive conditions or cumulative threats are identified.*

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5. NOISE

SC/67b/E16 provided an update to the sub-committee on several activities related to new progress on international strategies to address ocean noise. The IWC engaged on this topic with both the United Nations (UN) and the International Maritime Organisation (IMO) this past year. The United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea will hold its 19th meeting in June 2018, the focus of which will be anthropogenic underwater noise. The IWC submitted a letter (IWC.ALL.307) to the Division for Ocean Affairs and the Law of the Sea of the Office of Legal Affairs, summarising the recommendations by the Scientific Committee on the topic of Anthropogenic Underwater Noise. Additionally, the IWC submitted a letter to the IMO Marine Environmental Protection Committee (MEPC) 72 (MEPC 72/INF.9). The letter was drafted by a group formed at SC/67a to provide the Secretariat with a summary of the relevant material and discussions within the Committee on shipping noise (particularly from SC/66b/Rep10). New initiatives by a number of other international bodies are also mentioned in SC/67b/E16, including the European Commission decision (2017/848) to require EU Member States to establish threshold values to ensure that levels of anthropogenic noise do not adversely affect populations of marine animals. Finally, several new topics were brought to the Committee's attention, including recent studies documenting the responses of cetaceans to shipboard echo-sounders, and a compilation of studies evaluating the effects of noise on marine fish and invertebrates.

The sub-committee welcomed the update on international efforts addressing anthropogenic noise, and encouraged expanded international coordination regarding assessment and protection of acoustic habitat quality.

Attention: CG-R
*The sub-committee **recommended** that levels of anthropogenic noise and its effects on marine species be explicitly considered in the management of sanctuaries and marine protected areas.*

SC/67b/E07rev1 presents guidelines developed by the Convention on Migratory Species (CMS) Secretariat, also on behalf of the ASCOBANS and ACCOBAMS Secretariats, for Environmental Impact Assessments for noise-generating offshore industries. These guidelines were endorsed through CMS Resolution 12.14 on Adverse Impacts of Anthropogenic Noise on Cetaceans and Other Migratory Species, and provide a pathway to implementing the Best Available Techniques (BAT) and Best Environmental Practice (BEP). Prideaux (2017) presents technical support information for the CMS guidelines, including information on assessment criteria and noise considerations for multiple groups of marine species.

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.*

Van Opzeeland and Boebel (2018) reported a conceptual framework exploring the potential of soundscape planning in reducing (mutual) acoustic interference between hydroacoustic instrumentation and marine mammals is presented. This framework is based the idea of acoustic niches, namely the partitioning the acoustic environment on the basis of time, space, frequency and signal structure. This study explores how the principle of acoustic niches could be used to reduce potential acoustic interference by employing marine soundscape planning strategies (e.g., shifting the timing or position of hydroacoustic experiments, or adapting signal structure or frequency). The paper examines acoustic data from three

recording locations in polar oceans, and illustrates the potential efficacy of smart planning for four different hydroacoustic instrumentation types: multibeam echo-sounders, air guns, RAFOS (Ranging and Fixing of Sound) and tomographic sound sources.

In discussion, it was noted that this approach may be useful not only to reduce the overlap in frequency range and timing between hydroacoustic activities and marine mammal acoustic activity, but also for the hydroacoustic community, to plan data collection activities at times when there are fewer interfering biological signals.

Attention: G
*The sub-committee welcomed the information on using marine soundscape planning strategies to reduce interference between hydroacoustic instrumentation and marine mammals, and **encouraged** work to further develop this approach.*

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.*

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 (https://www.cms.int/en/guidelines/cms-family-guidelines-EIAs-marine-noise), noting that these guidelines will help improve global standards for environmental impact assessments.*

Cholewiak *et al*. (in press), presented a study utilising modelling approaches to evaluate relative levels of communication masking for four baleen whale species in the Stellwagen Bank National Marine Sanctuary, in Massachusetts Bay, U.S. An agent-based modelling framework was used to calculate changes in communication space in comparison to reference conditions (10 dB lower than current ambient noise). The model included current background ambient noise, as well as noise layers from three classes of vessels: large vessels carrying AIS transmitters; smaller, local fishing vessels, and whale-watching vessels. Acoustic data were collected using bottom-mounted recorders, source levels for animals and vessels were calculated empirically and sound propagation was modelled throughout the study area. Results from this study suggest that the area over which multiple species of baleen whales communicate is severely decreased by the presence of vessels. In general, this study provides a framework by which to comparatively quantify communication masking, allowing for important insights on the relative contributions of different anthropogenic sound sources.

In discussion, it was noted that there are multiple parallel efforts using agent-based modelling to evaluate the interactions between cetaceans and anthropogenic activities. The sub-committee also noted that this work demonstrates that noise is not being appropriately mitigated within the waters of marine protected areas, and expressed concern regarding the long-term health effects on cetaceans. The sub-committee also discussed strategies that have been initiated by certain ports, such as the Port of Vancouver, to encourage noise reduction of ships through reductions in port fees.

Attention: G
*The sub-committee welcomed the work on modelling cetacean communication space, and **encouraged** scientists engaged in the development of modelling techniques that address multiple anthropogenic impacts, such as noise and entanglement in fishing gear to bring these forward to the Scientific Committee.*

Attention: CG-R
*The sub-committee **recommended** that levels of anthropogenic noise and its effects on marine species be explicitly considered in the management of marine protected areas.*

Attention: S
*The sub-committee **recommended** that a pre-meeting on noise be organised for SC/68b and that an intersessional email group be convened to develop the agenda for that pre-meeting.*

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6. STATE OF THE CETACEAN ENVIRONMENT REPORT – SOCER

SC/67b/E01 presented the State of the Cetacean Environment Report (SOCER). This report is the result of several Commission resolutions, which directed the Committee to provide regular updates on environmental matters that affect cetaceans. Resolution 2000-7 requested the annual submission of this report to the Commission. SOCER has a cycle of focusing on the following regions: Atlantic Ocean, Pacific Ocean, Arctic and Antarctic Oceans, Indian Ocean and Mediterranean and Black Seas. Each SOCER also includes a Global section. The 2018 SOCER (Appendix 3) focuses on the Mediterranean and Black Seas, summarising key papers and articles published within the past two years. Next year will focus on the Atlantic Ocean. This year's regional SOCER represents the final year of the most recent cycle, which will be combined in a five-year compendium (2014: Atlantic Ocean through 2018: Mediterranean and Black Seas) to present to the Commissioners. SOCER will soon have its own dedicated page on the IWC website and the compendium will be sent as a circular to all Contracting Governments. Response from the Committee to this year's SOCER solicitation was excellent, and members of the Committee are directed to Appendix 3 for the complete summary of global information.

The UN's 'First Global Integrated Marine Assessment' reported the major threats in the Mediterranean to be habitat loss and degradation, followed by fishing, climate change, pollution, eutrophication and invasive species. The 'Ocean Health Index' showed the lowest score for Libya (44 out of 100) and the highest for Malta (79). Six of the nine Mediterranean countries evaluated lie below the global average (70). Climate change strongly affects the Mediterranean due to 'tropicalisation' (e.g., exponential increase in subtropical Red Sea species). The Mediterranean also had the fourth highest concentration of floating debris in the world. Values are comparable to those in the major subtropical gyres, but the proportion of large objects is even higher. In some areas, whale distribution overlaps highly with marine debris and ship traffic, including in the Pelagos Sanctuary. Seismic survey noise affects 27% of the surface of the Mediterranean. The EU Directive on Marine Strategy is seeking to mitigate noise ('noise budget'; future 'European Motorways of the Sea'). Conservation agreements are currently too weak to adequately address underwater noise, collisions with ships, bycatch in fishing gear and ingestion of plastic litter. Protected areas here are very unevenly distributed, reflecting uncoordinated conservation efforts. The Mediterranean remains a pollution hotspot (e.g. PCBs, heavy metals).

Alien species in the Black Sea are a major threat (e.g. ctenophores (comb jellies) led to the collapse of 26 commercial fish stocks and caused a major ecosystem shift), as are harmful algal blooms. Critical status has been recognised for 13 out of 37 benthic habitats, including coastal lagoons, estuaries and deltas. These developments, along with illegal fishing (gillnet entanglement), pose the greatest threats to the three cetacean species here (all listed as Endangered or Vulnerable). The most recent of several large-scale mortalities may have killed thousands of neonate and juvenile harbour porpoises. Vessel traffic in the Istanbul Strait, one of the busiest international waterways in the world, significantly affected dolphin behaviour. The pollutants in Black Sea waters, sediments and organisms have become a matter of great concern.

The sub-committee welcomed the information provided in the SOCER report and thanked the editors for the report and for providing tables with recently published contaminant concentration data for cetaceans that will be added to the contaminant mapping website. The sub-committee **encouraged** the continuation of compiling contaminant data tables in future SOCER reports. Next year SOCER will be focussing on the Atlantic and the editors welcome input from the community for that region.

7. UPDATE ON OTHER STANDING TOPICS AND PREVIOUS RECOMMENDATIONS

7.1 Marine debris [litter]

Papers SC/67b/E10 and SC/67b/E15 were originally drafted at the request of the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) and as part of a process that led its workshop on marine debris, which was held in April 2018 in La Spezia, Italy just a few weeks prior to the meeting of the Scientific Committee.

SC/67b/E10 is a new review of the literature that relates to interactions between cetaceans and marine debris. One conclusion is that whilst there has been an increase in relevant information (published works show that almost 80% of cetacean species are known to be affected), a quantifiable assessment of effects, specifically on cetaceans, remains elusive. In terms of whether particular types of marine debris should be targeted to help mitigate the threat to cetaceans, there seems to be no clear signal in the current literature pointing towards a focused action beyond urgently trying to stop all forms of plastics entering the seas and oceans. However, the available information does suggest that some types of marine debris may be especially problematic. For example, items linked to fishing activities, such as portions of ropes, nets, lines, and hooks constitute a substantial portion of ingested debris. Similarly, there are a number or reported lethal cases, where plastic bags fully occluded gastrointestinal passages or filled up stomach cavities. Recent publications (e.g., Lusher *et al*. 2015, 2018) reconfirm the earlier suggestion that deep-diving offshore species ingest much plastic and may be especially vulnerable.

SC/67b/E15 considers what data might be usefully collected to better understand the interactions between cetaceans and marine debris. Recommendations include that: (a) Post-mortem examinations should be conducted using a classical differential diagnostic approach when possible and, when not, efforts to document the presence of marine debris, both ingested and entangled, should still be put into place; and (b) debris should be characterised by material, size, colour, shape, mass and volume and, where possible, identified to source. A standard list of litter items is provided.

SC/67b/E13 is the preliminary report for the joint ACCOBAMS/ASCOBANS/Specially Protected Areas Regional Activity Center (SPA-RAC) workshop on marine debris and cetacean stranding that was held in April 2018 in La Spezia, Italy. Cetaceans are known to be affected by marine litter through ingestion and entanglement in fishing nets. The phenomenon is well-known in the ACCOBAMS area, and information exists mainly from the monitoring of strandings in the Mediterranean and the Black Seas. Strengthening collaboration between global and regional intergovernmental organisations and non-governmental organisations interested in this issue was an objective of this workshop, in order to ensure better synergy and to optimise efforts. More than eighty attendees from 21 different countries participated in the workshop. The workshop provided the opportunity: (a) to further develop effective cooperation with the ongoing regional initiatives on marine debris, including ghost nets; (b) to assess the impact of plastic materials on cetaceans; and (c) to discuss requirements for the development of a common approach and joint guidelines.

SC/67b/E11 investigated the occurrence of microplastics in the food web of cetaceans to assess the risk of microplastic uptake in baleen whales. Common minke whale was chosen as an example because most data are available, and it has

similar feeding behaviour to many other baleen whales. A two-step procedure was used. First, the common minke whale diet in different regions was evaluated; and second, available evidence of microplastic ingestion by these prey species was reviewed. The results suggest that minke whales feeding in different geographic areas are exposed to different risks of ingesting microplastics. Specifically, the highest levels of microplastic contamination were reported for Scombridae and Gadidae. Generally, prey species in coastal areas show higher levels of microplastic contamination than those in offshore areas, putting common minke whale feeding in these areas at higher risk of microplastic ingestion than those feeding in offshore areas. Research on microplastics ingestion by prey species belonging to many of the families are urgently needed; and collaborations with scientists having access to fisheries research vessels to investigate microplastics ingestion, especially in the Northern Pacific, are recommended.

The sub-committee discussed what information on impacts of microplastics in prey is available in the literature. The issues regarding contradictory results and the limitations of lab experiments (e.g., higher doses and shorter durations than in the field) were also discussed. The sub-committee noted that microplastics is an important emerging issue. It was also noted that standardisation of how the measurements are made and identifying the types of plastics present are both important. Assessing the absorption of POPs from plastics is also important. There is a movement to standardise protocols, including the size of microplastics analysed, but the cost of analysis increases as the size of the microplastics decrease. It was also discussed that microplastics might be more difficult to find in large whales, but that is why investigating microplastics in the prey is a good approach. Furthermore, the trophic level of the predators will influence whether microplastics are observed. Variability in microplastics across different geographic locations and variations in patterns due to climate change (e.g. Polar Regions) was also discussed. It was concluded that exposure to microplastics might be widespread, difficult to detect, and the impacts are also challenging to determine.

The sub-committee discussed the need to collect better information on this issue as well as identify the data that should be collected. The sub-committee also discussed that different organisations may categorise debris differently and it was the proposed that IWC could identify best practice protocols for categorisation. It was also suggested that it would be prudent to liaise with others that are working with sea turtles since marine debris is an issue with sea turtles. The sub-committee commented that these papers, along with discussions at the ACCOBAMS workshop, and the discussions of the intersessional marine debris correspondence group, indicated that the collection and sharing of information related to marine debris requires attention. This led to one of the focuses of the workshop proposal. The sub-committee thanked the authors for the information on plastics and microplastics.

Attention: C-A
*The sub-committee **drew attention** to the fact that marine debris remains a threat, and that in particular, exposure to plastics (including microplastics) is a rapidly emerging area of concern.*

Attention: S
*The sub-committee **recommended** the organisation of an intersessional workshop on Marine Debris, preferably to coincide with the World Conference on the Biology of Marine Mammals in Barcelona in December, 2019.*

7.2 Climate change

Climate change was highlighted at SC/67a as being an overarching issue that is important to various topics, and that where relevant its impact should be discussed in conjunction with that topic. Notwithstanding that, sub-committee may want to initiate a specific activity related to climate change in future. It was noted that 'State of the Cetacean Environment Report (SOCER) 2018' (Appendix 3), featuring the Mediterranean and Black Seas, identified climate change as a major threat. Climate change is a particular issue for enclosed seas, where organisms cannot migrate to higher latitudes. SOCER summarised results of several studies on climate change. For example, Bianchi *et al*. (2018) reported that the Mediterranean Sea may be doubly affected because it is increasingly being inhabited by (sub) tropical non-indigenous species ('tropicalisation'). Moreover, warm-water native species previously restricted to southern sectors are now establishing themselves in the colder northwest basin ('meridionalisation'). If the present seawater warming continues, the Mediterranean would undergo a generalised process of biotic homogenisation. Such major ecosystem changes will probably ultimately affect the entire food web, including top predators such as cetaceans. The authors point to the need for sustained monitoring in the region.

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.*

7.3 Cetacean diseases of concern

SC/67b/CMP13 reported on use of Unmanned Aerial Vehicle (UAV) health assessment techniques undertaken as a trial study during recent surveys for tagging of humpback whales off the coast of Oman. Studies were undertaken to address concerns of previously reported body condition (Willson *et al*., 2014), interaction with fisheries (Minton *et al*., 2011), and increasing prevalence of skin lesions considered to be related to poxviruses (Van Bressem *et al*., 2014). Research and monitoring of health assessment metrics have been recommended by the Convention for Migratory Species Concerted Action Plan for Arabian Sea humpback whales. Photogrammetry based body condition assessment of seven whales

revealed that two fell into a lower margin for length width relationship. Lesion coverage ranged between 0.5% and 75% coverage of the dorsal surface of the animal, with the highest coverage on males. Respiratory condensate blow samples are still awaiting analysis at Woods Hole Oceanographic Institution. Based on success of the trial the team is making plans to include the work as a standard feature of surveys to build long term datasets of these health assessment metrics.

General health information for post-mortem examinations on 2017 landed bowhead whales was provided in SC/67b/AWMP08 highlighting results from several major retrospective screening survey studies and pathological findings. Key results included decreasing levels of organic pollutant in archived blubber and muscle samples, limited detection of anthropogenic radionuclides at low levels in bowhead muscle, and continued absence of major viral and bacterial pathogens that could impact bowhead health. In addition, marked interannual variation of *Giardia spp*. with presence of human host associated giardia assemblages was also observed, suggesting environmental marine contamination with human faeces. Highly variable presence of marine biotoxins in bowhead whale faeces was also found, suggesting complex environmental drivers of harmful algae blooms in the Arctic. Pathological findings observed in 2017 landed bowhead whales were consistent with previous years' findings with a low prevalence of fatty tumours and gastric nodules associated with *anisakis* infection. Kidney worm infection with associated kidney lesions were detected in 10/13 bowhead whales. Molecular characterisation of kidney worm specimens for species identification has been inconclusive and further efforts are underway to characterise the species. Arctic climate change (e.g., diminishing sea ice, increased sea surface temperature, prey shifts) may be setting the stage for an evolving host-parasite relationship in the Bering-Chukchi-Beaufort Sea bowhead whale stock.

The investigation of trichinellosis of 53 landed gray whales and 246 Pacific walruses off Chukotka (Russia) conducted in 2006, 2010 and 2017 by Kirov Agricultural Academy was reported in SC/67b/E02. The authors found that *trichinella* transmission in the coastal ecosystem off Chukotka can occur due to trophic-ecological factors, necrophagy and predation. The role of mechanical vectors in invasion is governed by numerous invertebrates and some vertebrates. The gray whale samples were negative to trichinellosis but the infestation of walruses was 1.45% in 2006. For the Native people of the Arctic, there is currently no alternative to marine mammal subsistence hunting. Taking into account that the threat of trichinellosis infection persists, periodical and critical studies of trichinellosis infestation in harvested whales, walruses, and seals in the Chukotka region will continue.

For the first time, baleen samples from a large number of gray whales (n=24) that were harvested for subsistence in Chukotka (Russia) were tested for glucocorticoid hormones and the findings are reported in SC/67b/E04. Samples were collected by Chukotka scientists for the 6-year study period and were analysed by Severtsov Institute of Ecology and Evolution in Moscow in 2018. Sex hormones were also analysed but the results were not included in this report. Samples tested were collected primarily from young animals, the size of their baleens being highly positively correlated with the animals' size and age. Reliable sex differences in the cortisol concentration in different parts of the baleens were not observed. The trend of increasing of cortisol concentration in the proximal part of the baleen was found. Some correlations suggest that larger whales have a lower cortisol level, which can be an indicator of both lower stress and a lower metabolic rate in larger whales. Analysis of sex and stress hormones is a very efficient tool for characterising the internal features of animals, which depend on external factors. Hormone investigations of harvested whales, walruses and seals from Chukotka waters will continue, with logistical and financial support by the Governor of the region, Department of Agricultural and Industrial Development.

The sub-committee thanked all the presenters for the updates on diseases in cetaceans and **agreed** that the work on the Arabian Sea humpback whales using blow sampling and photogrammetry should continue and if possible be expanded to include analyses of the blow beyond the microbiome work. Standardisation efforts (such as those being pursued by the photo-ID sub-committee), for measuring body condition using UAVs for photogrammetry, and for collecting blow samples, should progress to ensure this useful tool can provide comparable data across studies, taking into account the differences between the various platforms available. Cross-validation with current methods for assessing body condition from visual health assessments are essential.

Paper SC/67b/E05, which reported progress on the development of liquid chromatography-tandem mass spectrometry (LC-MS/MS) methods to analyse steroid hormones in gray whales, was not presented due to schedule conflicts with the presenter.

Attention: S, SC
*The sub-committee **agreed** to hold a focussed 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.*

7.4 Progress on previous recommendations

7.4.1 Pollution

The SC/67a recommendations: to make the effect of contaminants on cetacean populations (SPOC) model available to the public; to review mercury in cetaceans; and to include new data into the contaminant mapping tool, have all been completed. Modifications to the SPOC model and estimating the half-life of persistent organic pollutants in cetacean populations following mitigation will be completed at SC/68a.

7.4.2 Cumulative effects
A workshop on understanding the cumulative effects of multiple stressors was held as a pre-meeting to SC/67b. A summary of the findings and recommendations are given in this report and a separate workshop report will be published shortly.

7.4.3 Diseases of concern
The content on the Cetacean Diseases of Concern (CDoC) website will now be utilised and merged with the Strandings Initiative, in particular the Hot Topics and Laboratory List. The current content will be reviewed by the Strandings Initiative Expert Panel and additional topic experts (for example those working on harmful algal blooms) within the intersessional steering group and will be used in the training and background materials for the stranding responders.

The quarterly CDoC updates are still of interest to the sub-committee but a means of progressing this on a voluntary basis was not identified. Endeavours to find assistance for this work are ongoing.

7.4.4 Strandings
The strandings initiative has progressed as recommended at SC/67a and a full progress report can be found in Appendix 2. This work will continue with the new IWC Stranding Coordinator now in post.

7.4.5 Noise
In response to a previous recommendation, that the sub-committee receive the recently developed seismic survey guidelines by the New Zealand government as these would be a useful example for other countries, a link to the technical working group reports created during the NZ seismic guidelines review is now available (*http://www.doc.govt.nz/our-work/seismic-surveys-code-of-conduct/work-of-the-technical-working-groups/*).

These guidelines are provided for reference and were not discussed by the sub-committee. It should be noted that the technical working group was tasked with determining 'biologically relevant sound levels' but that this part should be considered to be a 'draft' as the group did not agree on final text and recommendations.

As recommended, the intersessional group presented a summary of the IWC recommendations on shipping noise for the IMO Marine Environment Protection Committee in 2018.

8. WORK PLAN AND BUDGET REQUESTS FOR 2019-20

8.1 Work plan for 2019-20
The sub-committee **agreed** that the work plan summarised in Annex K, Appendix 4 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.

8.2 Budget requests for 2019-20

Table 1
Summary of the 2-year budget request for Environmental Concerns.

RP no.	Title	2019 (£)	2020 (£)
Meetings/Workshop			
	Marine Debris Workshop		20,000
	Noise Pre meeting		12,000
Modelling/Computing			
Research			
	Strandings initiative	4,500	4,500
Database/Catalogues			
	SOCER	3,000	3,000
Total request		**7,500**	**39,500**

Intersessional groups

Table 2
Intersessional groups.

SC Agenda Item/ Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 15.1 E		Pollution	Planning activities and work priorities beyond Pollution 2020 (SC/68a)	Holm (Convenor), (patricia.holm@unibas.ch), Greg Donovan, (greg.donovan@iwc.int), Sarah Ferriss, (sarah.ferriss@iwc.int), Ailsa Hall (ajh7@st-andrews.ac.uk), Teri Rowles (teri.rowles@noaa.gov), Lori Schwacke (lori.schwacke@nmmf.org), Sarah Smith (Sarah.smith@iwc.int), Mark Simmonds, (mark.simmonds@sciencegyre.co.uk) Raphaela Stimmelmayr (Raphaela.Stimmelmayr@north-slope.org or rafstimmel@gmail.com) *pollution2020@dist.iwc.int*

SC Agenda Item/ Sub-Committee	Type	Group (short name)	Terms of Reference	Members
Item 15.3 E		Diseases of concern	Planning focussed session for 2019 (SC/68a)	Stimmelmayr (Convenor), (Raphaela.Stimmelmayr@north-slope.org or rafstimmel@gmail.com), Ailsa Hall, (ajh7@st-andrews.ac.uk), Sarah Ferriss, (sarah.ferriss@iwc.int), Frances Gulland, (Gullandf@TMMC.org), David Mattila, (david.mattila@iwc.int), Teri Rowles, (teri.rowles@noaa.gov), Kathrine Ryeng, (kathrine.ryeng@imr.no), Sarah Smith (sarah.smith@iwc.int), Robert Suydam, (Robert.Suydam@north-slope.org) *codc@dist.iwc.int*
Item 15.5 E		Noise	Planning pre-meeting for 2020 (SC/68b)	Cholewiak (Convenor), Salvatore Cerchio (scerchio@gmail.com), Dan Hubbell (dhubbell@eia-global.org), Dave Lundquist (dlundquist@doc.govt.nz), Ana Sirovic (asirovic@ucsd.edu), Leigh Torres (leigh.torres@oregonstate.edu),Rob Williams (rmcw@st-andrews.ac.uk), Mark Simmonds (mark.simmonds@sciencegyre.co.uk) *noise@dist.iwc.int*
Item 15.7.2 E		Climate change	Developing appropriate intersessional activities and suggestions for future engagement including potentially a workshop or pre-meeting (SC/68a)	Simmonds (Convenor), (mark.simmonds@sciencegyre.co.uk), Bjørge Arne, (arne.bjoerge@imr.no), Greg Donovan, (greg.donovan@iwc.int), Caterina Fortuna, (caterina.fortuna@iwc.int), Silvia Frey, (sfrey@oceancare.org), Ailsa Hall, (ajh7@st-andrews.ac.uk), Toshihide Kitakado, (kitakado@kaiyodai.ac.jp), Russell Leaper, (russell@ivyt.demon.co.uk), Chris Parsons, (ecm-parsons@earthlink.net), Robert Suydam, (Robert.Suydam@north-slope.org), Rob Williams, (rmcw@st-andrews.ac.uk), Sarah Ferriss, (sarah.ferriss@iwc.int), Sarah Smith, (sarah.smith@iwc.int) *climatechange@dist.iwc.int*

Work plan

Table 3

Work plan for Environmental Concerns.

Topic	Intersessional 2018/19	2019 Annual Meeting (SC/68a)	Intersessional 2019/20	2020 Annual meeting
Marine debris	Plan workshop (Organiser: Simmonds)	Report on Workshop Plan	Hold workshop (Organiser: Simmonds)	Workshop report
Strandings Initiative	Respond to emergency requests, carry out training, standardization of protocols	Report on activities and progress	Respond to emergency requests, carry out training, standardization of protocols	Report on activities and progress
Pollution 2020	Complete model update, contaminant map, estimation of PCB degradation rates, report on PCB mitigation measures	Report on completion of Pollution 2020 and PCB mitigation measures		
Diseases of Concern	Identify and invite IPs for morbillivirus and Brucella focus session	Hold focus session and report recommendations to sub-committee		
SOCER	Atlantic Ocean focus	SOCER report	Pacific Ocean focus	SOCER report
Noise	Identify the priority topics, Steering Committee, and IPs for workshop in 2020; identify topics for noise update in 2019	Report on Workshop Plan and noise updates	Plan workshop, compile relevant documents, conduct workshop (Organiser: Cholewiak)	Workshop report

9. ADOPTION OF REPORT

The report was adopted at 14:02hrs on 1 May 2018.

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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 Review on intersessional progress on the Pollution 2020 initiative
    - 2.2 Report on mercury in cetaceans
    - 2.3 Impact of heavy fuel oils on cetaceans
    - 2.4 Other pollution issues
3. Cumulative effects
4. Strandings and mortality events
    - 4.1 Update on the IWC strandings initiative
    - 4.2 New information on unusual mortality events
5. Noise
6. State of the Cetacean Environment Report - SOCER
7. Update on other standing topics and previous recommendations
    - 7.1 Marine debris
    - 7.2 Climate change
    - 7.3 Cetacean diseases of concern
    - 7.4 Progress on previous recommendations
        - 7.4.1. Pollution
        - 7.4.2. Cumulative effects
        - 7.4.3. Disease of concern
        - 7.4.4. Strandings
        - 7.4.5. Noise
8. Work plan and budget requests for 2019-20
    - 8.1 Work plan for 2019-20
    - 8.2 Budget requests for 2019-20

Appendix 2

SHORT REVIEW ON STRANDINGS INITIATIVE INTERSESSIONAL PROGRESS AND PLANS FOR 2019

As established during the 66th IWC Scientific Committee, the Commission endorsed the recommendations of the Whale Killing Methods and Welfare Issues Working Group (WKM&WI WG) and the Scientific Committee on Strandings, including the establishment of an Stranding Expert Strandings Panel (SEP) and Coordinator post. An Intersessional Steering Group (ISG) on Strandings was tasked during SC/66b with selecting the SEP, overseeing its first meeting (including the development of the budget), and working with the Secretariat as appropriate.

Nominations were solicited, taking into consideration the Terms of Reference recommended during SC/66b that the SEP should include representation and areas of expertise from: (1) regional experts in stranding response; (2) diverse agencies and organisations; and (3) multi-disciplinary expertise. Selection of Expert Panelists was achieved through an online voting process. While under-representation was overcome during the SC/67a for Asia, this was not done for African nations (except South Africa). The ISG proposed a draft governance structure for the IWC Initiative on Strandings which included a Stranding Coordinator position description (SC/67a/E06). At SC/67a, the Standing Working Group (SWG) on Environmental Concerns presented a list of recommendations included in Annex K of the Scientific Committee report. Presented here, are progress updates on these points.

An ISG comprising of members of Scientific Committee, Conservation Committee, and Whale Killing Methods and Welfare Issues Working Group was established with Dr. Claire Simeone and Dr. Sandro Mazzariol as co-convenors. The Chair of the Conservation Committee and the Chair of the Whale Killing Methods and Welfare Issues Working Group were invited to join the ISG. Furthermore, the ISG finalised the including two representatives for Asia from the list of nominees, although unfortunately as yet, no representation for Africa outside South Africa. In time for the next meeting, the ISG will be substituted by a Steering Committee. This committee would guide and assist the work of the SEP and coordinate work on strandings amongst the SEP, Scientific Committee, Whale Killing Methods and Welfare Issues Working Group and Commission. This work will include the: (a) development of an initial budget and review of subsequent budgets proposed by the SEP for recommendation to the Commission; (b) appointment of Panel Members (with advice from the Chair and Co-ordinator) to ensure appropriate turnover of membership and continuity; and (c) provision of conduit for communication amongst the SEP, Scientific Committee, Whale Killing Methods and Welfare Issues Working Group and Commission.

Membership of the Steering Committee will include representatives nominated by the Scientific Committee and the Whale Killing Methods and Welfare Issues Working Group. The Scientific Committee chair (or his/her appointee) and the Whale Killing Methods and Welfare Issues Working Group Chair (or his/her appointee) and the Chair of the Conservation Committee (or his/her appointee) will be permanent members. The Secretariat, Stranding Coordinator and Chair of the SEP will be *ex officio* members. The Steering Committee will be asked to select a Chair. The final SEP composed experts with different skills and expertise related to strandings and includes Claire Simeone (USA), Sandro Mazzariol (Italy), Milton Marcondes (Brazil), Ursula Siebert (Germany), Rob Deaville (UK), Lindsay Porter (Malaysia/China), Nantarika Chansue (Thailand), Aviad Sheinin (Israel), Daren Grover (New Zealand), Katie Moore (USA), Frances Gulland (USA), Raphaela Stimmelmayr (USA), Doug Coughran (Australia), Gabriela Hernandez (Costa Rica), Marcy Uhart (Argentina), Michael Meyer (South Africa).

The selection was made by the Steering Committee on the basis of the following criteria, revisited and confirmed also by the SEP: (a) regional experts in stranding response; (b) experts from diverse agencies and organisations (e.g. governmental, NGO, academia); multi-disciplinary experts; and (d) Stranding Coordinator. Panel membership terms have been proposed to be flexible, with an annual review of membership. This shall be decided by the Chair and the Steering Committee based upon availability of members, expertise, performance and if necessary, lottery. Unfortunately, in March 2018 one of the panelist from Oceania, Doug Coughran, passed away. Discussion about an additional representation for Oceania (specifically Australia) has been raised by Daren Grover (New Zealand). The SEP met virtually in July 2017, electing a Chair (Dr. Sandro Mazzariol - Italy), who will serve for the next 3 years, revising the ToR and agreeing on the establishment of two sub-committees on training and emergency response in order to best facilitate the necessary work. Here below we report the revised terms of Reference and *modus operandi* for the SEP:

(1) Identify and, as appropriate, develop: (a) advice documents for Principles and Guidelines on stranding response, including how to respond effectively; (b) advice documents for Principles and Guidelines on sampling, including how to conduct scientific investigations to meet the needs of the Committee; and (c) advice on how to communicate stranding science and management decisions.
(2) Assist member states and regional or national networks to build strandings response capacity, in general and specifically, through: (d) the development of curricula for training (live and dead strandings response and scientific investigation) and a plan for the delivery of training events; (e) a strategy for handling requests received by the Secretariat, including assistance in coordination of emergency response; (f) a strategy for the development of information through a variety of avenues including consideration of a centralised data repository and the reporting of unusual cetacean events; (g) opportunities for communication and collaboration.
(3) Provide an annual report on activities to the Steering Committee on Strandings, Scientific Committee, Whale Killing Methods and Welfare Issues Working Group and the Commission. This will include: (a) incidents of unusual

cetacean events and responses to these; and (b) an estimated budget for each biennium for review by the Steering Committee before submission to the Commission. These Terms of Reference may be reviewed by the SEP and suggestions for modifications submitted to the Scientific Committee and the Steering Committee.

The ISG and the EP finalised a job description and person specification to recruit the Strandings Coordinator to the IWC secretariat. The recruitment was finalised in February 2018, with the appointment of Karen Stockin (New Zealand) for a one year 0.5 FTE position. The Coordinator is a member of and provide support to the SEP. This support will include: contacting the ESP for guidance on strandings events for which advice has been requested; the development of quarterly reports of activities for the SEP members; and development of an annual report for submission to the Steering Group on Strandings, Scientific Committee, Working Group on Whale Killing Methods and Welfare Issues and Commission. These reports shall also be made available on the IWC website. The Coordinator shall be also responsible for arranging all support services to the SEP, and for contacting the SP for guidance concerning any event which might be occurring. The Coordinator shall provide quarterly reports of activities to the SEP members, and an annual report to both the Scientific Committee and Commission. The Chair and the Coordinator shall organise at least one SEP meeting every biennium, possibly in- person or in a mixed form. When possible, in-person meetings will be planned in conjunction with other workshops or conferences. Virtual meetings will be also organised every other year. The SEP may establish Committees of members, or their representatives, on an *ad hoc* or standing basis as it deems necessary. Such Committees shall report to the SEP. The Coordinator shall support any such committee. In this regards, in July 2017, the SEP decided to establish 2 different sub-committees related to training and emergency response. These working groups discussed protocols and best-practice and a prioritisation system in order to efficiently use limited funding. Concerning this relevant issue, both subcommittees agreed upon a semi-flexible system to guide discussion. Both subcommittees prioritise IWC SEP support to the locations (Africa, Middle East and Asia, Central and South America) without an already established stranding network with existing expertise and facilities involved. Specific criteria are here below reported: (a) for onsite training, regions where emergencies has been already occurred are welcome, in particular those involving threatened species. Here, the involvement of Governmental bodies and presence of co-funding are both encouraged and appreciated. (b) for onsite emergency response and intervention, the (sub)committee would like to prioritise those events representing most concern to species conservation and/or compromised animal welfare (i.e. threatened species, diseases of concern, mass strandings, unusual stranding events and oil spills; live stranding for which significant welfare concerns exist). The degree of financial support will be evaluated against these criteria. Since July 2017, the SEP received requests of support for training and emergency response support, with each application evaluated on a case by case scenario, with the IWC Secretariat. Specifically, the SEP was invited to support a joint training activity organised in autumn 2018 in Chile and Peru. A successful project proposal was submitted to the Welfare Intersessional Steering Group for financial support from welfare voluntary funds (£10,000). Funding has also been provided by the host governments and further funding requests was additionally submitted to the Conservation Management Plan (CMP) fund.

Regarding emergencies, the SEP was contacted for technical advice on emergencies involving large cetacea (Russia) or mass stranded animals (Yemen - Socotra). In addition, for this activity the SEP has recently supported a request for funding from Argentina (£5,000) to support postmortem analyses relating to the recent mass stranding of common dolphins that occurred March/April 2018. Future efforts are required to finalise the selection processes necessary to efficiently respond to training and emergency response requests, as well as identify how best to optimise available funds. As emergencies and training activities are expensive, a specific fundraising stategy should be prioritised and implemented in order to respond most effectively to unusual mortality events. The SEP should also work to increase its visibility and profile since many stranding events were not directly reported. Finally, the Strandings Coordinator in conjunction with the SEP and the ISG, should work to collaborate with CITES regarding procedures for transboundary transport of diagnostic specimens for cetacean disease investigations in emergency situations.

Report of the First IWC Expert Panel on Strandings Virtual Meeting, 5 July 2017 13:00-16:00 GMT

Members present: Simeone (co-Convenor), Mazzariol (co-Convenor), Chansue, Coughran, Deaville, Grover, Gulland, Hernandez, Marcondes, Moore, Porter, Scheinin, Siebert, Stimmelmayr, Uhart. *Ex officio* members present: Fortuna, Greig, Matilla, Rendell, Rowles, Smith.

Not in attendance: Meyer, Hall, Donovan

I. Welcome, introductions Mazzariol and Simeone welcomed the Expert Panelists to the meeting.

A. Appointment of Co-Chairs and Rapporteurs: Mazzariol and Simeone were appointed Co- Chairs of the meeting. Greig was appointed Rapporteur.

B. Review and adopt agenda: the agenda was adopted without changes.

II. Background

Simeone reviewed the historical context of the Strandings Initiative, including Annex K of SC/67a. As the Commission will not meet until 2018 to approve the Strandings Initiative structure, an interim structure has been implemented by the Intersessional Steering Group (ISG). The Expert Panel (EP) noted that if the goal is to develop worldwide protocols for live and dead stranding response, regional concerns and standards would need to be recognised and incorporated (e.g.

European rules on welfare and hygiene). The EP stressed that best practices should be recommendations and guidance advice from the specialised group rather than governance documents.

III. Governance structure

Simeone reviewed the draft governance structure (Appendix A). Based on previous discussions, the EP recommended changing the word 'protocols' to 'advice documents' for best practices on stranding response. The current Terms of Reference (TOR) includes only 'live strandings response' (Section 2.d) and the EP suggested that a provision also be made for dead strandings in the TOR. It was noted that 'establishing stranding networks' worldwide is beyond the scope and capacity of the IWC, but that developing best practices for countries to reference and utilise is an attainable goal. The EP also recommended replacing 'Unusual Mortality Events' with 'Unusual Cetacean Events' for clarity, and renaming 'Best Practices' to 'Principles and Guidelines' to allow for flexibility across regions. The EP tasked the Committee with developing a flow chart to describe specific tasks that will to guide the work of the initiative, taking care not to be too restrictive. The EP noted the importance of standardised reporting, and collation of cases into a database to promote information sharing and learning. The EP will collaborate with the IWC Working Group on Global Databases and Repositories on this work. The EP recommended that notes on the TOR will be circulated among the EP, and a final vote will take place anonymously online to finalise the TOR. The vote was conducted by 24 July 2017.

III.a Discussion on term lengths and rotation of panelists

As currently proposed, Panelists would serve 2-4 year terms. The EP noted that in certain regions there may be challenges in securing regional representation, and that memberships should not be restricted to two years. Several members felt that two years was too short of a term, particularly as the initiative is beginning. It was noted that for the SC, only the Chair and Vice-Chair have fixed terms. Several options were recommended, including: Chair: (a) Fixed term limit, 2 years; (b) Fixed term limit, 3 years; (c) Fixed term limit, 4 years Members: (a) Fixed term limit, 4 years; (b) Minimum term limit, 2 years, with no upper term limit; (c) Review of membership every 2 years, with flexible terms at the Chair's discretion; (d) No set terms, with annual review. The EP recommended voting on these options to finalise Chair and Member terms. Voting took place by 25 July 2017.

III.b. Discussion on frequency of meetings

Simeone reviewed the current recommendations of the ISG that include meeting every biennium. During SC/67a, the ISG determined that the funds currently allocated towards an in-person meeting may be better utilised for an emergency response fund. Several panelists noted the importance of face-to-face discussion and proposed alternating between virtual and in-person meetings. The EP noted that global/regional conferences or workshops for other societies/groups may provide opportunities to have ad hoc in-person meetings. Several options were suggested, including:

(a) One in-person meeting every biennium (every 2 years);

(b) One in-person meeting every biennium, with virtual meetings every other year;

(c) One initial in-person meeting to start, followed by virtual meetings; and

(d) In-person meetings for smaller Committees, virtual meetings for larger EP group.

The EP recommended voting on these options to finalise meeting frequency. The EP also suggested surveying EP members attending the upcoming Society for Marine Mammalogy biennial conference in October as a potential meeting time. Voting was conducted by 25 July 2017.

III.c. Solicit nominations for Expert Panel Chair

The EP recommended requesting anonymous nominations and voting for the EP Chair. Voting was conducted by 25 July 2017.

IV. Strandings Initiative Work – Emergency Response

Simeone reviewed the proposed funding for emergency response. The EP determined that many aspects of emergency response are in need of definition and clarification, including:

(a) definition of 'emergency';
(b) development of criteria for evaluating requests;
(c) development of a flow chart/decision tree for coordination of requests and emergency response: (i) flow chart for evaluating the event; and (ii) flow chart for determining the level of response needed;
(d) requirements for requests for assistance – governments vs. NGOs;
(e) criteria for support – response *vs* investigation;
(f) criteria and protocols for virtual advice requests to the EP;
(g) reporting/database recommendations to centralise reporting of stranding events, and list of species-specific expertise (regional); and
(h) finalisation of budget for an emergency response.

The EP recommended that a Committee on Emergency Response be formed to work on these topics. Committee on Emergency Response: Chansue, Coughran, Grover, Hernandez, Marcondes, Matilla, Meyer, Moore, Porter, Scheinin, Siebert. Coordinated by Mazzariol/Simeone.

V. Strandings Initiative work – in-country trainings

Simeone reviewed the proposed funding for in-country trainings. Moore summarised the Global Marine Animal Stranding Training toolkit (GMAST), a project that has developed basic-level training materials for global stranding response (*http://gsinteractive.net/GMAST/*). The SC has previously recommended collaboration with this project for the development of more advanced training materials. The GMAST training materials have been used in Belize, Russia, and will be used at an upcoming training in Oman. It was noted that a variety of materials exist, and that the EP should decide which avenues are most appropriate to pursue. The EP determined that many aspects of trainings are in need of definition and clarification, including:

(a) development of criteria for evaluating requests for training;
(b) identification of existing training materials;
(c) development of structure for regional training (i.e. curricula, follow-up, contact lists); and
(d) evaluation of potential requests (Chile/Peru).

The EP recommended that a Committee on Trainings be formed to work on these topics. Committee on Trainings: Deaville, Grover, Gulland, Hernandez, Matilla, Moore, Scheinin, Siebert, Stimmelmayr, Uhart. Coordinated by Mazzariol/Simeone.

VI. Budget

Smith reviewed the current allocation of funds for the strandings initiative. The initiative fund totals £25,000, with a potential for allocating additional existing funds from the Whale Killing Methods and Welfare Initiative (WKM&WI). Determining the level of funding requested as early as possible will be helpful for this process. The EP recognised that a finalised 2-years budget is a priority, which will be submitted to the ISG for review. In addition, the ISG could request science funds through the Environmental Concerns Sub-Committee. Longer term, the ISG should consider external fundraising sources, including governments, non-governmental organisations, trusts, and grant-giving bodies. The IWC finance and administration committee is investigating the financing of conservation initiatives in general and the Secretariat can help identify additional funding sources. The entanglement initiative has had success with a variety of small funding sources. The EP recommended that both the Training and Emergency Response Committees prioritise actions and timelines in order to facilitate the fundraising process, and work to develop a realistic budget for their work as soon as possible. The ultimate development and approval of the budget for the Strandings Initiative lies with the ISG, and the Committees will submit their budgets to the ISG.

VII. Next steps

The EP recommended the following steps for continued work.

(a) Reporting: notes from this meeting will be circulated for review by the EP, and a final report will be submitted to the ISG.
(b) Voting: a virtual platform will be used to allow EP members an anonymous vote on issues raised. A simple majority will be used to resolve issues, unless otherwise specified by the EP.
(c) Budget: the EP recommended that a 2-year budget be submitted to the ISG for review as soon as possible, within 1-2 months. The ISG will submit a final budget to the Secretariat.
(d) Next Meeting: The SMM biennial meeting will be investigated as a potential for an in-person meeting of the EP. Committees will begin their work virtually as soon as possible.
(e) Strandings Coordinator position posting: Mazzariol discussed that this item would be discussed off-line, and a Committee formed to finalise the posting and submit to the ISG and Secretariat.

Adjunct A

Draft Governance Structure of the Strandings Initiative. IWC Initiative on Strandings

DRAFT Governance Structure
Updated 25 July 2017

1. INTRODUCTION
At IWC/66 in October 2016 the Commission considered and endorsed recommendations on strandings developed at Scientific Committee annual meetings (SC/66a and SC/66b) and from the Whale Killing Methods and Welfare Issues Working Group. These had taken into account recommendations from two recent IWC workshops on strandings response: (1) The *Investigations of Large Mortality Events, Mass Strandings and International Stranding Response Workshop*, San Francisco, December 2015, focused on response and investigations of cetacean strandings, with a focus on unusual or

large scale mortality events; and (2) The *Workshop to Develop Practical Guidance for the Handling of Cetacean Stranding Events*, Kruger National Park, May 2016, focused on building global capacity for effective cetacean stranding response, in particular highlighting relevant actions in the Commission's Welfare Action plan. In particular, the Commission endorsed a recommendation to establish a Strandings Coordinator post, and an Expert Panel on strandings to provide guidance on strandings response and investigations. This document provides proposals on Governance of the Strandings Initiative, including proposed Terms of Reference for the Expert Panel and Steering Group arrangements. These take into account the interest of several Commission subcommittees in this topic, including both the Scientific Committee and the Whale Killing Methods and Welfare Issues Working Group.

2. Terms of Reference and *modus operandi* for the Expert Panel on Strandings

The Expert Panel will (IWC, 2017, p.304) undertake the key activities given below.

(1) Identify and, as appropriate, develop:
   (a) advice documents for Principles and Guidelines on stranding response, including how to respond effectively;
   (b) advice documents for Principles and Guidelines on sampling, including how to conduct scientific investigations to meet the needs of the Committee; and
   (c) advice on how to communicate stranding science and management decisions.

(2) Assist member states (and regional or national networks) to build strandings response capacity, in general and specifically, through:
   (a) the development of curricula for training (live and dead strandings response and scientific investigation) and a plan for the delivery of training events;
   (b) a strategy for handling requests received by the Secretariat, including assistance in coordination of emergency response[1];
   (c) a strategy for the development of information through a variety of avenues including consideration of a centralised data repository and the reporting of unusual cetacean events; and
   (d) Opportunities for communication and collaboration.

(3) Provide an annual report on activities to the Steering Committee on Strandings, Scientific Committee.

Whale Killing Methods and Welfare Issues Working Group and the Commission. This will include: (a) incidents of unusual cetacean events and responses to these; and (b) an estimated budget for each biennium for review by the Steering Committee before submission to the Commission.

These Terms of Reference may be reviewed by the Expert Panel and suggestions for modifications submitted to the Scientific Committee and the Steering Committee.

2.1 Membership

The Expert Panel should include the following representation and areas of expertise:

(a) regional experts in stranding response, including those leading the work on the Global Marine Animal Stranding Toolkit (GMAST);
(b) experts from diverse agencies and organisations (e.g. governmental, NGO, academia);
(c) multi-disciplinary experts (e.g. logistics, biology, medicine, pathology, epidemiology, toxicology, database management, stranding management); and
(d) International Stranding Response Coordinator.

The Expert Panel shall select a Chair to serve a three-year term of office.

The Co-ordinator shall be a member of and provide support to the Expert Panel. This support will include: contacting the Expert Panel for guidance on strandings events for which advice has been requested; the development of quarterly reports of activities for the Expert Panel members; and development of an annual report for submission to the Steering Group on Strandings, Scientific Committee, Working Group on Whale Killing Methods and Welfare Issues and Commission. These reports shall also be made available on the IWC website. The initial membership of the Panel will be decided by the Steering Committee. Panel membership terms will be flexible, with an annual review of membership. This shall be decided by the Chair and the Steering Committee based upon availability of members, expertise, performance and if necessary, lottery.

Should a vacancy arise mid-term, the Chair will recommend a replacement to the Steering Committee who shall decide. If the Chair feels that a member of the Panel is not contributing to the work as expected over a two-year period, he/she may recommend to the Steering Committee that the person is removed from the Panel. The Steering Committee shall decide.

2.2 Modus operandi

The Chair in co-operation with the Co-ordinator shall organise at least one Expert Panel meeting every biennium, with virtual meetings every other year. When possible, in-person meetings will be planned in conjunction with other workshops or conferences. The report of the meeting shall be prepared by the Coordinator and the agreed report will be distributed

[1]Support services for the activities of the Expert Panel are outlined in a separate budget document

to the Expert Panel, Steering Committee, Scientific Committee and Commission, as well as placed on the IWC website. The website will also host all associated papers and reports.

Work in between meetings will be undertaken electronically. The Co-ordinator shall be responsible for arranging all support services to the Expert Panel, and for contacting the Expert Panel for guidance concerning any event which might be occurring. The Coordinator shall provide quarterly reports of activities to the Expert Panel members, and an annual report to both the Scientific Committee and Commission.

The Expert Panel may establish Committees of Expert Panel members, or their representatives, on an *ad hoc* or standing basis as it deems necessary. Such Committees shall report to the Expert Panel. The Coordinator shall support any such committee.

Appendix 3

STATE OF THE CETACEAN ENVIRONMENT REPORT (SOCER) 2018

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

INTRODUCTION

Several resolutions of the International Whaling Commission, including Resolutions 1997-7 and 1998-5, directed the Scientific Committee to provide regular updates on environmental matters that affect cetaceans. Resolution 2000-7 welcomed the concept of the State of the Cetacean Environment Report (SOCER) and requested the annual submission of this report to the Commission. The first full SOCER (Stachowitsch *et al.* 2003) was presented in 2003 and subsequent editions initiated and continued a cycle of focusing on the following regions: Atlantic Ocean, Pacific Ocean, Arctic and Antarctic Oceans, Indian Ocean and Mediterranean and Black Seas. Each SOCER also includes a Global section addressing the newest information that applies generally to the cetacean environment. The 2018 SOCER features the **Mediterranean and Black Seas,** summarising key papers and articles published from ca. 2016 through 2018 to date. This year's regional SOCER represents the final year of the most recent cycle, which will be combined in a 5-year compendium (2014: Atlantic Ocean through 2018: Mediterranean and Black Seas) to present to the Commissioners at IWC/67 in Florianopolis, Brazil.

MEDITERRANEAN and BLACK SEAS

General

THE EUROPEAN MARINE STRATEGY FRAMEWORK DIRECTIVE AND CETACEAN CONSERVATION

The European Marine Strategy Framework Directive seeks to implement a precautionary and holistic ecosystem-based approach for managing European marine waters. A questionnaire survey was distributed to nations bordering the Mediterranean and Black Seas to investigate implementation of the Framework, specifically with respect to cetaceans. Those reporting (50% return rate) noted that their national implementation of the Framework did refer to cetaceans, but the specifics of these various implementations were heterogeneous. This unevenness in implementation may hinder transboundary collaboration and, therefore, cetacean conservation. ACCOBAMS could help stimulate collaboration amongst scientists involved in cetacean monitoring and develop transboundary conservation initiatives. The authors note that 'Transboundary conservation is most cost-efficient when there is true coordination between countries', which is currently lacking. The authors also suggest that 'Marine mammal experts should promote to their respective governments the monitoring of cetaceans at regional, rather than national scales'.

(SOURCE: Authier, M., Descroix Commanducci, M.F., Genov, T., Holcer, D., Ridoux, V., Salivas, M., Santos, M.B., and Spitz, J. 2017. Cetacean conservation in the Mediterranean and Black Seas: Fostering transboundary collaboration through the European Marine Strategy Framework Directive. *Mar. Pol.* 82: 98-103)

NEW CONSERVATION ACTION PLAN FOR CETACEANS IN ISRAELI WATERS

Israel has 180 km of coast on the Mediterranean Sea and has legal influence over 26,000 km^2 of ocean surface area, with 12 species of cetaceans recorded from this area. An Action Plan for 2017-2022 seeks to 'ensure that marine mammal populations in the waters of Israel enjoy a 'favourable conservation status'… arising from a combination of legislative, management, research, education and awareness initiatives'. The plan notes bycatch, underwater noise and prey depletion as the highest priority threats to Israeli cetaceans. Chemical pollution, climate change and habitat degradation are possible major threats, and marine debris, directed takes, ship strikes, oil pollution and disturbance are possible minor threats. The plan outlines numerous legislative, institutional and research initiatives, as well as proposals for local capacity building, cetacean conservation and public outreach.

(SOURCE: Bearzi G. 2017. *Action Plan for Marine Mammals in Israel*, 2017-2022. Israel Marine Mammal Research & Assistance Center (IMMRAC), Michmoret, Israel)

THE RECENT DECLINE OF THE BLACK SEA HARBOUR PORPOISE – A HISTORICAL CONTEXT

An analysis of archaeological specimens of cetaceans from the Black Sea (from 800 to 1600 years ago) suggests that cetaceans were subjected to fisheries bycatch, as well as directed hunting, in the past. Therefore, there has been a long history of anthropogenic takes of cetaceans in the Black Sea, from the late Classical through the medieval era. Genetic analyses of harbour porpoise specimens suggest that, despite these removals, there was an expansion of porpoise numbers in the Black Sea, followed by a dramatic decline over the past century. This decline illustrates that recent anthropogenic removals of porpoises greatly exceed the historical impact of fisheries bycatch and directed takes.

(SOURCE: Biard, V., Gol'din, P., Gladilina, E., Vishnyakova, K., McGrath, K., Vieira, F.G., Wales N., Fontaine, M. C., Speller, C., and Olsen, M.T. 2017. Genomic and proteomic identification of Late Holocene remains: Setting baselines for Black Sea odontocetes. *J. Archaeol. Sci.: Rep.* 15: 262-271)

A DISTINCT HARBOUR PORPOISE POPULATION IN THE AZOV SEA

The Azov Sea is a small enclosed body of water (37,000 km^2) that connects to the Black Sea via the narrow Kerch Strait. The sea is seasonally occupied by harbour porpoises. Analyses of porpoise skulls showed that the Azov and Black Sea porpoises are distinct from North Atlantic skulls, i.e., supporting their status as part of the subspecies *Phocoena phocoena relicta*. However, the skulls of Azov Sea porpoises were distinct from Black Sea porpoises, suggesting that the Azov Sea porpoise is a genetically distinct population, which would warrant special conservation consideration.

(SOURCES: Gol'din, P. and Vishnyakova, K. 2016. Habitat shapes skull profile of small cetaceans: Evidence from geographical variation in Black Sea harbour porpoises (*Phocoena phocoena relicta*). *Zoomorphology* 135(3): 387-393; Gol'din, P.E. and Vishnyakova, K.A. 2015. Differences in skull size

of harbour porpoises, *Phocoena phocoena* (Cetacea), in the Sea of Azov and the Black Sea: Evidence for different morphotypes and populations. *Vestn. Zool.* 49(2): 171-180)

FIRST GLOBAL INTEGRATED MARINE ASSESSMENT: MEDITERRANEAN SEA

A major UN overview of the world's oceans noted that the Mediterranean Sea is a marine biodiversity hotspot (ca. 17,000 species). This includes nine species of marine mammals (five of the family Delphinidae and one each of Ziphiidae, Physeteridae, Balaenopteridae and Phocidae). Its habitats and ecosystem types are also diverse. At present, habitat loss and degradation, followed by fishing, climate change, pollution, eutrophication and the establishment of invasive species are the major threats to most of the taxonomic groups and habitats. These threats are all expected to increase in the future, especially climate change and habitat degradation.

(SOURCE: Inniss, L. and Simcock, A. (Joint coordinators); Rice, J. (Lead member of 14 contributors). 2016. The first global integrated marine assessment: World ocean assessment I. *United Nations, Chapter 36A:* p. 18-20, http://www.un.org/Depts/los/global_reporting/WOA_RPROC/Chapter_36A.pdf)

SURVEY GAPS FOR CETACEANS IN THE EASTERN AND SOUTHERN MEDITERRANEAN

An analysis of cetacean surveys found there were serious gaps in survey coverage in the eastern and southern Mediterranean Sea. This means that there is a gap in our understanding of cetacean distribution, abundance and environmental factors in these regions of the Mediterranean.

(SOURCE: Mannocci, L., Roberts, J.J., Halpin, P.N., Authier, M., Boisseau, O., Bradai, M.N., Cañadas, A., Chicote, C., David, L., Di-Méglio, N., Fortuna, C.M., Frantzis, A., Gazo, M., Genov, T., Hammond, P.S., Holcer, D., Kaschner, K., Kerem, D., Lauriano, G., Lewis, T., Notarbartolo di Sciara, G., Panigada, S., Raga, J.A., Scheinin, A., Ridoux, V., Vella, A., and Vella, J. 2018. Assessing cetacean surveys throughout the Mediterranean Sea: A gap analysis in environmental space. *Sci. Rep.-UK* 8: 3126, 1-14, doi:10.1038/s41598-018-19842-9)

MARINE ISSUES IN THE MEDITERRANEAN SEA

This book on Mediterranean marine mammals is a valuable contribution to conservation efforts, presenting the latest information on cetaceans and their habits, as well as attempting to bridge the gap between scientific insights and policy. The Mediterranean Sea is a hotspot of marine and coastal diversity. Although no cetacean species is endemic here, unique populations have formed, requiring special conservation consideration. Of the 12 common marine mammal species, six are considered Mediterranean 'subpopulations' and are listed as Threatened on the IUCN's Red List. Many decision-makers are apparently unaware of 'how serious the predicament is for these species and their fragile habitat'. The first chapter outlines the Mediterranean regions and the overall status and threats of their marine mammals. The remaining chapters are devoted to key species such as sperm, fin and Cuvier's beaked whale, killer whales, long-finned pilot whales, and Risso's, rough-toothed and bottlenose dolphins, as well as to selected regions. The overall threats are identified as naval sonar, seismic exploration, whale watching disturbance, ship strikes, epizootics, fisheries, pollution, coastal development and climate change. The final chapter discusses international legal conservation frameworks, regional agreements (e.g., ACCOBAMS) and specific treaties (e.g., Pelagos Sanctuary). The authors conclude by underlining that 'what is probably lacking are specific provisions having a legally binding nature that directly address a number of threats affecting Mediterranean marine mammals, such as underwater noise, collisions with ships, bycatch in fishing gear and ingestion of plastic litter'.

(SOURCE: Notarbartolo di Sciara, G., Podestà, M., and Curry, B.E. (eds). 2016. *Advances in Marine Biology Vol. 75: Mediterranean Marine Mammal Ecology and Conservation.* Elsevier, London. 428 pp.)

OCEAN HEALTH INDEX AND THE MEDITERRANEAN SEA

The Ocean Health Index, compiled by the University of California at Santa Barbara, has released its third annual update. It is based on 10 ecological, economical and societal categories or 'goals', each of which is measured and scored based on four dimensions (status, trend, pressures and resilience). By country, the values diverge considerably around the Mediterranean, from a low ranking for Libya (ranking 220 out of 220, index score 44 out of 100) to a high for Malta (rank 19, score 79). For comparison, the overall health of the oceans globally is 70 out of 100 points. Six of the nine Mediterranean countries evaluated lie below this global average (although some only marginally so).

(SOURCE: http://www.oceanhealthindex.org)

MARINE PROTECTED AREAS IN THE MEDITERRANEAN SEA

CBD Aichi Target 11 seeks to protect at least 10% of important marine and coastal habitats, with MPAs being the main global strategy for the conservation of marine biodiversity. The Mediterranean Sea contains variously designated protected areas: Natura 2000 sites, national sites, Ramsar sites, Specially Protected Areas of Mediterranean Importance, the Pelagos Sanctuary and Biosphere Reserves. Mediterranean MPAs are very unevenly distributed, with 80% concentrated in just three countries in the northwest part of the basin. This geographic distribution can be improved, although size, spacing and shape of existing MPAs are favourable: one third, for example, are bigger than the average ecological threshold of 20 km^2. However, these reasonably good MPA designs are apparently 'accidental', i.e., the result of largely independent national and regional nature conservation processes. Efforts to consolidate an ecologically coherent network of Mediterranean MPAs are clearly required.

(SOURCE: Rodríguez-Rodríguez, D., Rodríguez, J., Blanco, J.M., and Malak, D.A. 2016. Marine protected area design patterns in the Mediterranean Sea: Implications for conservation. *Mar. Pollut. Bull.* 110:335-342, https://doi.org/10.1016/j.marpolbul.2016.06.044)

Habitat degradation

General

CETACEAN ABUNDANCE AND ECOSYSTEM TRENDS IN THE NORTHWEST MEDITERRANEAN

Trends in cetacean abundance were investigated via sighting data from ship-board surveys (1990-2014) covering an area of approximately 29,000 km^2 in the northwest Mediterranean, and via strandings data collected from the Ligurian coast

(1986-2014). The analysis revealed a significant annual increasing trend in sightings of striped dolphins and sperm whales but a significant decrease in encounters with fin whales and Risso's dolphins. No trends were found for Cuvier's beaked whales. Striped and Risso's dolphin strandings decreased over time, but fin whale strandings increased. The decrease in striped dolphin strandings was influenced by a spike in mortality from a morbillivirus outbreak early in the period. Examining strandings both spatially and temporally, fin whales and striped dolphins appeared to be shifting northwards into more coastal waters, while Risso's dolphins shifted into more oceanic waters. No trends were found for sperm or Cuvier's beaked whales. Risso's dolphin and sperm whale encounter rates appeared to be associated with sea surface temperature and surface water chlorophyll levels. Striped dolphin and fin whale encounter rates were correlated, respectively, to the number of fishing boats (negatively) and number of ferries (positively), the former suggesting a conflict between cetaceans and fishing vessels. Moreover, sperm whale group size was inversely correlated to the number of boats. The relative abundance of striped and Risso's dolphins and sperm and fin whales might be correlated with the concurrent decreasing productivity in the region (as measured by decreasing chlorophyll and fishery productivity).
(SOURCE: Azzellino, A., Airoldi, S., Lanfredi, C., Podestà, M. and Zanardelli, M. 2017. Cetacean response to environmental and anthropogenic drivers of change: Results of a 25-year distribution study in the northwestern Mediterranean Sea. *Deep Sea Res. Pt. II: Topic. Stud. Oceanogr.* 141: 104-117)

NARROW ECOLOGICAL NICHE OF MEDITERRANEAN FIN WHALES MAKES THEM VULNERABLE TO ANTHROPOGENIC CHANGE

An isotopic analysis was conducted to investigate the diet and ecological niche of fin whales in the Mediterranean Sea and North Atlantic. The analysis showed that Mediterranean fin whales, which are known to feed mainly on krill, had a much narrower dietary niche than the Atlantic whales, which have a more diverse diet. The authors suggest that a narrow ecological niche makes Mediterranean fin whales 'more susceptible to ecosystem fragmentation and other anthropogenic impacts'.
(SOURCE: Das, K., Holleville, O., Ryan, C., Berrow, S., Gilles, A., Ody, D. and Michel, L.N. 2017. Isotopic niches of fin whales from the Mediterranean Sea and the Celtic Sea (North Atlantic). *Mar. Environ. Res.* 127: 75-83)

Fisheries interactions

SICILIAN FISHING CAPACITY DECREASE IS CORRELATED WITH DOLPHIN STRANDINGS DECREASE

This analysis compared strandings of bottlenose and striped dolphins in Sicily with values of engine power, based on fishing vessels registered in 48 Sicilian ports, from 1995 through 2012. Fishing capacity decreased during this period, as did strandings; this correlation was statistically significant. Strandings tended to be clustered near ports with high fishing capacity. Bottlenose dolphin strandings were more frequent where bottom otter trawls were more frequently used. Therefore, while fishing capacity can be an indicator of the level of threat to cetaceans, it can also predict decreases in dolphin mortality.
(SOURCE: Crosti, R., Arcangeli, A., Romeo, T. and Andaloro, F. 2017. Assessing the relationship between cetacean strandings (*Tursiops truncatus* and *Stenella coeruleoalba*) and fishery pressure indicators in Sicily (Mediterranean Sea) within the framework of the EU Habitats Directive. *Eur. J. Wildlife Res.* 63: 55-68, https://doi.org/10.1007/s10344-017-1111-8)

SEASONAL CLOSURE OF GILLNET FISHERIES IN THE AZOV SEA MIGHT REDUCE BYCATCH LEVELS

Stranding and bycatch data for harbour porpoises from 1999 to 2013 in the Azov Sea showed a peak in strandings in July and August, a period when females are lactating and very young animals are newly foraging independently. The stranding peak did not coincide with the regional peak of the turbot, shad and sturgeon fisheries, which is in the spring. Bycatch reduction could therefore be achieved by closing coastal gillnet fisheries in the peak stranding period. Because this is not peak fishing season, such time-area closures would minimise the economic impact on local fisheries.
(SOURCE: Vishnyakova, K. and Gol'din, P. 2015. Seasonality of strandings and bycatch of harbour porpoises in the Sea of Azov: The effects of fisheries, weather conditions and life history. *ICES J. Mar. Sci.* 72(3): 981-991)

Marine Debris

COASTAL MACRO-LITTER IN THE TURKISH MEDITERRANEAN SEA

Thirteen beaches along the northeast Mediterranean shores of Turkey yielded an average density of 0.9 litter items/m^2. Eight of these beaches were classified either as 'dirty' or 'extremely dirty'. Litter from convenience food consumption and smoking made up more than half of the litter collected. Agricultural, industrial and fisheries-related items contributed only 6%. Plastic items made up over 89%. Less than 4% had been transported from neighbouring countries. The researchers identified direct deposition as the main source of this litter and underlined poor local awareness and the need for educational programs to help reduce coastal litter.
(SOURCE: Aydin, C., Güven, O., Salihoglu, B., and Kideys, A.E. 2016. The influence of land use on coastal litter: An approach to identify abundance and sources in the coastal area of Cilician Basin, Turkey. *Turk. J. Fish. Aquat. Sci.* 16: 29-39, doi: 10.4194/1303-2712-v16_1_04)

MICROPLASTICS FOUND IN PREY FISH OF CETACEANS

Three commercially relevant demersal fish species - the lesser spotted dogfish, European hake and red mullet - are currently used as biomonitors for marine pollution in Spain. The stomachs of 212 specimens revealed that about 18% contained microplastics. Red mullet had the highest abundance (33%) in the Mediterranean (Barcelona). Most of the documented material was fibres, with potential sources being hygiene and cosmetic products, textiles and industrial fishing gear (especially neutrally or negatively buoyant nylon). Laboratory studies have shown that microplastics may have the ability to enter and propagate through the marine food web. Hake and mullet are prey of Mediterranean cetaceans, pointing to a potential direct transfer of marine debris to dolphins and porpoises.
(SOURCE: Bellas, J., Martínez-Armental, J., Martínez-Cámara, A., Besada, V., and Martínez-Gomez, C. 2016. Ingestion of microplastics by demersal fish from Spanish Atlantic and Mediterranean coasts. *Mar. Pollut. Bull.* 109: 55-60, https://doi.org/10.1016/j.marpolbul.2016.06.026)

PLASTIC IN THE MEDITERRANEAN SEA

The Mediterranean Sea is heavily affected by marine debris. The average density of plastic (1 item/4 m^2) and its frequency (100% of all sites sampled) are comparable to the accumulation zones described for the five subtropical gyres (e.g., Great Pacific Garbage Patch), and the proportion of large objects is even higher than in those gyres. The authors attribute this to high human pressure and the semi-enclosed geography of the Mediterranean.

(SOURCE: Cózar, A., Sanz-Martin, M., Marti, E., Gonzalez-Gordillo, J.I., Ubeda, B., Galvez, J.A., Irigoien, X., and Duarte, C.M. 2015. Plastic accumulation in the Mediterranean Sea. *PLOS ONE*, doi:10.1371/journalpone.0121762)

FLOATING MACRO-LITTER AND CETACEANS: THEY WILL MEET

This is one of the first studies to directly compare the distribution of marine debris with cetacean presence. The researchers recorded 1993 floating items (overall density: 15 items/km^2) along the coast of France between Marseille and Monaco (281 transects, more than 5000 km travelled). Most items were plastic bags/packaging. Sightings (n = 259, of 2194 individuals) of six species of cetaceans corresponded by ca. 50% with plastic distribution. Considering the ingestion, entanglement and strangulation risk of cetaceans in marine litter, this high overlap and thus potential for interaction is cause for concern, particularly for endangered sperm whales. Importantly, this study's transects partially overlapped with the Pelagos Sanctuary, revealing a sensitive situation. The authors note that they monitored only the 'tip of the iceberg' because, in the Mediterranean, litter densities on the seafloor are higher than for floating litter. They call for actions to reduce the presence of macro-litter at sea.

(SOURCE: Di-Méglio, N. and Campana, I. 2017. Floating macro-litter along the Mediterranean French coast: Composition, density, distribution and overlap with cetacean range. *Mar. Pollut. Bull.* 118: 115-166, https://doi.org/10.1016/j.marpolbul.2017.02.026)

MICROPLASTICS POSE A THREAT TO MEDITERRANEAN FIN WHALES

The level of microplastics, as well as the toxicology of fin whale populations, were compared between the Gulf of California and the Pelagos Sanctuary in the Mediterranean Sea. Concentrations of microplastics in the Gulf of California ranged up to 0.14 items/m^3, while the Mediterranean had levels several times higher (up to 9.67 items/m^3, mean: 0.31 ± 1.17 items/m^3). Furthermore, phthalate and organochlorine contaminant levels, as well as biomarker responses, were significantly higher in Mediterranean fin whales. There was a clear overlap between areas with fin whales feeding and microplastic high density in the Ligurian and Sardinian seas. The authors conclude that 'Mediterranean fin whales appear to be exposed to absorbed and constituent contaminants of plastic, as a result of direct and indirect ingestion of microplastic, macroplastic and contaminated prey. These results represent a warning for the vulnerable Mediterranean fin whale population'. See Table 1 for biomarker and contaminant values.

(SOURCE: Fossi, M.C., Marsili, L., Baini, M., Giannetti, M., Coppola, D., Guerranti, C., Caliani, I., Minutoli, R., Lauriano, G., Finoia, M.G., Rubegni, F., Panigada, S., Bérubé, M., Urbán Ramírez, J., Panti, C. 2016. Fin whales and microplastics: The Mediterranean Sea and the Sea of Cortez scenarios. *Environ. Poll.* 209: 68-78)

PLASTIC DEBRIS IN WHALE PROTECTED AREA

Modelling of ocean currents with field data confirmed that the Pelagos Sanctuary, a Specially Protected Area of Mediterranean Importance, suffers heavy impacts from micro- and macro-plastics. The most abundant polymer was polyethylene, suggesting fragmentation of larger packaging as the primary source. There was a large overlap between marine litter hotspots and fin whale feeding habitat. This is an important contribution for risk assessment of fin whale exposure to microplastics.

(SOURCE: Fossi, M.C., Romeo, T., Baini, M., Panti, C., Marsili, L., Campani, T., Canese, S., Galgani, F., Druon, J.-N., Airoldi, S., Taddei, S., Fattorini, M., Brandini, C., and Lapucci, C. 2017. Plastic debris occurrence, convergence areas and fin whales feeding ground in the Mediterranean Marine Protected Area Pelagos Sanctuary: A modelling approach. *Front. Mar. Sci* 4: 167, https://doi.org/10.3389/fmars.2017.00167)

HIGH SEA SURFACE MICROPLASTIC DENSITIES IN NORTHERN ADRIATIC SEA

Seventeen trawls over a 20-month period revealed abundant microplastics in the Slovenian part of the northern Adriatic. The average concentration was 406 x 10^3 particles/km^2, equivalent to 5.41 particles/m^3. Most of the analysed particles were polyethylene. This is amongst the highest concentrations reported in the Mediterranean, further corroborating the Mediterranean as one of the world's marine litter hotspots.

(SOURCE: Gajšt, T., Bizjak, T., Palatinus, A., Liubartseva, S., and Kržan, A. 2016. Sea surface microplastics in Slovenian part of the Northern Adriatic. *Mar. Pollut. Bull.* 113:392-399, https://doi.org/10.1016/j.marpolbul.2016.10.031)

FISHING ACTIVITY AND MERCHANT SHIPS ASSOCIATED WITH MACRO-LITTER IN SPAIN

The Mediterranean Sea region produces the highest amounts of municipal waste per person per year in the world. Marine litter densities are more than 100,000 items/km^2 on the seafloor close to metropolitan areas (mass occasionally greater than that of megafauna) and the fourth highest concentration of floating debris in the world. This study revealed increasing densities in the Gulf of Alicante (Spain) from the open sea to the coast. By weight, 76% was plastic, metal and glass. Fishing activity was identified as being the source of nearly 30% of this litter. Overall, likely sources were merchant ships in open waters and recreational and fishing vessels in coastal waters. The latter reflects (a) the practice of discarding old or damaged gear and tackle overboard and (b) unintentional losses due to snagging, especially on rocky grounds closer to shore. This type of debris poses an entanglement threat to cetaceans. The authors encourage 'marine retention programmes' on trawlers to reduce marine litter.

(SOURCE: García-Rivera, S., Sánchez Lizaso, J.L., and Bellido Millán, J.M. 2017. Composition, spatial distribution and sources of macro-marine litter on the Gulf of Alicante seafloor (Spanish Mediterranean). *Mar. Pollut. Bull.* 119: 110-118, https://doi.org/10.1016/j.marpolbul.2017.06.022)

BULGARIAN BLACK SEA COAST HEAVILY POLLUTED WITH LITTER

The Bulgarian Black Sea has received little attention regarding marine litter. The eight beaches studied along the Bulgarian coastline were classified as being highly polluted with litter. Artificial polymer materials made up nearly 85% of this material. Cigarette butts, followed by plastic caps/lids and cups, were the most abundant items. Litter densities

were highest on urban beaches, indicating that recreational activities associated with tourists and campers were key sources. The data collected in this and other studies in European seas are important for the European Marine Strategy Framework Directive, designed to achieve or maintain 'Good Environmental Status' for all European seas by 2020. Marine litter is one of 11 'descriptors' considered for determining this status.
(SOURCE: Simeonova, A., Chuturkova, R, and Yaneva, V. 2017. Seasonal dynamics of marine litter along the Bulgarian Black Sea coast. *Mar. Pollut. Bull.* 119: 110-118, https://doi.org/10.1016/j.marpolbul.2017.03.035)

FIRST MARINE LITTER STUDY ON THE SOUTHEAST BLACK SEA COAST

Nine beaches along the Turkish southeast coast of the Black Sea yielded a mean density of 0.16 litter items/m^2 by number and 3.6 g/m^2 by weight. Plastic marine debris is known to be the most abundant litter category in Turkish waters and was also the most abundant along the southeast coast of the Black Sea, followed by Styrofoam and fabric. Although the values were at the lower end of the range reported from other regions, the authors identify the source as inappropriately stored or disposed-of wastes and underline the role of major rivers and streams that empty into the Black Sea.
(SOURCE: Terzi, Y. and Seyhan, K. 2017. Seasonal and spatial variations of marine litter on the south-eastern Black Sea coast. *Mar. Pollut. Bull.* 120: 154-158, http://dx.doi.org/10.1016/j.marpolbul.2017.04.041)

Ship strikes

SPERM WHALES AT RISK OF SHIP STRIKES IN NORTHWEST MEDITERRANEAN SEA

Collisions with large vessels may be a conservation issue for the endangered Mediterranean sperm whale population. Comparing the sightings of sperm whales with ship traffic density yielded maps of collision risk in relation to vessel speed. The calculations show that the whales were more at risk from merchant vessels along the French and Italian continental coasts, and by conventional ferries on the east side of the islands of Corsica and Sardinia in the Pelagos Sanctuary. The authors estimated that 74 animals could be at risk of being struck by ships during the summer months in the Pelagos Sanctuary. The authors also noted that 9% of photo-identified sperm whales had scars attributed to ship strikes. These results provide a basis for defining high-risk areas and initiating mitigation measures that encompass commercial vessels, leisure boats and naval boats. While enforced shipping lanes avoid areas of high whale density, observers to detect whales (with infra-red vision at night), early warning systems and training for ships' crews could also be mitigation measures to reduce ship strike risk.
(SOURCE: Di-Meglio, N., David, L., and Monestiez, P. In press. Sperm whale ship strikes in the Pelagos Sanctuary and adjacent waters: assessing and mapping collision risks in summer. *J. Cetacean Res. Manage.* In press)

Chemical pollution

PYRETHROID INSECTICIDE FOUND IN STRIPED DOLPHINS FROM THE ALBORÁN SEA

Insecticide pyrethroid levels were determined from the liver of striped dolphins in the Alborán Sea. Pyrethroids were detected in 87% of the specimens, with a mean total concentration of 300 µg/kg lipid weight. The bioaccumulation of these insecticides was unlike that of POPs: the concentration increased slightly from calves to juveniles, but there was little difference between juveniles and adults. These levels are a cause for concern, although their toxicological impact is currently unknown. See Table 2 for values.
(SOURCE: Aznar-Alemany, Ò., Giménez, J., de Stephanis, R., Eljarrat, E. and Barceló, D. 2017. Insecticide pyrethroids in liver of striped dolphin from the Mediterranean Sea. *Environ. Pollut.* 225: 346-353)

HIGH HEAVY METAL CONCENTRATIONS IN THE EASTERN BLACK SEA

The contamination of Black Sea waters, sediments and organisms with a wide range of pollutants has become a matter of great concern. The main metal pollution problem in the eastern Black Sea coast of Turkey is related to agricultural run-off, sewage effluents with deficient or no treatment, and river-borne wastes from mines. The levels of metals in a bivalve and snail species were significantly above tolerable levels. Due to the bioaccumulation potential of heavy metals, such high levels are a potential cause for concern for higher-level predators such as cetaceans.
(SOURCE: Baltas, H., Sirin, M., Dalgic, G., Bayrak, E.Y., and Akdeniz, A. 2017. Assessment of metal concentrations (Cu, Zn, and Pb) in seawater, sediment and biota samples in the coastal area of Eastern Black Sea, Turkey. *Mar. Pollut. Bull.* 122: 475-482, http://dx.doi.org/10.1016/j.marpolbul.2017.06.059)

ENDOCRINE-DISRUPTING CHEMICALS FOUND IN FISH OFF SICILY

Endocrine-disrupting chemicals can show harmful effects on the reproduction and development of aquatic animals by interfering with normal hormonal levels and processes. This study used an improved method to detect three such compounds in all samples of red mullet collected from two sites (characterised by different degrees of pollution) off Sicily. The similar levels in both sites point to background values attributable to the global distribution of these contaminants rather than a local source. The three pollutants belong to category 1 (clear evidence of endocrine-disrupting activity) of Endocrine Disruptor Chemicals. The levels were sufficiently high to prompt the researchers to point to a potential risk for the health of aquatic animals, the Mediterranean Sea ecosystem, and the local human population for whom red mullet is a food source. Red mullet is also a prey species for dolphins.
(SOURCE: Errico, S., Nicolucci, C., Migliaccio, M., Micale, V., Mita, D.G., and Diano, N. 2017. Analysis and occurrence of some phenol endocrine disruptors in two marine sites of the northern coast of Sicily (Italy). *Mar. Pollut. Bull.* 120: 68-74, http:///dx.doi.org/10.016/j.marpolbul.2017.04.061)

HIGH LEVELS OF PCBS FOUND IN THREE MEDITERRANEAN CETACEANS

PCB levels in bottlenose and striped dolphins in Europe were amongst the highest recorded levels in cetaceans globally, exceeding all known PCB toxicity thresholds for marine mammals. In the western Mediterranean Sea (1990-2009), PCB concentrations in striped dolphins showed a marked decline after 1990 and then stabilised from 2003 to 2008, but still consistently exceeded all mammalian toxicity thresholds. Although they were not as high as PCB levels in the UK and Ireland, levels in killer whales from the Strait of Gibraltar were also potentially toxic. PCBs can lead to immune system

suppression and it was noted that, for example, distemper due to cetacean morbillivirus infection was frequently seen in Mediterranean striped dolphins, and various lesions were observed in bottlenose dolphins and killer whales. The Mediterranean Sea is a global PCB hotspot and most of its cetacean species have declined over decades. The authors state that 'Without significant mitigation, PCBs will continue to drive population declines or suppress population recovery in Europe for many decades to come'. Despite regulations and mitigation measures to reduce PCB pollution, their biomagnification in marine food webs continues to cause severe impacts amongst cetacean top predators in European seas. See Table 3 for values.

(SOURCE: Jepson, P.D., Deaville, R., Barber, J.L., Aguilar, À., Borrell, A., Murphy, S., Barry, J., Brownlow, A., Barnett, J., Berrow, S., Cunningham, A.A., Davison, N.J., ten Doeschate, M., Esteban, R., Ferreira, M., Foote, A.D., Genov, T., Giménez, J., Loveridge, J., Llavona, Á., Martin, V., Maxwell, D.L., Papachlimitzou, A., Penrose, R., Perkins, M.W., Smith, B., de Stephanis, R., Tregenza, N., Verborgh, P., Fernandez, A., and Law, R.J. 2016. PCB pollution continues to impact populations of orcas and other dolphins in European waters. *Sci. Rep.-UK* 6:18573)

GENETIC ANALYSES OF SKIN SAMPLES REVEAL CONTAMINATION HOTSPOTS

Skin samples of stranded specimens of four cetacean species (bottlenose, striped and Risso's dolphins, fin whales) were examined for genetic markers specific to contaminants of emerging concern. Animals from three basins (Ionian, Tyrrhenian and Adriatic) were sampled. Three of four markers tested showed higher expression in the samples collected from the Adriatic. The researchers highlighted the role freshly stranded specimens can play in determining the region from which individual cetaceans come and the pollution levels there.

(SOURCE: Mancia, A., Lunardi, D., and Abelli, L. 2018. The chronicles of the contaminated Mediterranean seas: A story told by the cetaceans' skin genes. *Mar. Pollut. Bull.* 127: 10-14, https://doi.org/10.1016/j.marpolbul.2017.11.037)

HIGH HEAVY METAL CONCENTRATIONS IN HUMAN FOOD (AND DOLPHIN PREY) IN THE AEGEAN SEA

The levels of Hg, Cd, Pb, Cr, Cu and Zn were measured in four species of fish - annular seabream, common pandora, European hake and red mullet - along the Turkish coast of the Aegean Sea. In one of the two bays sampled, the levels of Cd and Pb were above the FAO's tolerable limits for three species, and the levels of Hg were at the maximum permitted limits for two species. Accordingly, the consumption of red mullet and common pandora in this area is potentially hazardous to human health due to Hg concentrations. Dolphins are also known to prey on these species.

(SOURCE: Pazi, I., Gonul, L.G., Kucuksezgin, F., Avaz, G., Tolun, L. Unluoglu, A., Karaaslan, Y., Gucver, S.M., Orhon, A.K., Siltu, E., and Olmuz, G. 2017. Potential risk assessment of metals in edible fish species for human consumption from the Eastern Aegean Sea. *Mar. Pollut. Bull.* 120: 409-413, https://doi.org/10.1016/j.marpolbul.2017.05.004)

CHEMICALS ASSOCIATED WITH PLASTICS CONCENTRATED IN SEA TURTLES

Sea turtles (one leatherback, 12 loggerhead) stranded along the Sicilian coast were examined for phthalates, chemicals used in the plastics industry. The total concentrations of the four phthalates examined were high in all tissues. The levels in fat were comparable to those found in marine mammals, underlining that these chemicals leach from plastics and enter the food chain. This supports the potential of monitoring these substances as tracers for microplastic ingestion, and the authors call for efforts to adopt a common plastics waste management policy amongst all Mediterranean countries.

(SOURCE: Savoca, D., Arculeo, M., Barreca, S., Buscemi, S., Caracappa, S., Gentile, A., Persichetti, M.F., and Pacem A. 2018. Chasing phthalates in tissues of marine turtles from the Mediterranean Sea. *Mar. Pollut. Bull.* 127: 165-169, https://doi.org/10.1016/j.marpolbul.2017.11.069)

TRACE ELEMENTS IN MEDITERRANEAN STRIPED DOLPHINS

The examination of trace elements (Hg, Se, Cd, Cu, Zn, Fe, Mn and As) in seven specimens of striped dolphin stranded along the Israeli coast from 2006-2011 showed no change from an earlier series beginning in 2001. The Hg values were high (and higher than in other seas), but might reflect the relatively high natural background level of Hg in the Mediterranean. The pathology findings included meningoencephalitis, pneumonia and hepatitis (but no DMV). Striped dolphins have suffered four DMV epidemics (1990-1992, 2006-2008, 2011 and 2013) in this area. This suggests a prolonged DMV circulation in the Western Mediterranean along with an inadequate level of antiviral immunity. This compromised immunity may be caused or aggravated by pollutants. This would impact the health and conservation status of Mediterranean striped dolphins (currently listed as Vulnerable on the IUCN Red List), calling for continued monitoring of the concentrations of heavy metals and other pollutants in this species.

(SOURCE: Shoham-Frider, E., Goffman, O., Harlavan, Y., Kress, N., Morick, D., Roditi-Elasar, M., Shefer, E., and Kerem, D. 2016. Trace elements in striped dolphins (*Stenella coeruleoalba*) from the Eastern Mediterranean: A 10-years perspective. *Mar. Pollut. Bull.* 109: 624-632, http://doi.org/10.1016/j.marpolbul.2016.05.021)

TRACE ELEMENT LEVELS IN MEDITERRANEAN CETACEANS AS ECOLOGICAL INDICATORS

See Table 4 for values measured in sperm whales and bottlenose dolphins.

(SOURCES: Monteiro, S.S., Torres, J., Ferreira, M., Marçalo, A., Nicolau, L., Vingada, J.V. and Eira, C. 2016. Ecological variables influencing trace element concentrations in bottlenose dolphins (*Tursiops truncatus*, Montagu 1821) stranded in continental Portugal. *Sci. Total Environ.* 544: 837-844; Squadrone, S., Brizio, P., Chiaravalle, E. and Abete, M.C. 2018. Sperm whales (*Physeter macrocephalus*), found stranded along the Adriatic coast (Southern Italy, Mediterranean Sea), as bioindicators of essential and non-essential trace elements in the environment. *Ecol. Indic.* 58: 418-425)

POP LEVELS HIGHER IN MEDITERRANEAN THAN IN NORTH ATLANTIC OR SOUTHERN HEMISPHERE CETACEANS

See Table 5 for values in three species of cetacean.

(SOURCE: Pinzone, M., Budzinski, H., Tasciotti, A., Ody, D., Lepoint, G., Schnitzler, J., Scholl, G., Thomé, J.-P., Tapie, N., Eppe, G., and Das, K. 2015. POPs in free-ranging pilot whales, sperm whales and fin whales from the Mediterranean Sea: Influence of biological and ecological factors. *Environ. Res.* 142: 185-196)

Disease and mortality events

General

MASS MORTALITY OF JUVENILE AND NEWBORN HARBOUR PORPOISES IN THE BLACK SEA

The endemic harbour porpoise subspecies in the Black Sea has experienced several large-scale mortalities in the 21st century. In 2016, unusually large numbers of newborns and juveniles washed up on beaches along the Black Sea coasts

of Bulgaria and Turkey (in Turkey: 7.2 individuals/km, with 150 individuals along one 22 km stretch in July alone). In total, 443 stranded cetaceans (435 of them harbour porpoises) were reported in Turkey (coastline length: 300 km), and 234 cetaceans (218 harbour porpoises) in Bulgaria (coastline length: 238 km). Most were newborns less than 70 cm long. Öztürk et al. estimate that thousands of juveniles died during this mortality event. Such successive high mortalities of young animals could be a serious impediment to the recovery of this endangered subspecies.
(SOURCES: Sanders, N. 2016. Mass mortality event of Black Sea harbour porpoises. IUCN - SSC Cetacean Specialist Group. http://www.iucn-csg.org/index.php/2016/08/25/mass-mortality-event-of-black-sea-harbour-porpoises; Öztürk, A.A., Tonay, A.M., Dede, A., Danyer, I., and Popov, D. 2017. Unusual mass mortality of harbour porpoises on the coast of the western Black Sea (Bulgaria and Turkey) in summer 2016. Abstract submitted to 31st European Cetacean Society Conference, Middlefart, Denmark)

STRANDING RATE OF PORPOISES CORRELATES WITH FISH STOCK DYNAMICS IN THE AZOV SEA

In 1999-2014, harbour porpoise stranding rates were regularly monitored on the southern coast of the Azov Sea, particularly at the uninhabited abraded coast of the Tarkhan Cape. Specifically, the general trends and annual fluctuations in strandings were compared to the catch reports of the Azov Sea anchovy, an important prey for porpoises. The fluctuations in stranding rates correlated with the population dynamics of the anchovy stock. A cosine function, based on the data from 1999-2012, correctly predicted maximum strandings in 2013 and their substantial decline in 2014. The function worked particularly well when biases affecting carcass preservation, such as discovery rate and drift conditions, were reduced. In certain environments and over established time periods, the cetacean stranding rate can be an indicator of population trends which may be verified by external factors, including the dynamics of prey stocks.
(SOURCE: Vishnyakova, K. and Gol'din, P. 2015. Cetacean stranding rate correlates with fish stock dynamics: Research of harbour porpoises in the Sea of Azov. *Mar. Biol.* 162: 359-366)

Harmful Algal Blooms (HABs)

FIRST GLOBAL INTEGRATED MARINE ASSESSMENT: BLACK SEA

The upper layer of water (ca. 150 m) in the Black Sea supports unique marine, freshwater, brackish and relic species (approximately 5000). The deeper layers are saturated with hydrogen sulphide and largely devoid of multi-cellular invertebrates. The eastern sector is a recognised biodiversity hotspot. A UN report identifies invasion by alien species as a key threat to the Black Sea ecosystem, with two species being of particular importance. The first is an American filter-feeding comb jelly, which has led to the collapse of pelagic fish populations (26 commercial fish stocks) and caused a major shift in the marine ecosystem (partially offset by the invasion of another, predatory comb jelly). The second is algae that produce harmful algal blooms and can further deplete the oxygen in the water. Temperature increases at the surface mixing with cold intermediate water layers have further accelerated species shifts. Critical status has been recognised for 13 out of 37 benthic habitats, including the neritic water column, coastal lagoons, estuaries and deltas. These developments, along with illegal fishing (gillnet entanglement), pose the greatest threats to the three cetacean species inhabiting the Black Sea, all of which are listed as Endangered or Vulnerable on the IUCN Red List.
(SOURCE: Inniss, L. and Simcock, A. (Joint coordinators); Rice, J. (Lead member of 14 contributors). 2016. The first global integrated marine assessment: World ocean assessment I. *United Nations, Chapter 36A:* p. 16-18. http://www.un.org/Depts/los/global_reporting/WOA_RPROC/Chapter_36A.pdf)

Climate change

CLIMATE CHANGE A 'DOUBLE ISSUE' IN THE MEDITERRANEAN SEA

Climate change is a particular issue for enclosed seas, where organisms cannot migrate to higher latitudes. The Mediterranean is doubly affected because it is increasingly being inhabited by (sub) tropical non-indigenous species ('tropicalisation'). Moreover, warm-water native species previously restricted to southern sectors are now establishing themselves in the colder northwest basin ('meridionalisation'). The authors report that 20 southern species have been found for the first time at Genoa, including zebra seabream, parrotfish and juvenile Indo-Pacific bluespotted cornetfish. The linear increase in the number of warm-water native species and the exponential increase in the number of non-indigenous species point to a tropicalisation (rather than a meridionalisation) even in the northern sectors of the Mediterranean basin. If the present seawater warming continues, the Mediterranean would undergo a generalised process of biotic homogenisation. Such major ecosystem changes probably ultimately affect the entire food web, including top predators such as cetaceans. The authors point to the need for sustained monitoring as 'a major concern for scientists and environmental managers alike'.
(SOURCE: Bianchi, C.N., Caroli, F., Guidetti, P., and Morri, C. 2018. Seawater warming at the northern reach for southern species: Gulf of Genoa, NW Mediterranean. *J. Mar. Biol. Assoc. UK* 98:1-12, doi:10.1017/S0025315417000819)

CLIMATE CHANGE COULD REDUCE COMMON DOLPHIN HABITAT IN THE ALBORÁN SEA

A special volume of the journal *Deep Sea Research Part II: Topical Studies in Oceanography* was devoted to Atlantic and Mediterranean megafauna. Papers addressed abundance, distribution and habitats; one paper highlighted climate change (see also Azzellino et al., 2017, in this SOCER). Short-beaked common dolphin distribution and environmental variables recorded in the Alborán Sea were used to project the impacts of climate change via changes in sea surface temperatures on dolphin habitat. The authors conclude that increasing sea surface temperatures will lead to a decrease in common dolphin habitat.
(SOURCE: Cañadas, A. and Vázquez J.A. 2017. Common dolphins in the Alborán Sea: Facing a reduction in their suitable habitat due to an increase in sea surface temperature. *Deep Sea Res. Pt. II: Topic. Stud. Oceanogr.* 141: 306-318)

Noise impacts

VESSEL TRAFFIC ALTERS THE BEHAVIOUR OF BOTTLENOSE DOLPHINS AND HARBOUR PORPOISES IN THE ISTANBUL STRAIT

The Istanbul Strait is one of the busiest international waterways in the world. The effect of marine traffic, location and season on the behavioural transitions, behavioural budget and bout duration (average time in each behavioural state) of bottlenose dolphins was investigated and modelled. Marine vessels were the main driving force for behavioural transitions, leading to significant changes in behavioural budget and bout durations. There was a significant decrease in socialising, surface-feeding and resting behaviour in the presence of boats, whilst diving behaviour increased. Moreover, dolphins spent less time surface-feeding, resting, socialising and diving once disrupted. The current level of vessel-dolphin interaction in this area (51% of observation time) was sufficient to significantly alter the dolphins' cumulative behavioural budget. Finally, speed and distance of vessels played a considerable role in the directional responses of dolphins. The authors argue for creating protected zones in order to mitigate vessel-dolphin interactions, because the population is already classified as 'at risk' and still lacks a species-specific conservation plan. In a second study, high-speed ferries and boats were identified as the major cause of disturbance. Accordingly, the authors recommend that the proposed protected zones (three different seasonally managed areas) should limit the speed and density of marine traffic. A third study on the endangered Black Sea harbour porpoise in the strait showed similar results: vessel presence, speed and distance affected behavioural bout length and swimming direction, but there was no significant cumulative (diurnal) behavioural budget change. Nonetheless, exposure to high-speed vessels resulted in a strong response, which could lead to porpoise displacement from large areas. Porpoise density was higher in areas with less traffic (northern strait) and lower in areas of high traffic (southern and central strait). The authors argue for species-specific conservation actions, especially in the northern sections of the strait, including vessel exclusion zones, enforced speed limits and the designation of specific channels for ferries.

(SOURCES: Bas, A.A., Christiansen, F., Öztürk, B., Öztürk A.A., Erdoğan, M.A., and Watson, L.J. 2017. Marine vessels alter the behaviour of bottlenose dolphins *Tursiops truncatus* in the Istanbul Strait, Turkey. *Endang Species Res* 34:1-14; Bas A.A., Öztürk A.A., and Öztürk B. 2015. Selection of critical habitats for bottlenose dolphins (*Tursiops truncatus*) based on behavioral data, in relation to marine traffic in the Istanbul Strait, Turkey. *Mar. Mamm. Sci.* 31: 979-997; Bas, A.A., Christiansen, F., Öztürk, A.A., Öztürk, B., McIntosh, C. 2017. The effects of marine traffic on the behaviour of Black Sea harbour porpoises (*Phocoena phocoena relicta*) within the Istanbul Strait, Turkey. *PLoS ONE* 12(3): e0172970. doi:10.1371/journal.pone.0172970)

LOWER CETACEAN ABUNDANCE IN AREAS OF HIGH VESSEL TRAFFIC IN THE WESTERN MEDITERRANEAN

Shipping vessel number and cetacean abundance, determined via line transect surveys, were examined in the western Mediterranean Sea region. In locations with cetacean sightings, shipping traffic was 20% lower compared to random locations where no sightings were made. Most cetacean species, common bottlenose dolphins excepted, were observed in locations with lower levels of vessel traffic. Line transects in the Pelagos Sanctuary found reduced abundances of fin whales and striped dolphins in areas with more vessel traffic in the southeast region, and of large whales in the western portion of the sanctuary, where there is more vessel traffic. In the central part of the sanctuary - with moderate vessel traffic yet important feeding habitat locations - there were minor differences in the abundance of species (specifically Cuvier's beaked whales, sperm whales, fin whales and striped dolphins). It is possible that feeding habitats are so important that cetaceans still use these areas despite boat disturbance.

(SOURCE: Campana, I., Crosti, R., Angeletti, D., Carosso, L., David, L., Di-Méglio, N., Moulins, A., Rosso, M., Tepsich, P. and Arcangeli, A. 2015. Cetacean response to summer maritime traffic in the Western Mediterranean Sea. *Mar. Environ. Res.* 109: 1-8)

ITALY INTRODUCES MONITORING SCHEME FOR MARINE MAMMAL PRESENCE FOR SEISMIC EXPLORATION

Anthropogenic noise (e.g., naval sonar, pile driving, geophysical surveys) has now been recognised as a threat to marine fauna. Current oil and gas industry and navy protocols, as well as other guidelines based on 'best practise' or precautionary approaches for civil and industrial activities, are not standardised. In 2015, the Italian Environmental Impact Assessment Commission issued new criteria for obtaining permits for oil and gas exploration. It mandated that seismic operators apply a standardised protocol to compare the presence of marine mammals before, during and after offshore seismic surveys (see http://www.va.minambiente.it/it-IT). It established a 60-day monitoring period using both visual and acoustic methods. The authors underline that this approach, if used internationally, would improve the study of far-reaching intense low-frequency noise. The collected data are to be stored and made public by the Italian Ministry of the Environment.

(SOURCE: Fossati, C., Mussi, B., Tizzi, R., Pavan, G., and Pace, D.S. 2017. Italy introduces pre and post operation monitoring phases for offshore seismic exploration activities. *Mar. Pollut. Bull.* 120: 376-378, https://doi.org/10.1016/j.marpolbul.2017.05.017)

RESIDENT POPULATION OF BOTTLENOSE DOLPHIN AFFECTED BY VESSEL NOISE

Vessel traffic is known to affect the resident bottlenose dolphin's distribution and habitat use in the Cres-Losinj archipelago (Croatia, Adriatic Sea, a Natura 2000 site). This study found that the acoustic behaviour of the population is also affected by vessel noise. Dolphins significantly changed their whistle structure at high levels of ambient noise and in the presence of boats. These waters are visited consistently by sensitive mother-calf groups. The researchers called for an improved understanding of the overall acoustic repertoire of bottlenose dolphins and for determining potential population-level changes in the presence of these disturbance factors.

(SOURCE: Gospic, N.R. and Picciulin, M. 2016. Changes in whistle structure of resident bottlenose dolphins in relation to underwater noise and boat traffic. *Mar. Pollut. Bull.* 105: 193-198, https://doi.org/10.1016/j.marpolbul.2016.02.030)

UNDERWATER NOISE HOTSPOTS IN THE MEDITERRANEAN SEA AND THE EXTENT OF SEISMIC SURVEYING

A number of noise-producing activities might threaten cetaceans in the Mediterranean Sea, including coastal and offshore activities, seismic surveys, naval exercises and vessel traffic. Between 2005 and 2015, 1446 harbours, 228 oil/gas drilling platforms, 52 windfarm projects, 830 seismic exploration areas and a number of military exercise areas were identified.

In July 2014, 7 million maritime vessel positions were recorded every 10 minutes. On average, there were 1500 vessels present in the area at any time, with the heaviest density of traffic in northern and western parts of the Mediterranean Sea and in Greek waters. The maximum and minimum areas where seismic surveys were being conducted were calculated: 27% of the surface of the Mediterranean (675,000 km^2) in 2013 and 3.8% (67,000 km^2) in 2005. Hotspots of underwater noise that overlapped key cetacean habitat included the Pelagos Sanctuary, the Strait of Sicily and the Hellenic Trench. The authors conclude that 'these results provide strong evidence of multiple stressors acting on the marine environment and of the need for urgent management and conservation actions'.
(SOURCE: Maglio, A., Pavan, G., Castellote, M., and Frey, S. 2016. *Overview of Noise Hotspots in the ACCOBAMS Area.* Report for the ACCOBAMS Secretariat)

RECOMMENDATIONS FOR REDUCING THE IMPACTS OF SEISMIC SURVEYS AND UNDERWATER NOISE IN THE EASTERN MEDITERRANEAN SEA

A workshop was held in Croatia on mitigating the impacts of underwater noise, particularly from seismic surveys, in the eastern Mediterranean Sea. The workshop was attended by 65 participants from 15 countries. Recommendations from the meeting included taking a precautionary approach to noise management; developing a 'noise budget' for eastern Mediterranean waters; considering potential cumulative or synergistic impacts on cetaceans, including the impacts of climate change; and assessing the effectiveness of mitigation measures and monitoring activities. Better communication and sharing of information was also suggested, in particular information on the distribution of sensitive species. Strategic Environmental Assessments should be conducted by governments and analysed before any locations are licensed to the oil and gas industry. The *Convention on Migratory Species (CMS) Guidelines on Environmental Impact Assessments for Marine Noise Generating Activities* should be incorporated into national legislation and species management plans. The number of seismic surveys should be limited and their timing should be planned to avoid key periods for sensitive species. Duplication of seismic surveys should be avoided and the use and development of the best-available quieting technologies (e.g., marine vibroseis) should be pursued. The lack of training of (and capacity for) marine mammal observers and acoustic monitoring staff on seismic survey vessels should be addressed. A global report should be prepared on the best available technology and environmental practises for the mitigation of underwater anthropogenic noise, and should be made available to all government agencies in the region. Education and awareness-raising of the need to reduce noise in the marine environment was also recommended. Finally, subsidies for the oil and gas industry should be removed and public funds should be spent in line with the objectives of the 2015 Paris Agreement on Climate Change, i.e., in a way to reduce greenhouse gas emissions.
(SOURCE: NRDC, OceanCare, DBU. 2017. *Mitigating the impact of underwater noise on marine biodiversity with specific focus on seismic surveys in the south eastern European waters in the Mediterranean Sea.* Workshop held November 22-23, 2017. Split, Croatia.)

OVERLAP BETWEEN CETACEANS AND SHIPPING IN THE PELAGOS SANCTUARY

A spatial analysis was conducted of shipping and the distribution of striped and bottlenose dolphins and fin whales in the southern part of the Pelagos Sanctuary. Overlap with vessel traffic occurred for all three species, with the greatest degree of overlap for striped dolphins, followed by bottlenose dolphins, then fin whales. Importantly, despite their lower overlap with shipping, fin whales might be particularly vulnerable to this source of disturbance because the overlap was associated with productive feeding areas, and animals focusing on feeding might be less reactive to approaching vessels.
(SOURCE: Pennino, M.G., Arcangeli, A., Prado Fonseca, V., Campana, I., Pierce, G.J., Rotta, A., and Bellido, J.M. 2017 A spatially explicit risk assessment approach: Cetaceans and marine traffic in the Pelagos Sanctuary (Mediterranean Sea). *PLoS ONE* 12(6): e0179686, https://doi.org/10.1371/journal.pone.0179686)

FIN WHALES SILENT WHEN SEISMIC SURVEY NOISE DETECTED IN THE IONIAN SEA

Acoustic recordings made in the Ionian Sea detected 20 Hz calls from fin whales and pulses from seismic survey airguns. Airgun pulses were recorded in four of the 10 analysed months and occurred daily between 25 November 2012 and 21 February 2013 - this period coincided with an absence of recorded fin whale calls. The daily airgun pulses led to an increase in low frequency background noise (below 50 Hz) of 10 dB. The received levels of airgun pulse noise indicated that the sound originated several hundreds of kilometres from the recording site. This suggests a significant impact from seismic surveys on fin whale vocalisations in this area.
(SOURCE: Sciacca, V., Viola, S., Pulvirenti, S., Riccobene, G., Caruso, F., De Domenico, E. and Pavan, G. 2017. Shipping noise and seismic airgun surveys in the Ionian Sea: Potential impact on Mediterranean fin whale. *Proceed. Mtgs Acoust.* 27, 040010: 1-10, https://doi.org/10.1121/2.0000311)

THE POTENTIAL IMPACT OF SEISMIC SURVEYS IN THE MEDITERRANEAN SEA

This review assessed sources of underwater noise that might pose a problem for cetaceans in the Mediterranean Sea. Potential sources included: (a) shipping traffic; (b) military exercises; (c) seismic surveys; (d) development projects, both coastal and offshore; and (e) marine tourism. Over the past 10 years, seismic surveys have increased in the southeast Mediterranean, especially in the Adriatic Sea and the Hellenic Trench. Concern about the impacts of underwater noise extends also to essential prey species such as zooplankton. However, the author notes that 'the full extent of the impact of seismic surveys at the population level is mostly unknown, partially due to the lack of baseline knowledge about the abundance and distribution of [cetaceans]'. A number of mitigation measures was recommended, including: (a) improved cetacean surveys; (b) the establishment of strandings detection programmes; (c) more research on the impacts of seismic surveys; (d) no-go zones for seismic surveys; (e) increased capacity in Mediterranean nations to conduct effective environmental impact assessments; (f) the use of new technologies, such as marine vibroseis; (g) better funding and training (e.g., for marine mammal observers on seismic survey vessels); and (h) improved communication amongst stakeholders.
(SOURCE: Štrbenac, A. 2017. *Overview of Underwater Anthropogenic Noise, Impacts on Marine Biodiversity and Mitigation Measures in the South-Eastern European Part of the Mediterranean, Focussing on Seismic Surveys*. Report from Stenella Consulting, Croatia, for OceanCare, Switzerland)

COMPARING MONITORED AND MODELLED NOISE LEVELS IN ITALIAN WATERS AS A STRATEGY FOR PLANNING FUTURE SHIPPING TRAFFIC ROUTES

Acoustic noise levels were measured in waters off Sicily and compared with the results of a model based on AIS data. The hydrophones were installed at a depth of over 2000 m, 25 km off Catania, Sicily. The measured values correlated well with the passage of ships tracked by AIS. This monitoring was requested by the EU Directive on Marine Strategy in an effort to achieve 'Good Environmental Status'. The data are essential in planning new routes for shipping traffic (as anticipated for the future 'European Motorways of the Sea'). They will also be helpful in elaborating mitigation measures for protected species that could be threatened by high noise levels at low frequencies; e.g., fin whales. Comparing noise distribution with animal density will help identify noise hotspots for the most sensitive species.

(SOURCE: Viola, S., Grammauta, R., Sciacca, V., Bellia, G., Beranzoli, L., Buscaino, G., Caruso, F., Chierici, F., Cuttone, G. D'Amico, A., De Luca, V., Embriaco, D., Favali, P., Giovanetti, G., Marinaro, G., Mazzola, S., Filiciotto, F., Pavan, G., Pellegrino, C., Pulvirenti, S., Simeone, F., Speziale, F., and Riccobene, G. 2017. Continuous monitoring of noise levels in the Gulf of Catania (Ionian Sea). Study of correlation with ship traffic. *Mar. Pollut. Bull.* 121: 97-103, https://doi.org/10.1016/j.marpolbul.2017.05.040)

GLOBAL

General

MONITORING WHALE HEALTH VIA DRONES

A small hexacopter drone was used to collect the blow from humpback whales off the east coast of the USA. Genetic analysis of the blow samples allowed identification of an array of microbes, identifying the normal microbial flora of the whale respiratory tract. No known respiratory pathogens were detected. This new technique allows the non-invasive monitoring of the respiratory health of whales.

(SOURCE: Apprill, A., Miller, C.A., Moore, M.J., Durban, J.W., Fearnbach, H., and Barrett-Lennard, L.G. 2017. Extensive core microbiome in drone-captured whale blow supports a framework for health monitoring. *mSystems* 2: e00119-17, https://doi.org/10.1128/mSystems.00119-17)

GLOBAL THREAT MAPS FOR MARINE MAMMALS

More than 1780 publications (published between 1991 and 2016) were reviewed to determine the threats to 121 marine mammal species. From these data, risk maps were produced and compared with mapped distributions of marine mammals. Almost all species were reported to be facing at least one threat. Bycatch had the greatest impact for the most species (112 species), followed by pollution (99 species), direct harvesting (89 species) and ship strikes (86 species). Threats such as urban development, tourism, directed catches and fishing affected more than 60 species. Threats were associated with more than 51% of marine mammal core habitat. Particular threat hotspots included the coastal waters of temperate and polar areas, notably the Baltic and Mediterranean Seas. Risk patterns for odontocetes and mysticetes were similar, with high-risk areas for both being concentrated on the east coasts of North America and Asia, with additional risk zones for mysticetes off the west coast of South America and off southern Australia. Humpback and sperm whales were exposed to the greatest area of risk, and common bottlenose dolphins were exposed to the highest diversity of risks. Species with restricted distributions had the greatest risks with respect to the proportion of their core habitat affected (e.g., Hector's, Heaviside's and Chilean dolphins, vaquita, franciscana and gray and North Atlantic right whales). The authors note that 'human activities in coastal waters worldwide impose previously unrecognised levels of cumulative risk for most of marine mammal species'. They also suggest that these risk maps might be useful for planning marine protected areas for marine mammals.

(SOURCE: Avila, I.C., Kaschner, K. and Dormann, C.F. 2018. Current global risks to marine mammals: Taking stock of the threats. *Biol. Conserv.* 221: 44-58)

ENVIRONMENTAL CHANGES AND ANTHROPOGENIC DISTURBANCE COULD HAVE SIGNIFICANT POPULATION-LEVEL EFFECTS

A model was constructed to investigate the effects of environmental changes and anthropogenic disturbances on the energetics of blue whales in the eastern North Pacific. The model predicted that unprecedented environmental changes (such as in 2005, when the annual California Current-induced upwelling was delayed by several months) affecting female reproductive success will cause a decline in recruitment rates (dropping from 95% to 69%), with reproductive failures increasing (aborted calf rate will increase from 2% to 26%). Modelling intense local disturbances (such as an exercise using naval sonar, seismic surveys or similar) revealed that if whales stayed in the disturbed location, the abortion rate for calves rose to 12.5% and the proportion of calves starving rose to 18.5%, with the recruitment rate dropping to 63%. Modelling a widespread but weak level of disturbance (such as from whale watching or shipping traffic) showed a small drop in recruitment rate (to 94%), partly because of a calf starvation rate of 0.2%, on average. This modelling exercise demonstrates the significant effect major environmental changes (from climate change, for example) or intense anthropogenic disturbances could have on threatened whale populations.

(SOURCE: Pirotta, E., Mangel, M., Costa, D.P., Mate, B., Goldbogen, J.A., Palacios, D.M., Hückstädt, L.A., McHuron, E.A., Schwarz, L., and New, L. 2018. A dynamic state model of migratory behavior and physiology to assess the consequences of environmental variation and anthropogenic disturbance on marine vertebrates. *Am. Nat.* 191(2): E40-E56, https://doi.org/10.1086/695135)

Habitat degradation

General

LANDMARK CONVENTION ON BALLAST WATER ENTERED INTO FORCE IN 2017

The IMO has crafted a convention that requires ships to manage their ballast water to remove, render harmless or avoid the uptake or discharge of aquatic organisms and pathogens with ballast water and sediment. The goal is to avoid the spread of invasive species, which is threatening 'the ecological and economic well-being of the planet'. These clear and robust new standards require all ships to carry a ballast water record book and an International Ballast Water Management

Certificate. Most ships will have to install onboard systems to treat ballast water and eliminate unwanted organisms. The entry into force involved ratification by 30 States (total 52 contracting Parties), representing 35% of world merchant shipping tonnage. This is an important step forward in checking the spread of, amongst others, harmful algae that cause mass mortalities of marine organisms (e.g., fish kills), promote oxygen depletion, and affect all levels of the food chain, including cetaceans.
(SOURCE: The Maritime Executive. Ballast water convention to enter into force in 2017, https://www.maritime-executive.com/article/ballast-water-convention-to-enter-into-force-in-2017#gs.nb0nIE8)

Fisheries interactions

FISHERIES DISCARDS REMAIN A GOBAL ISSUE

A global marine fisheries bycatch reconstruction project estimated that fish discarded by commercial fisheries peaked at 18.8 million tons in 1989, declining afterward to current levels of less than 10 million tons/year. Most discards were generated by industrial (i.e., large-scale) fisheries. More recently, fleets operating in northwest Pacific and western central Pacific waters have generated the most discards (reflecting a shift from Atlantic waters). The fact that essentially marketable species are involved suggests 'a combination of poor fishing practices and poor management procedures'. The discards amount to approximately 10% of the world's marine fishery catches, pointing to a major, wasteful exploitation that potentially affects the entire marine ecosystem, including top predators such as cetaceans.
(SOURCE: Zeller, D., Cashion, T., Palomares, M., and Pauly, D. 2017. Global marine fisheries discards: A synthesis of reconstructed data. *Fish and Fisheries* 19: 30-39, https://doi.org/10.1111/faf.12233)

Marine Debris

MARINE DEBRIS RECOGNISED AND ADDRESSED BY HIGHEST INTERNATIONAL ORGANISATION

Marine debris has been recognised as a crucial issue by the UN Environment Assembly, which seeks by 2025 to 'prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and microplastics'. The recent actions related to this 'Sustainable Development Goal 14' include a 2017 commitment by Member States to the 'Our Ocean, Our Future: Call for Action' declaration, as well as the 'Group of 20 Action Plan on Marine Litter', also adopted in 2017. The UN Environment Assembly has, amongst eight other points of action, invited the 'relevant international and national organizations and conventions…to increase their action to prevent and reduce marine litter and microplastics and their harmful effects and to coordinate where appropriate to achieve that end'. The first meeting of the Ad Hoc Open-Ended Expert Group on Marine Litter and Microplastics will be held in late May 2018 in Nairobi, Kenya, and the ministers of all Member States are invited to submit position papers.
(SOURCE: Marine litter and microplastics. United Nations. UNEP/EA.3/Res.7. 2018)

Disease and mortality events

Harmful Algal Blooms (HABs)

TOXIC ALGAL BLOOMS ON THE RISE IN NORTHERN HEMISPHERE

High-resolution sea-surface temperature records over the last three decades were used to model the trends in HABs in the North Atlantic and North Pacific Oceans. The model shows that increasing ocean temperatures have facilitated the expansion of two harmful dinoflagellates, *Alexandrium fundyense*, which produces saxitoxin (causing paralytic shellfish poison in humans) and *Dinophysis acuminata*, which produces okadaic acid (causing diarrheic shellfish poisoning in humans). The temperature effect meant increased growth rates of these organisms and increased durations of HAB events (bloom season). Beyond the human health threat, HABs also affect ecosystems (e.g., fish kills) and cetaceans. The authors predict that continued ocean warming will 'promote the intensification and redistribution of these, and likely other HABs, around the world'.
(SOURCE: Gobler, C.J., Doherty, O.M., Hattenrath-Lehmann, T.K., Griffith, A.W., Kang, Y., and Litaker, R.W. 2017. Ocean warming since 1982 has expanded the niche of toxic algal blooms in the North Atlantic and North Pacific Oceans. *PNAS*. 201619575, https://doi.org/10.1073/pnas.1619575114)

Oil spills

IMMUNE SYSTEM RESPONSES IN DOLPHINS EXPOSED TO THE DEEPWATER HORIZON (DWH) OIL SPILL

To investigate the effect of the DWH oil spill on living common bottlenose dolphins in Barataria Bay, Louisiana, blood samples were analysed from live-captured animals. Potentially oil-exposed animals demonstrated an increase in T white blood cells (in 2011) and B white blood cells (in 2011 and 2013). Certain cytokine levels were notably different from levels in a control population (and perhaps indicative of bacterial infections by pathogens such as *Brucella* - one of the pathogens that was implicated in the high rate of young dolphin mortalities post-oil spill). The white blood cell responses were similar to 'those documented in other species following exposure to oil or [polyaromatic hydrocarbons] and were most pronounced in [Barataria Bay in] 2011, at the place and time most affected by oil'.
(SOURCE: De Guise, S., Levin, M., Gebhard, E., Jasperse, L., Hart, L.B., Smith, C.R., Venn-Watson, S., Townsend, F., Wells, R., Balmer, B., Zolman, E., Rowles, T., and Schwacke, L. 2017. Changes in immune functions in bottlenose dolphins in the northern Gulf of Mexico associated with the *Deepwater Horizon* oil spill. *Endanger. Species Res.* 33: 291-303)

OIL-DISPERSANT MIX CAUSES DOLPHIN WHITE BLOOD CELL SUPPRESSION

The immunotoxicity of the oil released in the DWH oil spill and the chemical dispersant Corexit was examined by investigating dolphin white blood cell responses to exposure *in vitro*. Oil exposure caused a proliferation of white (T and B) blood cells, but exposure to the oil mixed with the dispersant led to a decrease. The authors conclude that 'The immunosuppression of [lymphocyte cells] at environmentally relevant concentrations of oil and dispersant suggests that marine mammals may be unable to mount an adequate defence against xenobiotic threats following exposure to oil and dispersant, leaving them more susceptible to disease'.

(SOURCE: White, N.A., Godard-Codding, C., Webb, S.J., Bossart, G.D. and Fair, P.A. 2017. Immunotoxic effects of in vitro exposure of dolphin lymphocytes to Louisiana sweet crude oil and Corexit™. *J. Appl. Toxicol.* 37: 676-682)

Climate change

COLLAPSE OF THE WEST ANTARCTIC ICE SHEET MIGHT BE INEVITABLE

As a result of climate change-related melting, warm seawater inundation underneath the ice sheet and shearing stresses, there are concerns that the Western Antarctic Ice Sheet will collapse. Satellite images indicate that there is currently a high level of seawater undermining the ice sheet, increasing this likelihood. At present, most moderate (and worst-case) climate change models predict the collapse of the ice sheet. This could lead to a 20 cm rise in sea level per decade by 2100, in addition to major associated Antarctic ecosystem changes.
(SOURCE: Hulbe. C. 2017. Is ice sheet collapse in West Antarctica unstoppable? *Science* 356: 910-911)

CLIMATE CHANGE-INDUCED REDUCTION IN KRILL BIOMASS PREDICTED

A study estimating the effects of ocean warming on krill biomass in the Scotia Sea (the northern part of the Antarctic Peninsula and adjacent areas to the northeast) noted considerable declines. In particular, krill biomass in the northern Scotia Sea could potentially decline by 40%. This would likely have impacts on Antarctic predators - for example, a decline in penguin abundance of 30% was predicted, and there was a high risk of these animals becoming depleted. The study also noted that if current krill fishing ceased immediately, the impacts on the krill population could be mitigated. Although in this model the impacts on mysticetes were slight in this particular region (there was an impact upon pinnipeds), this study nonetheless does project a decline in krill biomass and ecosystem change in at least part of the Southern Ocean because of climate change. This calls for an investigation of the impacts of krill biomass reduction in regions more critical for mysticetes.
(SOURCE: Klein, E.S., Hill, S.L., Hinke, J.T., Phillips, T., and Watters, G.M. 2018. Impacts of rising sea temperature on krill increase risks for predators in the Scotia Sea. *PLoS ONE* 13(1): e0191011, 1-21)

MAJOR DECREASE IN BIOLOGICAL PRODUCTIVITY PREDICTED DUE TO CLIMATE CHANGE

A new study predicted that fish populations may decline by as much as 20% globally and 60% in the North Atlantic due to a decline in ocean mixing, a result of climate change. The model assumes a 'business-as-usual' scenario, i.e., carbon emissions continue at the same rate as present. In particular, a combination of changing winds and warmer upper waters in the Southern Ocean will cause more nutrients to sink into the deeper layer of the ocean and become trapped there, substantially decreasing the productivity of Antarctic waters. The authors suggest that these changes could mean that fisheries will be reduced for a thousand years or more. This will have major impacts on the prey base of cetaceans.
(SOURCE: Moore, J.K., Fu, W., Primeau, F., Britten, G.L., Lindsay, K., Long, M., Doney, S.C., Mahowald, N., Hoffman, F., and Randerson, J.T. 2018. Sustained climate warming drives declining marine biological productivity. *Science* 359: 1139-1143)

RECORD LEVELS OF ATMOSPHERIC CARBON DIOXIDE LEVELS RECORDED

Atmospheric carbon dioxide levels exceeded 410 ppm in March 2018, the highest levels ever recorded in human history. Predicted levels in carbon dioxide will likely exceed 412 ppm in May 2018, which is 47% higher than pre-industrial carbon dioxide levels.
(SOURCE: Scripps Institution of Oceanography. 2018. The Keeling curve. *https://scripps.ucsd.edu/programs/keelingcurve*)

CLIMATE CHANGE PREDICTED TO INCREASE NUTRIENT POLLUTION

Nutrient pollution (which in turn would result in ecosystem degradation and oxygen-deprived 'dead zones') is predicted to increase due to climate change-induced precipitation (which could increase nutrients in river systems by approximately 19% in the USA alone). To prevent this, the amount of nitrogen input into the environment (e.g., via fertilisers) would have to be reduced by a third (thereby affecting food production). In particular, greater precipitation will increase nutrient pollution in the waters of India, China and southeast Asia.
(SOURCE: Sinha, E., Michalak, A.M., and Balaji, V. 2017. Eutrophication will increase during the 21st century as a result of precipitation changes. *Science* 357: 405-408)

Noise impacts

BEAKED WHALES RESPOND TO MID-FREQUENCY SONAR UP TO 100 KM AWAY

The behaviour of tagged Cuvier's beaked whales was observed in response to mid-frequency military sonar exposure during naval exercises off the coast of southern California. During sonar-exposed deep dives, subsequent shallow dives and surface intervals were longer than normal. The longer interval between deep dives suggested disrupted foraging. Longer deep (foraging) dive intervals were noted even when the sonar sources were approximately 100 km away.
(SOURCE: Falcone, E.A., Schorr, G.S., Watwood, S.L., DeRuiter, S.L., Zerbini, A.N., Andrews, R.D., Morrissey, R.P. and Moretti, D.J. 2017 Diving behaviour of Cuvier's beaked whales exposed to two types of military sonar. *Roy. Soc. Open Sci.* 4: 170629, 1-21)

HARBOUR PORPOISES RESPOND WHEN EXPOSED TO A SINGLE SEISMIC AIRGUN

Tagged harbour porpoises were exposed to a single seismic airgun for one minute (at a distance of 0.42-0.69 km and sound exposure levels of 135-147 dB re 1 μPa^2) and their reactions recorded. Two animals demonstrated shorter and shallower dives (normal behaviour resumed after 17 hours) and one animal rapidly swam away from the sound source (normal diving/swimming behaviour resumed after 35 hours), avoiding the area of the sound source for six days. This study demonstrates a significant behavioural reaction by harbour porpoises to just a single seismic airgun (seismic surveys typically have an array of many airguns).
(SOURCE: van Beest, F.M., Teilmann, J., Hermannsen, L., Galatius, A., Mikkelsen, L., Sveegaard, S., Balle, J.D., Dietz, R., and Nabe-Nielsen, J. 2018 Fine-scale movement responses of free-ranging harbour porpoises to capture, tagging and short-term noise pulses from a single airgun. *Roy. Soc. Open Sci.* 5: 170110, 1-14, *http://dx.doi.org/10.1098/rsos.170110*)

'RAMP-UP' MAY NOT BE AN EFFECTIVE MITIGATION MEASURE FOR PROTECTING CETACEANS FROM MILITARY SONAR

'Ramp-up' or 'soft start', a gradual increase in volume of an intense anthropogenic sound source, is a frequently touted mitigation measure for intense sound-producing activities, such as seismic surveys or military sonar exercises. The assumption is that the initial low sound level will warn cetaceans that there will be an acoustic event, so that they can move out of the area of impact. However, only a few studies have tested whether this indeed occurs. A study on the reaction of a tagged humpback whale to a ramp-up of mid-frequency sonar (1.3-2.0 kHz) found that there was some response to the ramped-up signal, but the whale was at times unresponsive to the low levels of sound during the soft start. It was suggested that naïve, non-feeding or more skittish animals (such as mothers with calves) might react more readily to the initial low levels of sound, making this method more effective for these classes of animals. Overall, however, 'ramp-up may not be effective' as a mitigation measure for intense sound activities.

(SOURCE: Wensveen, P.J., Kvadsheim, P.H., Lam, F.-P. A., von Benda-Beckmann, A.M., Sivle, L.D., Visser, F., Curé, C., Tyack, P.L., and Miller, P.J.O. 2017. Lack of behavioural responses of humpback whales (*Megaptera novaeangliae*) indicate limited effectiveness of sonar mitigation. *J. Exp. Biol.* 220: 4150-4161. doi:10.1242/jeb.161232)

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Appendix 1

GLOSSARY

Species glossary

Blue whale	*Balaenoptera musculus*
Chilean dolphin	*Cephalorhynchus eutropia*
Common bottlenose dolphin	*Tursiops truncatus*
Common bottlenose dolphin (Black Sea)	*Tursiops truncatus ponticus*
Cuvier's beaked whale	*Ziphius cavirostris*
Fin whale	*Balaenoptera physalus*
Franciscana	*Pontoporia blainvillei*
Gray whale	*Eschrichtius robustus*
Harbour porpoise	*Phocoena phocoena*
Harbour porpoise (Black Sea)	*Phocoena phocoena relicta*
Heaviside's dolphin	*Cephalorhynchus heavisidii*
Hector's dolphin	*Cephalorhynchus hectori*
Humpback whale	*Megaptera novaeangliae*
Killer whale	*Orcinus orca*
Long-finned pilot whale	*Globicephala melas*
North Atlantic right whale	*Eubalaena glacialis*
Risso's dolphin	*Grampus griseus*
Rough-toothed dolphin	*Steno bredanensis*
Short-beaked common dolphin	*Delphinus delphis*
Sperm whale	*Physeter macrocephalus*
Spinner dolphin	*Stenella longirostris*
Striped dolphin	*Stenella coeruleoalba*
Vaquita	*Phocoena sinus*
Leatherback sea turtle	*Dermochelys coriacea*
Loggerhead sea turtle	*Caretta caretta*
Annular seabream	*Diplodis annularis*
Black Sea (Azov Sea) anchovy	*Engraulis encrasicolus*
Black Sea shad	*Alosa maeotica*
Black Sea turbot	*Scophthalmus maeoticus*
Common Pandora	*Pagellus erythrinus*
European hake	*Merluccius merluccius*
European sturgeon	*Huso huso*
Indo-Pacific bluespotted cornetfish	*Fistularia commersonii*
Lesser spotted dogfish	*Scyliorhinus canicula*
Parrotfish	*Sparisoma cretense*
Red mullet	*Mullus barbatus*
Turbot	*Psetta maeotica*
Zebra seabream	*Diplodus cervinus*
Antarctic krill	*Euphausia superba*
Comb jelly (filter-feeding)	*Mnemiopsis leidyi*
Comb jelly (predatory)	*Beroe ovata*

Heavy metals
Al – Aluminium
As – Arsenic
Cd – Cadmium
Cr – Chromium
Cu – Copper
Fe – Iron
Hg – Mercury
Mn – Manganese
Mo – Molybdenum
Ni – Nickel
Pb – Lead
Se – Selenium
Sn –Tin
V – Vanadium
Zn – Zinc

Glossary of terms

Abraded: Abrasion is the mechanical scraping of a rock surface by friction between rocks and moving particles during their transport by wind, glacier, waves, gravity, running water or erosion. An abraded coastline is formed by this action.
ACCOBAMS: Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area.
AIS: Automatic Identification System (automatic vessel-tracking system).
Benthic: Referring to the ocean bottom.
Bifenthrin: An insecticide in the pyrethroid family. It is highly toxic to aquatic organisms.
Bioaccumulation: Increase in concentration of a pollutant within an organism compared to background levels in its diet.
Biomagnification: Increase in concentration of a contaminant from one link in a food chain to another.
Biomarker: A biological indicator, e.g., blood chemical levels, of health status or pollutant level.
Biomonitor: Species used to track toxic chemical compounds, elements or their metabolites in the environment. These compounds are typically measured in the biomonitor's blood and urine.
Biosphere Reserves: Areas comprising terrestrial, marine and coastal ecosystems that promote solutions reconciling the conservation of biodiversity with its sustainable use, managed by UNESCO.
Bivalve: An aquatic mollusc with a flattened body enclosed by a hinged shell, e.g., clam, oyster.
Bottom otter trawls: A form of bottom trawl net that 'ploughs' up to 15 cm into the sea floor, using flat boards ('otter boards') to keep the mouth of the net open.
Brucella: Various species of bacteria that cause the disease brucellosis.
CBD Aichi Target: The Conservation on Biological Diversity's biodiversity targets, as determined at the Tenth Conference of the Parties in 2010, in Nagoya, Japan (Aichi Prefecture) - see *https://www.cbd.int/sp/targets/*
Comb jelly: A free-swimming representative of the invertebrate phylum Ctenophora.
CYP1A1: Also referred to as cytochrome P450 1A, a gene whose expression serves as a biomarker for plastics exposure.
CYP2B: Also referred to as cytochrome P450 2B, a gene whose expression serves as a biomarker for plastics exposure.
Cyhalothrin: An insecticide in the pyrethroid family.
Cytokine: Any of a number of substances, such as interferon, interleukin, and growth factors, that are secreted by certain cells of the immune system and have an effect on other cells.
dB: Decibel – a logarithmic measure of sound pressure level.
DDD: The organochlorine pesticide dichlorodiphenyldichloroethane, a breakdown product of DDT.
DDE: The organochlorine dichlorodiphenyldichloroethylene, a breakdown product of DDT.
DDT: The organochlorine pesticide dichlorodiphenyltrichloroethane, which tends to accumulate in the ecosystem and in the blubber and certain internal organs of cetaceans.
Deltamethrin: An insecticide in the pyrethroid family.
Dinoflagellate: A large group of unicellular algae belonging to the phytoplankton.
Dioxin: Toxic organic chemicals that can accumulate in the blubber of cetaceans. These chemicals are carcinogenic and can cause reproductive defects.
DMV: Dolphin morbillivirus
Endemic: Native or restricted to a certain country, area or region.
Endocrine disruptor: The endocrine system is a system of ductless glands producing hormones that control and moderate metabolic processes in the body. Chemicals that mimic these hormones or otherwise interfere with their activity are known as endocrine disruptors.
Epizootic: A disease outbreak in non-human animals, equivalent to an epidemic in human populations.
Eutrophication: Input of nutrients into an aquatic system, typically associated with excessive plant growth and oxygen depletion.
FAO: Food and Agriculture Organization, an intergovernmental organization with 194 Member Nations.
Gyre: Large system of rotating ocean currents.
HBCD: Hexabromocyclododecane, a brominated flame retardant.
HCB: Hexachlorobenzene, an organochloride compound.
HCH: Hexachlorocyclohexane, a polyhalogenated compound.
Hexacopter: An unmanned helicopter (drone) with six rotors.
Hz: Hertz, a measure of sound frequency (pitch), in wave cycles per second (kHz=1,000 Hertz).
IMO: International Maritime Organisation.
IUCN: International Union for Conservation of Nature.
Lipid weight: A basis of measurement whereby concentrations of a substance are compared to the lipid (fat) content of a material.
LPO: Lipid peroxidation, the oxidative degradation of *lipids*. It is the process in which free radicals 'steal' electrons from the *lipids* in cell membranes, resulting in cell damage.

Lymphocyte cells: Small white blood cells that play a large role in defending the body against disease. Lymphocytes are responsible for immune responses. There are two main types of lymphocytes, B cells and T cells.
µg: Microgram
µPa: Micropascal, a unit of pressure.
MEHP: Monoethylhexylphthalate, a metabolite of the most common phthalate in the environment.
Meningoencephalitis: Inflammation of the membranes of the brain and the adjoining cerebral tissue.
Microplastics: Plastic particles 0.3-5 mm 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 cetacean mass mortality events have been associated with viruses from this family.
MPA: Marine Protected Area.
Natura 2000: A network of core breeding and resting sites for rare and threatened species, and some rare natural habitat types that are protected in their own right, under the European Commission.
Neritic: Relating to the shallow part of the sea near a coast and overlying the continental shelf.
nmol: Nanomole (equivalent to 10^{-9} moles).
OC: Organochlorine compound.
Organochlorine: Organic compound that contains 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.
Ortho and non-ortho PCBs: Chemical variants of PCBs, relating to their toxicity.
PBDE: Polybrominated diphenyl ether.
PCB: Polychlorinated biphenyl.
PCDDs: Polychlorinated dibenzo-p-dioxins.
PCDFs: Polychlorinated dibenzofurans
Permethrin: An insecticide (and skin medication for scabies and lice) in the pyrethroid family.
Phthalate: A class of substances added to plastics to increase their flexibility, transparency, durability, and longevity.
Polyaromatic hydrocarbons: Organic compounds containing only carbon and hydrogen, composed of multiple aromatic rings (organic rings in which the electrons are delocalized), found in coal and tar deposits.
Polyethylene: The most common form of plastic.
POPs: Persistent organic pollutants, organic compounds that are resistant to degradation and thus persist in the environment.
pmol: Picomole (equivalent to 10^{-12} moles).
ppm: Parts per million
Pyrethroid: An organic compound similar to the natural pyrethrins produced by flowers. Pyrethroids constitute the majority of commercial household insecticides.
Ramsar: The Convention on Wetlands (also known as the Ramsar Convention).
Relic species: A species more widespread or numerous in the past.
TBARS: Thiobarbituric acid reactive substances. The TBARS assay is one of the oldest laboratory measures of oxidative stress in serum or tissues. The assay measures the concentration of malondialdehyde produced due to degradation of unstable lipid peroxides.
TEQ: Toxic equivalent.
Tetramethrin: An insecticide in the pyrethroid family.
UN: United Nations.
UNESCO: United Nations Education, Scientific and Cultural Organization.
WHO: World Health Organisation.
Xenobiotic: Of or relating to substances, typically synthetic, that are foreign to the body or ecosystem.
Zooplankton: Free-floating marine animals.

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Table 1

Mean (± SD) values of plastics biomarkers and organochlorines in sampled fin whales. (Units: CYP1A1=pmol/mg protein; CYP2B=pmol/mg protein; LPO=nmol TBARS/mg protein; MEHP=ng/g f.w.; HCB=ng/g l.b.; DDT=ng/g l.b.; PCB=ng/g l.b.; OC=ng/g l.b.)

	N	CYP1A1	CYP2B	LPO	MEHP	HCB	ΣDDT	ΣPCBs	ΣOC
Mediterranean	30	71.9 ± 25.9	41.5 ± 22.9	11.0 ± 6.4	54.8 ± 27.7	29.9 ± 12.0	10480 ± 7480	13330 ± 8550	23830 ± 15060
Gulf of California	10	61.4 ± 28.4	52.9 ± 23.4	6.7 ± 3.8	40.0 ± 23.2	38.5 ± 33.6	3110 ± 2250	8754 ± 6540	11900 ± 6760

Table 2

Maximum insecticide pyrethroid values in the livers of striped dolphins from the Alborán Sea (µg/kg lipid weight).

Tetramethrin	Bifenthrin	Cyhalothrin	Permethrin	Deltamethrin	ΣPyrethroid
3400	36	18	1800	78	5200

Table 3

Maximum PCB levels (ΣPCB mg/kg lipid).

Bottlenose dolphin		Striped dolphin	Killer whale
Strait of Gibraltar	Western Mediterranean	Western Mediterranean	Strait of Gibraltar
879.3	601.39	2668.64	857.92

Table 4

Maximum trace element values recorded in cetaceans from the Mediterranean (mg/kg wet weight). Mercury levels in bottlenose dolphins were extremely high, although exceeded by levels in the Mediterranean and Adriatic Seas.

		n		Al	As	Cd	Cr	Cu	Fe	Hg	Mn	Mo	Ni	Pb	Se	Sn	V	Zn
Sperm whale	Italian coast, Adriatic Sea	3	Brain	2.73	0.73	0.06	0.02	3.35	56.57		0.56	0.02	0.04		9.14	0.23	0.02	16.5
			Muscle	7.05	5.54	0.03	0.05	0.56	198.2		1.02	0.01	0.03		3.10	0.01	0.06	48.5
			Liver	2.79	6.71	2.84	0.12	7.62	1554		1.16	0.30	0.17		94.0	0.60	0.03	53.5
			Kidney	11.36	1.75	2.60	0.14	1.97	235.6		1.48	0.03	0.06		6.40	0.18	0.05	13.5
Bottlenose dolphin	Portuguese coast, entrance of the Mediterranean	10	Muscle		2.72	0.31		3.46		3.14	4.65		1.93	0.22	2.03			24.2
			Liver		0.94	0.47		30.6		208	4.68		0.27	0.26	117			94.9
			Kidney		1.58	2.81		8.28		40.1	1.48		0.21	0.11	11.9			46.9

Table 5

Persistent organic pollutants detected in Mediterranean cetaceans. Pollutant levels were higher than comparative populations in the North Atlantic and southern hemisphere. The levels of organic contaminants frequently exceeded an estimated 17 mg/kg lipid weight toxicity threshold.

		Contaminant concentrations in mg/kg lipid weight									Contaminant concentrations in µg/kg lipid weight				
	n	ΣPCBs	ΣICES7	ΣPBDE	DDE	DDD	DDT	ΣDDT	ΣHCH	HBCD	ΣPCDD	ΣPCDF	Σnon-ortho PCB	Σortho PCB	WHO-TEQ/g lipid weight
Long-finned pilot whale	49	103	68	1.76	165	6.09	3.86	185	0.095	0.401	0.12	0.3	3.7	3627	472
Sperm whale	43	68.5	45.9	0.78	147	7.63	9.77	170	0.33	0.214	0.13	0/74	12.0	4735	1833
Fin whale	70	25.07	17.98	1.19	19.2	2.32	0.80	26.70		0.043					

Appendix 4

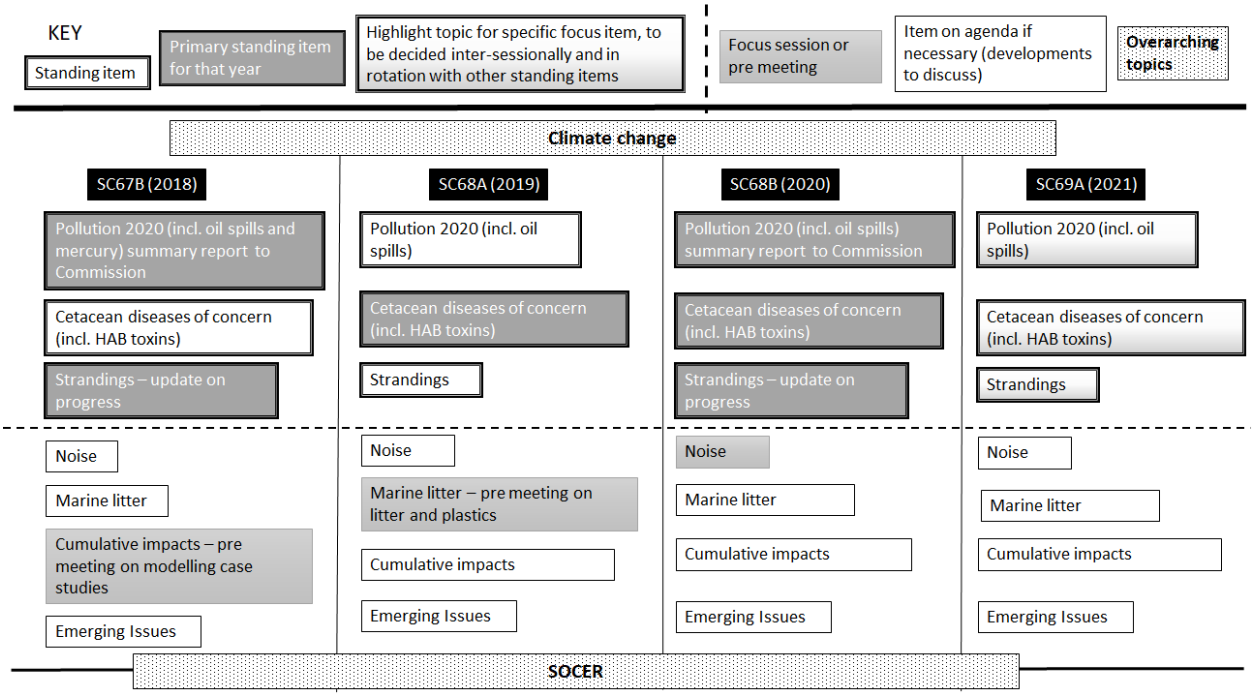

Fig.1. The Work Plan has three long-standing items: pollution, diseases of concern and strandings, three items that are dealt with on a cyclic basis: noise, marine litter and cumulative impacts and an emerging issue. Overarching these topics are SOCER and climate change.